1.0 INTRODUCTION

1.1 Purpose: This Evaluation Criteria establishes the requirements for fiber reinforced polymer (FRP) to be recognized in an evaluation report independently reviewed and issued by an evaluation service agency under the International Building Code® (IBC), the International Residential Code® (IRC), and the California Building Code® (CBC). Basis of recognition is IBC Section 104.11, IRC Section R104.11, and CBC Section 104.11. This Evaluation Criteria provides requirements for the evaluation of fiber reinforced polymers to supplement the requirements provided in the IBC, the IRC, the CBC, or other associated standards for these products.

1.2 Scope: The scope of this criteria is for using externally bonded fiber reinforced polymers to strengthen reinforced concrete diaphragms under seismic loading. This criteria is applicable to wet layup systems composed of high-strength fiber reinforced sheets, or fabrics, combined with a polymer resin. This criteria does not include prefabricated systems such as FRP plates, rods or near surface mounted systems. Other design requirements for strengthening concrete with FRP shall be in accordance with the IBC, ACI 318, and AC125.

The criteria provides guidelines to calculate, test and evaluate diaphragm shear, chord and collector enhancement using externally bonded FRP. This criteria shall apply to the following diaphragm systems:

2. Cast-in-place concrete composite topping slab diaphragms on precast floors or roofs at least two inches (51 mm) thick, provided the cast-in-place topping slab is reinforced and the surface of the previously hardened concrete on which the topping slab is placed is clean, free of laitance, and intentionally roughened.
3. Cast-in-place concrete non-composite topping slab diaphragms at least 2½ inches (63 mm) thick, provided the cast-in-place topping slab is detailed for continuous seismic load path to vertical lateral-force-resisting elements.

1.2.1 Limitations:

1. Measures shall be taken to mitigate thermal stresses that may develop from FRP reinforcement exposure to direct sunlight. For example, at roof diaphragm applications, shade or emissive coating may need to be provided to minimize potential for temperature elongation.
2. Detailed considerations for the shear transfer mechanism and related diaphragm shear strength are required for untopped precast concrete diaphragms. The failure mechanism in untopped concrete diaphragms is generally not expected to follow the same assumed truss action as that in conventional concrete, and special consideration is required at shear transfer between adjacent precast elements and into the supporting vertical elements. Some other considerations for untopped precast concrete diaphragms may include decreased composite action due to axial shortening from shrinkage cracking at interfaces between cast-in-place concrete and precast elements as well as axial elongation in the seismic lateral-force-resisting system beams. Although there are detailing considerations provided in Section 5.0 of this criteria, this criteria does not provide comprehensive design recommendations for untopped precast diaphragms.
3. Only the topped concrete portion of non-prismatic diaphragm systems shall be considered effective for seismic shear strength, such as in concrete over metal deck or waffle slab applications, unless specific component testing is provided to justify alternative values.

1.3 Definitions: For terms not defined in this section, applicable codes, or referenced standards shall have the ordinary accepted definition for the context for which they are intended.

1.3.1 Additives: Substances added to the polymer resin to aid in processing of the FRP material.

1.3.2 Carbon fiber reinforced polymer (CFRP): A composite material comprising a polymer matrix reinforced with a carbon fiber fabric.

1.3.3 Composite: Engineering materials (for example, concrete and FRP) made from two or more constituent materials that remain distinct but combine to form materials with properties not possessed by any of the constituent materials individually; the constituent materials are generally characterized as matrix and reinforcement.

1.3.4 Embedded Fiber Anchor: A post-installed FRP anchor placed into predrilled holes saturated with polymer resin, and anchored within concrete primarily by adhesive.

1.3.5 Evaluation Service Agency: Organization evaluating building products or finished construction for conformance to applicable codes and standards and publishing report or listing documents summarizing conclusions. The agency shall be accredited for the applicable product scope in accordance with ISO/IEC Standard 17065. The agency’s accreditation shall be issued by an accreditation body conforming to ISO/IEC 17011 and that is a signatory of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA) or another approved agency.

1.3.6 Fabric: A two-dimensional network of woven, nonwoven, knitted or stitched fibers, rovings or tows.

1.3.7 Fabric, Reinforcing: Continuous carbon, glass and aramid fibers are common reinforcements used in reinforcing fabrics. The reinforcing fabric provides strength and stiffness to the FRP system. The reinforcing fabric architecture may vary and may provide either uniaxial or multiaxial strength to the system. Most structural reinforcement applications will consist of a unidirectional laminate architecture.

1.3.8 Fiber-reinforced polymer (FRP): A general term for a composite material comprising a polymer matrix reinforced with fibers in the form of a fabric. Reference is made to Composite.

1.3.9 Filler: A finely divided, relatively inert material, such as silica fume added to resin to improve workability, reduce cost or reduce density.

1.3.10 Fiber Splice Anchor: An FRP anchor used for developing tension forces either between separate FRP sheets or between an FRP sheet and concrete, usually used to transition through an existing intersecting concrete component.

1.3.11 Force-Controlled Action: An action that is not allowed to exceed the nominal strength of the element being evaluated. Force-controlled actions and their acceptance criteria are prescribed in Chapter 7.5 of ASCE/SEI 41 when this criteria is used in the conjunction with ASCE/SEI 41. Force-controlled actions are classified as seismic load effects including Overstrength Factor when this criteria is used in conjunction with ASCE/SEI 7.

1.3.12 Glass fiber reinforced polymer (GFRP): A composite material comprising a polymer matrix reinforced with glass fiber fabric.

1.3.13 Laminate: A single or multiple plies of reinforced fabric and resin molded together.

1.3.14 Lay-up, dry: The process of saturation of reinforcing fabric with resin after the fabric has already been placed onto the host structure.
1.3.15 **Lay-up, wet**: The process of on-site saturation of the reinforcement fabric with resin followed by application of the saturated fabric to the host structure to cure in-place.

1.3.16 **Polymer**: The product of polymerization; more commonly a rubber or resin consisting of large molecules formed by polymerization.

1.3.17 **Resin**: Generally, a thermosetting polymer used as the matrix and binder in FRP composites.

1.3.18 **Resin, epoxy**: A class of organic chemical bonding systems used in the preparation of special coatings or adhesives for concrete or as binders in epoxy-resin mortars, concretes and FRP composites.

1.3.19 **Tow**: An untwisted bundle of continuous filaments.

1.3.20 **Unit Fiber Weight**: The expected dry carbon or glass fiber weight per surface area of laminate.

**2.0 REFERENCED STANDARDS AND DOCUMENTS**

Standards shall be applied consistent with the specific edition of the code(s) for which the Evaluation Report is prepared unless otherwise approved by UES.

2.1 **American Concrete Institute**
- American Concrete Institute, ACI 318-14 Building Code Requirements for Structural Concrete and Commentary.
- American Concrete Institute, ACI 355.4-11 Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary.
- American Concrete Institute, ACI 369.1-17 Standard Requirements for Seismic Evaluation and Retrofit of Existing Concrete Buildings (369.1) and Commentary.
- American Concrete Institute, ACI 440.2R-17, Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures.

2.2 **American Society of Civil Engineers**
- ASCE/SEI 41, Seismic Evaluation and Retrofit of Existing Buildings.

2.3 **ASTM International**
- ASTM E575, Standard Practice for Reporting Data from Structural Tests of Building Constructions, Elements, Connections, and Assemblies.

2.4 **Center for Transportation Research**
2.5 **International Code Council**

2.6 **International Organization for Standardization**
- ISO/IEC 17011:2004, Conformity Assessment, General Requirements for Accreditation Bodies Accrediting Conformity Assessment Bodies
- ISO/IEC 17020:2012 Conformity Assessment, Requirements for the Operation of Various Types of Bodies Performing Inspection

2.7 NIST/NEHRP GCR 10-917-4, Seismic Design of Cast-in-Place Concrete Diaphragms, Chords, and Collectors.

3.0 **BASIC INFORMATION**

3.1 **Description:** The following information and data shall be submitted for review and evaluation for recognition of concrete diaphragm strengthening using FRP materials in an evaluation report:

3.1.1 **Product Description:** The advanced composite material is composed of a reinforcing fabric combined with a polymer resin to make up the FRP material.

3.1.2 **Installation Instructions:** Installations shall be in accordance with the manufacturer’s applicator training program.

3.1.3 **Packaging and Identification:** Packaging labels for the system shall include the manufacturer or a registered trademark, model or name of the product, size and applicable certification body logo and evaluation report number.

4.0 **TESTING AND PERFORMANCE REQUIREMENTS**

4.1 **General:** The intent of testing is to verify the design equations and assumptions used in the engineering analysis. All or part of the tests described in this section, and any additional test identified for special features of the product or system, shall be specified. The test plan shall be a complete document.

Overall, qualification testing shall provide data on material properties, force and deformation limit states and failure modes, to substantiate the design strength equations and performance capability prescribed in this criteria. The specimens shall be constructed under conditions specified by the manufacturer, including curing. Tests shall replicate the anticipated construction details, loading conditions, support and boundary conditions expected in the building. Extremes of dimensional, reinforcing, and compressive strength parameters shall be considered. Specimens shall be loaded in both directions until the strengthening system is damaged, its capacity is reached, or the desired limit states are achieved.

At least two specimens for each loading case shall be tested except as specifically described. At least one specimen shall be tested for each critical combination of structural design strengths and deformations for each characteristic configuration of FRP system and concrete members. The specimen geometry, reinforcement, and details used to connect the tested configuration to the structure shall be consistent with those systems to be described in the evaluation report.
4.1.1 Diaphragm Shear Tests (In-Plane Shear):

4.1.1.1 Configuration: Specimens shall be configured to induce in-plane shear limit states or failure modes.

4.1.1.2 Procedure: Specimens may be gravity loaded (out-of-plane) to consider gravity load effects. The lateral load procedure shall consist of pseudostatic loading in both directions to find cracking and yielding load and deformation. The specimens shall be loaded in both directions until the strengthening system is damaged, its capacity is reached, or desired limit states are achieved.

It shall be permitted to use experimental data from FRP reinforcement shear-strengthening of reinforced concrete structural walls to justify the shear strengthening of diaphragms, provided all other requirements in Section 4.0 of this criteria are observed.

4.1.2 Collector Tests (Tension):

4.1.2.1 Configuration: Specimens shall be configured to induce tension limit states or failure modes in the strengthening element.

4.1.2.2 Procedure: Specimens may be gravity loaded to consider gravity load effects. The loading procedure shall consist of pseudostatic loading to determine cracking and yielding load and deformation. The specimens shall be loaded pseudostatically either in pure tension or in flexure such that the strengthening system is damaged, its capacity is reached, or desired limit states are achieved.

It shall be permitted to use experimental data from FRP reinforcement tension strengthening of beams to justify tension-strengthening of collector elements, provided all other criteria in Section 4.0 of this criteria have been observed and beam testing has been approved for seismic applications.

4.1.3 Transfer Across Cold Joint Tests:

4.1.3.1 Configuration: Specimens shall be configured to induce joint-related limit states or failure modes.

4.1.3.2 Procedure: The lateral load procedure shall consist of pseudostatic loading in both directions to find cracking and yielding load and deformation. The specimens shall be loaded in both directions until significant strength is no longer maintained. The limit states shall be determined based on material properties.

4.1.4 Testing Laboratories: Laboratories shall be accredited for the applicable testing procedures in accordance with ISO/IEC Standard 17025 or equivalent for the testing conducted and reported. The laboratory’s accreditation shall be issued by an accreditation body conforming to ISO/IEC 17011 and that is a signatory of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA) or another approved agency. Testing at a non-accredited laboratory may be permitted by the certification body, provided the testing is conducted under the supervision of an accredited laboratory and the supervising laboratory issues the test report.

4.1.5 Testing Reports: Test reports shall be submitted to the evaluation service agency for approval. Test reports shall include all of the applicable information required in the applicable test standard and ASTM E575. Test reports shall document the location, the time and date of the test, the characteristics of the tested specimen, the laboratory facilities, the test configuration, the applied loading and deformation under load, and the occurrence of any damage sustained by the specimen, together with the loading and deformation at which such damage occurred. The resulting test failure mode shall also be specified in the test report.

Previous reports or approvals from other approved evaluation service agencies, shall be considered acceptable for satisfying the requirements of Section 4.0 of this criteria provided the approval includes seismic applications.
4.1.6 **Product Sampling:** The test specimens of FRP laminates shall be sampled or verified by an accredited inspection agency or testing laboratory. The sampled product shall be representative of the production ongoing after the sampling has taken place. The product specifications shall be within the tolerance limits reported in the quality documentation and the relevant standards.

4.2 **Substrate Adhesion Testing:** Direct tension adhesion testing of cored samples shall be conducted using the method described by ASTM D4541 or ASTM D7522. A minimum of three tests shall be performed for each day of production or for each 500 ft² (46.45 m²) of FRP application, whichever is less. Pull-off tests shall be performed on a representative adjacent area to the area being strengthened. Field tests shall be performed on each type of substrate or for each surface preparation technique used.

The prepared surface with one-layer of the bonded FRP system shall be allowed to cure a minimum of 48 hours before execution of the direct tension pull-off test. The locations of the pull-off tests shall be representative and on flat surfaces. If no adjacent areas exist, the tests shall be conducted on areas of the FRP system subjected to relatively low stress during service. The minimum acceptable value for any single tension test is 175 psi (1207 kPa). The average of the three tests at each location shall not be less than 200 psi (1379 kPa). Additional tests may be performed to qualify the work. The tension adhesion tests shall exhibit failure of the substrate indicated by the presence of concrete on the underside of the test puck following the test.

4.3 **FRP Laminate Testing:** Composite material properties required for design, including tensile modulus, ultimate tensile strength, elongation, etc., shall be tested in accordance with ASTM D7565 or ASTM D3039.

4.4 **Anchorage:** The design strengths of FRP anchorage shall be substantiated through representative testing that includes the specific anchorage system, installation procedure, surface preparation, and expected environmental conditions.

5.0 **DESIGN**

5.1 **Limitations:** The tension design action in FRP reinforcement shall be designed as a non-ductile, force-controlled action. The criteria in this report is established for FRP composites transferring forces through a bond-line and through FRP anchorage, however FRP force transfer to alternative components, for example conventional post-installed expansion anchors, shall be permitted when the assembly is substantiated by experimental testing. Experimental testing and related reports shall meet the requirements of Section 4.1 of this criteria.

Clear spacing between FRP strips shall not exceed 18 inches (457.2 mm) maximum.

5.2 **Shear Strengthening of Concrete Diaphragms:** The shear strength of diaphragm sections of concrete may be enhanced by FRP laminates with fiber oriented parallel to the applied shear force. For external FRP reinforcement in the form of discrete strips with defined widths, the design shear strength of an FRP-strengthened concrete diaphragm may be determined using Equation (1). The strengthened element shall be considered a non-ductile, force-controlled action unless a ductile, deformation-controlled behavior is justified by experimental data. An additional reduction factor, \( \psi \), shall be applied to the contribution of the FRP system, \( V_f \), as follows: \( 0.85 \) for one or two-sided strengthening.

\[
\phi V_f = \phi (V_c + V_s + \psi V_f)
\]  

(1)

The strength reduction factor, \( \phi \), shall be taken from the ACI 318 for shear controlled concrete elements or the retrofit standard used in the retrofit project (for example, ASCE/SEI 41) used for the retrofit.

The shear contribution of the FRP, \( V_f \), shall be calculated from Equation (2):

For a two-sided retrofit:
\[
V_f = A_{fs}f_{te}
\]  

(2a)

For a one-sided retrofit:
\[
V_f = 0.75A_{fs}f_{te}
\]  

(2b)
The reinforcement area, $A_{v}$, shall be computed by Equation (3):

$$A_{v} = \begin{cases} 2nt_{f}d_{f} & \text{for a two-sided strengthening scheme} \\ nt_{f}d_{f} & \text{for a one-sided strengthening scheme} \end{cases} \tag{3a}$$

The effective design stress, $f_{u}$, shall be computed by Equation (4):

$$f_{u} = \varepsilon_{f}E_{f} \tag{4}$$

Where $d_{f}$ is the effective length of the diaphragm considered for seismic shear forces.

The effective design strain, $\varepsilon_{fe}$, is the maximum strain that shall be achieved in the FRP system at the nominal strength and is governed by the failure mode of the FRP system and of the strengthened reinforced concrete member and shall be computed by Equation (5):

$$\varepsilon_{fe} = \frac{k_{v}f_{u}}{f_{u}} \leq 0.004 \tag{5a}$$

for fully developed or fully anchored FRP reinforcement in accordance with Section 5.4 of this criteria where existing diaphragm slab reinforcement is fully developed along entire seismic load path in accordance with ACI 318 using $l_{d}$ as the minimum development length.

or

$$\varepsilon_{fe} = \frac{k_{v}f_{u}}{f_{u}} \leq 0.0015 \tag{5b}$$

for one or two-sided applications, not anchored to develop the capacity of the FRP.

The effective stress, $f_{e}$, of the FRP shall be computed using Equation (6):

$$f_{e} = \varepsilon_{fe}E_{f} \leq 0.75f_{e}E_{f} \tag{6}$$

The bond-reduction coefficient shall be computed from Equations (7) through (10):

$$k_{v} = \frac{k_{1}k_{2}}{468f_{u}} \leq 0.75 \tag{7}$$

$$L_{e} = \frac{2500}{(\varepsilon_{f}E_{f})^{2}} \tag{8}$$

$$k_{1} = \frac{(f_{e}E_{f})^{2}}{4000} \tag{9}$$

$$k_{2} = \frac{d_{f}^{-1}L_{e}}{d_{f}} \tag{10}$$

Alternatively, the shear contribution of the FRP reinforcement, $V_{f}$, shall be permitted to be calculated using Equation (11), where diaphragms have fiber bonded to one side only at an angle $\geq 75^\circ$ to the member axis:

$$V_{f} = 0.75A_{v}f_{e} \sin^{2}\theta \tag{11}$$

where

Commented [ws6]: What does bond have to do with anchored FRP systems? Bond will be lost and the anchors will carry the load. The strain limit is too low.

Commented [ws7]: Error is the equation

Commented [ws8]: Is this a stiffness based approach?
\[ f_j = 0.0015E_j \leq f_{fe} \quad (12) \]

The total shear strength provided by FRP and steel reinforcement shall be limited as set forth in Equation (13):

\[ V_i + V_f \leq 0.8\sqrt{f_{cu}b_wd} \quad (13) \]

5.3 Collector and Chord Design for Diaphragms: FRP reinforcement is permitted for strengthening of collector elements in tension.

5.3.1 Where FRP strips are applied to the bottom of an existing concrete beam, the available width of the concrete beam shall be taken as the concrete beam width minus a minimum of 1 inch (25.4 mm) on each beam edge. Where the FRP strip is applied to the side of an existing beam, the effective fiber width shall be taken as the clear depth under the bottom of existing slab minus 1 inch (25.4 mm) toward the bottom of the existing beam.

5.3.2 FRP laminates may be bonded directly to an existing collector element. To prevent an intermediate crack-induced debonding failure mode away from the section where externally bonded FRP terminates, the effective strain in FRP reinforcement shall be limited to the strain defined in Equation (14):

\[ \varepsilon_{fe} = 0.083 \frac{f_{cu}}{E_{fr}} \leq 0.9\varepsilon_{fu} \leq 0.006 \quad (14) \]

for fully developed or fully anchored FRP reinforcement in accordance with Section 5.3 of this criteria, where existing collector reinforcement is fully developed along entire seismic load path in accordance with ACI 318 using \( l_d \) as the minimum development length.

\( \varepsilon_{fe} \) shall not exceed the expected yield strain of the existing reinforcement where FRP reinforcement is either not fully developed or fully anchored in accordance with Section 5.3 of this criteria.

\( \varepsilon_{fe} \) shall not at any point exceed the expected yield strain of the existing reinforcement in a region where inadequate lap splices occur along the seismic load path unless higher strains are justified by experimental data for this condition.

5.3.3 Collector forces shall be fully developed into the vertical elements of the lateral force-resisting system considering strain compatibility and transfer of all tensile forces from the FRP reinforcement.

5.3.4 FRP reinforcement is effective in strengthening tension design actions only and shall not be relied upon for compression strength. Collector elements shall be evaluated for compression in accordance with ACI 318. It shall be permitted to assume an effective concrete element width equal to the FRP strip width plus the depth of the diaphragm thickness on each side of the collector element where occurs.

5.4 Anchorage of FRP Laminates: FRP anchorages may be used to transfer tensile forces from FRP laminates to the strengthened wall or diaphragm element. Anchors other than Embedded Fiber Anchors and Fiber Splice Anchors bonded through FRP adhesives, for example conventional post-installed anchors bonded to FRP through other means, shall be acceptable only where specific applications are substantiated by testing.

5.4.1 Development into Existing Concrete: Anchors shall be designed to develop the full tensile capacity of the anchored FRP sheets, or alternatively FRP usable strains shall be limited in accordance with Sections 5.2 and 5.3.2 of this criteria. The following additional conditions shall be observed unless testing is provided in accordance with Section 4.4 of this criteria to justify the design values of each unique condition:

1. Embedded Fiber Anchor embedment shall be a minimum of 2 inches (51 mm) into the core of the concrete component, defined from the inside face of the outer reinforcement layer, and a minimum of 10 times the anchor diameter.
2. For the bond of the fiber anchor into concrete, the Embedded Fiber Anchors shall be embedded into...
3. For the bond of the fiber anchor to the primary FRP strip, the maximum fan angle shall not exceed 60 degrees from the primary orientation of the FRP fibers (Figure 5.4.2 of this criteria illustrates this condition).

4. The Unit Fiber Weight of Embedded Fiber Anchors shall at least equal that of the anchored fabric.

5. The tributary FRP strip width of an embedded fiber shall not exceed 12 inches (305 mm).

6. The fiber anchor shears shall fully cover the primary FRP reinforcement sheets from 0 to ½ inch (0 to 12.7 mm) on each side (Figure 5.4.1 of this criteria illustrates this condition).

7. For a surface level offset, the horizontal dimension shall not be less than four times the vertical offset (Figure 5.4.3 of this criteria provides an example of Fiber Splice Anchor).

8. In order to reduce stress concentrations at the edge of an anchor hole, the anchor hole shall be rounded with a minimum chamfer radius of 0.7 times the fiber anchor diameter, but not less than ½ inch (12.7 mm).

9. The diameter of the anchor hole shall be oversized relative to the diameter of the fiber anchor based on the effective anchor laminate area from the above requirements as follows:
   - ¼ inch (3.2 mm) for diameters less than ½ inch (12.7 mm)
   - ¼ inch (6.4 mm) for diameters of ½ inch (12.7 mm) or greater

   10. Testing of embedded fiber anchors shall be provided in accordance with Section 4.4 of this criteria.

5.4.3.2 Fiber Splice Anchor Requirements: Fiber splice anchors shall be designed to develop the full tensile capacity of the anchored FRP sheets and comply with the following additional criteria:

1. The Unit Fiber Weight of Fiber Splice Anchors shall be at least equal to that of the anchored fabric.

2. The tributary FRP strip width of an embedded fiber shall not exceed 12 inches (305 mm).

3. For the bond of the fiber anchor to the primary FRP strip, the maximum fan angle shall not exceed 60 degrees from the primary orientation of the FRP fibers (Figure 5.3.2 of this criteria). The orientation of the anchor fibers shall be used to determine the effective tension component in the orientation of the primary FRP reinforcement fibers.

4. For a surface level offset, the horizontal dimension shall not be less than four times the vertical offset (Figure 5.4.3 of this criteria).

5. Fiber splice anchors terminating onto the surface of concrete shall have a minimum development length of \( l_d \) in accordance with ACI 318 of the concrete reinforcement in the fiber orientation (Figure 5.4.4 of this criteria).

6. In order to reduce stress concentrations at the edge of an anchor hole, the anchor hole shall be rounded with a minimum chamfer radius of 0.7 times the fiber anchor diameter, but not less than ¼ inch (3.2 mm) or greater.

5.5 Special Detailing and Load Path Considerations: A complete seismic load path shall be provided from the strengthened elements to the vertical elements in the seismic force-resisting system.

1. The design professional shall submit design calculations and related details to the building official for approval based on principles of mechanics for diaphragm openings, holes and penetrations.

2. Use of FRP reinforcement for force transfer across cold joints or between precast panels shall have fibers resisting tension in each direction of seismic loading. Generally, multiple layers of fibers may be provided at 45-degree orientations relative to cold joints. Shear strengthening of untopped precast diaphragms shall be designed such that flexibility between precast panels is negligible relative to global diaphragm shear flexibility.

6.0 QUALITY CONTROL

6.1 Manufacture:

6.1.1 Quality documentation complying with the UES Minimum Requirements for Listee’s Quality Assurance System (UES-010) shall be submitted. A complete description shall be provided of the quality management system used in the field to manufacture the FRP constituent materials.

6.1.2 A complete description shall be provided of the quality management system used in the field to inspect the installation of the FRP laminates, anchorage and related sampling of the materials for testing.
6.1.3 Inspections of manufacturing facilities are required for this product, by agencies accredited for the required tasks in accordance with ISO/IEC 17020, or ISO/IEC 17065.

6.2 **Installation**: Individual applicators shall be trained and deemed competent to prepare concrete substrates and apply the FRP System by the FRP manufacturer or accepted third-party trainer. Documentation demonstrating competency shall be made available.

6.3 **Inspection**: Special inspection and testing are required for materials preparation, substrate preparation, and application of the FRP system. Special inspection shall comply with IBC Sections 1704 and 1705. Special inspectors shall possess qualifications for inspection of FRP systems in accordance with IBC Section 1704.2.1. Duties of the special inspector shall be prepared in accordance with AC178 and ACI 440.2, for inclusion in the evaluation report. Testing shall comply with Section 4.2 of this criteria, AC178 and ACI 440.2.

7.0 **EVALUATION REPORT RECOGNITION**

Evaluation reports shall include the following information:

7.1 The manufacturer’s name, product name and the basic information set forth in Section 3.0 of this criteria for all assembly components.

7.2 Design provisions, including limitations, based on Section 5.0 of this criteria.

7.3 The following statement: Complete construction documents, including plans and calculations verifying compliance with this report, shall be submitted to the code official for approval. The construction documents shall be prepared and sealed by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

7.4 Evaluation reports shall indicate special inspection requirements as set forth in Section 6.3 of this criteria.

![Figure 5.4.1 – Plan View of Embedded Fiber Anchor](image)

Commented [ws14]: ½" overlap with concrete shown but discussion was removed. What is the distance of the anchor hole from the wall?
Figure 5.4.2 – Elevation of Embedded Fiber Anchor

Figure 5.4.3 – Elevation of Fiber Splice Anchor Through Existing Wall

Commented [ws15]: Label the inclined build up that is at a 4:1 slope
Figure 5.4.4 – Elevation of Fiber Splice Anchor Terminating onto Concrete

Commented [ws16]: I don’t really understand where the anchor needs development on the top side of the diaphragm where FRP is not being used.