

1 **Strengthening of Concrete Structures with Externally Bonded Fiber-**
2 **Reinforced Polymer (FRP) Materials using the Wet Layup Method—**
3 **Specification**

4 An ACI Standard
5 Reported by Committee 440

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41 This Specification covers requirements for strengthening concrete structures using externally
42 bonded fiber-reinforced polymer (FRP) materials using the wet layup method. This Specification
43 includes requirements for surface preparation of the substrate, including applying primers and
44 putties, saturating the dry fabric, installing the fabric on the substrate, identifying and repairing
45 defects, and field testing for quality control of the installation and materials.

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1 Keywords: bond-critical application; contact critical application; FRP system; laminate;
2 strengthening; wet layup.

3

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3 **PART 1—GENERAL**

4 **1.1—Scope**

5 **1.1.1** This Specification covers requirements for strengthening concrete structures using
6 externally bonded fiber-reinforced polymer (FRP) materials using the wet layup method.

7 **1.1.2** This Specification is incorporated by Contract Documents and provides requirements
8 for the Contractor.

9 **1.1.3** This Specification governs for construction within its scope, except project-specific
10 Contract Documents govern if there is a conflict.

11 **1.1.4** This Specification governs if there is a conflict with referenced material or testing
12 standards.

13 **1.1.5** Contractor is permitted to submit written alternatives to any provision in this
14 Specification for consideration.

15 **1.1.6** Do not use this Specification in conjunction with ACI 563 unless Contract Documents
16 state that this Specification governs for Work covered by 1.1.1.

17 **1.1.7** Ignore provisions of this Specification that are not applicable to the Work.

18 **1.1.8** Values in this Specification are stated in inch-pound units. A companion
19 Specification in SI units is available.

20 **1.1.9** The Notes to Specifier are not part of this Specification.

21

22 **1.2—Interpretation**

23 **1.2.1** Unless otherwise explicitly stated, this Specification shall be interpreted using the
24 following principles:

25 **1.2.1.1** Interpret this Specification consistent with the plain meaning of the words
26 and terms used.

27 **1.2.1.2** Definitions provided in this Specification govern over the definitions of the
28 same or similar words or terms found elsewhere.

29 **1.2.1.3** Whenever possible, interpret this Specification so that its provisions are in
30 harmony and do not conflict.

1 **1.2.1.4** Headings are part of this Specification and are intended to identify the scope
2 of the provisions or sections that follow. If there is a difference in meaning or implication between
3 the text of a provision and a heading, the meaning of the text governs.

4 **1.2.1.5** Footnotes are part of this Specification. The meaning of the provision text
5 governs in the event of a difference in meaning or implication between the provision text and a
6 footnote to that provision.

7 **1.2.1.6** Where a provision of this Specification involves two or more items,
8 conditions, requirements, or events connected by the conjunctions “and” or “or,” interpret the
9 conjunctions as follows:

10
11 “and” indicates that all of the connected items, conditions, requirements or events
12 apply

13 “or” indicates that the connected items, conditions, requirements, or events apply
14 singularly

15 **1.2.1.7** The use of the verbs “may” or “will” indicates that the Specification
16 provision is for information to the Contractor.

17 **1.2.1.8** The phrase “as indicated in Contract Documents” means the specifier
18 included the provision requirements in Contract Documents.

19 **1.2.1.9** The phrase “unless otherwise specified” means the specifier may have
20 included an alternative to the default requirement in Contract Documents.

21 **1.2.1.10** Unless otherwise stated, the inch-pound system of units is applicable to
22 combined standards referenced in this Specification.

23 24 **1.3—Definitions**

25 The following definitions shall govern in this Specification.

26 **accepted**—determined by Architect/Engineer to be in compliance with Contract Documents.

27 **Architect/Engineer**—the architect, engineer, architectural firm, or engineering firm developing
28 Contract Documents, or administering the Work under Contract Documents, or both.

29 **bond-critical application**—strengthening or repair application that relies on load transfer from
30 the substrate to the FRP system through bond of the FRP system to the substrate.

1 **contact-critical application**—strengthening or repair application that relies on load transfer
2 from the substrate to the FRP system through contact or bearing at the interface.

3 **Contract Documents**—set of documents that form the basis of a contractual relationship
4 between Owner and Contractor or design-builder. These documents are defined by the contractual
5 agreement, and can contain contract forms, contract conditions, specifications, drawings, addenda,
6 and contract changes.

7 **Contractor**—the person, firm, or entity under contract for construction of the Work.

8 **drawings**—graphic presentations that detail requirements for Work and may include written
9 notes.

10 **fiber orientation**—the direction of the principle fibers in a fabric reinforcement.

11 **FRP manufacturer**—company that makes components of FRP System.

12 **FRP system**—the fibers and resins used to create the composite laminate and resins used to bond
13 it to the concrete substrate.

14 **inspection agency**—the person, firm, or entity under contract for providing inspection services.

15 **lamina**—single layer of fiber reinforcement

16 **laminated**—multiple plies or lamina molded together

17 **specialty engineer**—an individual retained by the Contractor who is licensed to practice
18 engineering as defined by the statutory requirements of the professional licensing laws of the state
19 or jurisdiction in which the project is to be constructed.

20 **Owner**—the corporation, association, partnership, individual, public body, or authority for
21 whom the Work is constructed.

22 **putty**—thickened polymer-based resin used to prepare concrete substrate.

23 **Specification**—the written document that details requirements for Work.

24 **submit**—provide to Architect/Engineer for review.

25 **submittal**—document or material provided to Architect/Engineer for review and acceptance.

26 **testing agency**—the person, firm, or entity under contract for providing testing services.

27 **witness panel**—small mockup of laminate manufactured under conditions representative of field
28 application, to confirm that prescribed procedures and materials will yield specified mechanical
29 and physical properties.

30 **Work**—the entire construction or separately identifiable parts required to be furnished under
31 Contract Documents.

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1.4—Referenced standards

Standards of ACI and ASTM International cited in this Specification are listed by name and designation, including year.

1.4.1 American Concrete Institute

ACI 440.8-13—Specification for Carbon and Glass Fiber-Reinforced Polymer (FRP) Materials Made by Wet Layup for External Strengthening of Concrete and Masonry Structures

1.4.2 ASTM International

ASTM D4259-18—Standard Practice for Preparation of Concrete by Abrasion Prior to Coating Application

ASTM D7522/D7522M-15—Standard Test Method for Pull-Off Strength for FRP Laminate Systems Bonded to Concrete Substrate

ASTM D7565/D7565M-10(2017)—Standard Test Method for Determining Tensile Properties of Fiber Reinforced Polymer Matrix Composites Used for Strengthening of Civil Structures

1.5—Contractor requirements

1.5.1 Installation of the FRP System shall be directly overseen on-site by at least one individual trained by the FRP manufacturer.

1.6—Submittals

Submit the following before start of Work:

1.6.1 FRP Manufacturer’s Installation Quality Control Manual.

1.6.2 Documentation from FRP manufacturer that Contractor meets requirements of 1.5.

1.6.3 Product data sheets for FRP system constituent materials.

1.6.4 If specified, items in 2.2.1.1.

1.7—Storage and handling

1.7.1 Store and handle materials in a manner that complies with FRP manufacturer’s recommendations.

1.7.2 Store materials at temperatures recommended by FRP manufacturer.

1 **1.7.3** Store resins and hardeners away from direct sunlight, flame sources, and other
2 hazards as recommended by FRP manufacturer.

3
4 **1.8—Quality assurance**

5 **1.8.1** *General*—FRP system materials and installation may be tested and inspected by
6 Owner or Owner’s representative as Work progresses.

7 **1.8.2** Do not perform Work until testing agency has been retained by Owner or
8 Architect/Engineer.

9 **1.8.3** *Responsibilities of Contractor*—Unless otherwise specified, Contractor assumes
10 duties and responsibilities given in 1.8.3.1 and 1.8.3.2:

11 **1.8.3.1** Contractor shall coordinate with Owner’s inspection agency for agency’s
12 assignment of personnel.

13 **1.8.3.2** Allow access to the project site and assist Owner’s testing agency in
14 obtaining and handling samples at the project site.

15 **1.8.4** *Responsibilities of Owner’s inspection agency*—Unless otherwise specified, Owner’s
16 inspection agency will assume duties and responsibilities given in 1.8.4.1 and 1.8.4.2.

17 **1.8.4.1** Inspect Work and test materials as required by this Specification and other
18 documents if specified in contract documents. Inspection Agency may engage a separate testing
19 agency for material testing.

20 **1.8.4.2** Report test and inspection results of Work to Architect/Engineer, Owner,
21 and Contractor within 7 days of tests and inspections being performed.

22 **1.8.5** Owner’s inspection agency and its representatives will not be authorized to revoke,
23 alter, relax, enlarge, or release requirements of Contract Documents, nor to accept or reject any
24 portion of Work.

25
26 **PART 2—PRODUCTS**

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28 **2.1—Materials**

29 **2.1.1** FRP system materials shall conform to ACI 440.8.

30 **2.2—FRP System Design**

1 **2.2.1** FRP system design shall be in accordance with Method 1 or Method 2 as indicated
2 in Contract Documents.

3 **2.2.1.1** *Method 1*

4 **2.2.1.1(a)** Design FRP system for performance shown on drawings.

5 **2.2.1.1(b)** Submit design calculations prepared and sealed by the specialty
6 engineer responsible for designing FRP system demonstrating the proposed FRP
7 system layout meets the performance requirements on drawings.

8 **2.2.1.1(c)** Submit working drawings prepared and sealed by the specialty
9 engineer responsible for designing FRP system detailing extent, number of layers,
10 orientation and all other required information for installation of a specific FRP
11 system.

12 **2.2.1.2** *Method 2*

13 **2.2.1.2** FRP system design is shown on Drawings.

14
15 **PART 3—EXECUTION**

16
17 **3.1—Surface preparation**

18 **3.1.1** Verify dimensions of members to be strengthened are the same as indicated in
19 Contract Documents. Notify Architect/Engineer of any inconsistencies before proceeding with
20 Work.

21 **3.1.2** Inspect substrate for concrete deterioration.

22 **3.1.2.1** If deteriorated concrete is found, repair as indicated in Contract Documents.

23 **3.1.3** Inspect substrate for cracks.

24 **3.1.3.1** If cracks are found, repair as indicated in Contract Documents or as
25 instructed by Architect/Engineer.

26 **3.1.4** Eliminate protrusions, form lines, and other out-of-plane variations in the substrate
27 that exceed an amplitude of 1/32 in.

28 **3.1.5** Remove materials that would interfere with bonding to the substrate such as laitance,
29 curing compounds, dust, dirt, oil or incompatible materials from previous repairs.

30 **3.1.6** Prepare substrate in accordance with the following:

1 **3.1.6.1** For contact-critical applications as indicated in Contract Documents, clean
2 substrate in accordance with manufacturer’s recommendations.

3 **3.1.6.2** For bond-critical applications as indicated in Contract Documents,
4 mechanically abrade substrate in accordance with ASTM D4259 to achieve pull-off strength in
5 accordance with 3.5.2 unless otherwise specified.

6 **3.1.7** Where required, round outside corners and sharp edges to a radius not less than 1/2
7 in., unless otherwise specified in Contract Documents or required by FRP manufacturer.

8
9
10 **3.2—Temperature, humidity and moisture**

11 **3.2.1** Apply FRP system within temperature, humidity, and moisture conditions
12 recommended by FRP manufacturer.

13 **3.2.2** Air and substrate temperature shall be above dew point unless otherwise permitted
14 by FRP manufacturer.

15 **3.2.3** Do not apply FRP system if substrate temperatures are outside the range
16 recommended by FRP manufacturer.

17 **3.2.4** Do not apply FRP system if substrate moisture levels are outside the range
18 recommended by FRP manufacturer.

19
20 **3.3—Installation**

21 **3.3.1 Resins**

22 **3.3.1.1** Mix resins in accordance with the weight or volume ratio recommended by
23 FRP manufacturer.

24 **3.3.1.2** Do not dilute or otherwise modify resin except as permitted by FRP
25 manufacturer.

26 **3.3.1.3** Use additives in dosages recommended by FRP manufacturer.

27 **3.3.1.4** Use the mixed resin within its pot life as specified by FRP manufacturer.

28 **3.3.2 Cutting of fabric**

29 **3.3.2.1** Cut fabric to required length and width on a surface free of dust or fluids.

30 **3.3.3 Primer/putty application**

1 **3.3.3.1** Apply a system-compatible primer to the substrate if required by FRP
2 manufacturer.

3 **3.3.3.2** Apply primer uniformly to substrate at rate recommended by FRP
4 manufacturer.

5 **3.3.3.3** Apply putty to the substrate to fill surface irregularities or small voids if
6 required by FRP manufacturer.

7 **3.3.3.4** Apply putty within thickness limits recommended by FRP manufacturer.

8 **3.3.3.5** Do not apply primer or putty over a previously applied primer or putty coat
9 that has fully cured, unless the surface of the previous coat has been prepared as recommended by
10 FRP manufacturer.

11 **3.3.4** *Saturation*

12 **3.3.4.1** Saturate fabric as recommended by FRP manufacturer.

13 **3.3.5** *Placement of fabric*

14 **3.3.5.1** Install fabric with fiber orientation as indicated in Contract Documents.

15 **3.3.5.2** Remove air bubbles between the fiber and substrate or between plies using
16 methods recommended by FRP manufacturer.

17 **3.3.5.3** Install number of plies as indicated in Contract Documents.

18 **3.3.5.4** If multiple plies are required, follow FRP manufacturer’s recommended installation
19 procedure.**3.3.5.5** Do not apply additional plies to previously cured plies until previous ply surface
20 is prepared in accordance with FRP manufacturer’s recommendations.

21 **3.3.5.6** Provide lap splices and overlaps as indicated in Contract Documents.

22 **3.3.5.7** Seal seams and edges as recommended by FRP manufacturer.

23

24 **3.4—Curing**

25 **3.4.1** Cure FRP system within temperature, humidity, and moisture conditions
26 recommended by FRP manufacturer.

27 **3.4.2** Protect FRP system from contamination and damage during curing as recommended
28 by FRP manufacturer.

29

30 **3.5—Acceptance of Work**

1 **3.5.1 General**—Completed FRP system installation shall conform to requirements as
2 indicated in Contract Documents.

3 **3.5.1.1** FRP system installation that fails to meet one or more of the requirements
4 but subsequently is repaired to bring the installation into compliance will be accepted.

5 **3.5.1.2** Contractor shall be responsible to bring FRP system installation into
6 compliance with requirements. Work not brought into compliance may be subject to rejection.

7 **3.5.2 Pull-off Strength**—Owner’s inspection agency will perform pull-off testing on bond-
8 critical applications.

9 **3.5.2.1** Pull-off tests will be performed in accordance with ASTM D7522/D7522M.

10 **3.5.2.2** Unless otherwise specified, three pull-off tests will be performed for every
11 1,000 ft² of surface area of FRP system installation, with at least three tests per day.

12 **3.5.2.3** If FRP system is installed on substrates with different properties or on the
13 same substrate with different preparation, pull-off test requirements of 3.5.2.2 apply to each
14 substrate or preparation type.

15 **3.5.2.4** If a representative testing area is used for pull-off testing instead of the
16 installed FRP as shown in the Project Documents, this area shall have the same substrate, surface
17 preparation techniques, FRP system materials and number of layers as the installation.

18 **3.5.2.5 Criteria for determining adequate pull-off strength**—Pull-off strength is
19 satisfactory provided that the criteria of 3.5.2.5(a) and 3.5.2.5(b) are met.

20 **3.5.2.5(a)** Pull-off strength exceeds 200 psi.

21 **3.5.2.5(b)** Failure occurs in the substrate (Mode G in accordance with
22 ASTM D7522/D7522M).

23 **3.5.2.6** If either of the two requirements in 3.5.2.5 is not met, the Architect/Engineer
24 may make one of the decisions in 3.5.2.6(a) through 3.5.2.6(c)

25 **3.5.2.6(a)** A pull-off strength of 200 psi or less with failure in the substrate
26 is acceptable.

27 **3.5.2.6(b)** A pull-off strength greater than 200 psi with failure not in the
28 substrate (Mode A through F in accordance with ASTM D7522/D7522M) is acceptable.

29 **3.5.2.6(c)** Additional pull-off tests are required.

30 **3.5.3 Defects**—Installed areas will be inspected by Owner’s inspection agency for defects.

1 **3.5.3.1** Small delaminations 2 in.² or less are acceptable as long as the delaminated
2 area is less than 5% of the total laminate area and there are no more than 10 such delaminations
3 per 10 ft².

4 **3.5.3.2** Inject delaminations larger than 2 in.² and less than 25 in.² with epoxy.

5 **3.5.3.3** Delaminations 25 in.² and larger will be reported to Architect/Engineer and
6 Contractor shall submit remediation plan.

7 **3.5.4 Installation Tolerances**—If a placement tolerance given in 3.5.4.1 through 3.5.4.3 is
8 exceeded, the Architect/Engineer will evaluate effect of the deviation on capacity of the
9 strengthened structure, and may require remedial measures to be implemented:

10 **3.5.4.1** Fiber orientation, from specified axis: ± 5 degrees.

11 **3.5.4.2** FRP system with fiber orientation along longitudinal axis of member:

12 **3.5.4.2(a)** End of laminate, measured along member axis: ± 2 in.

13 **3.5.4.2(b)** Length of lap, measured along member axis: $- \frac{1}{2}$ in.

14 **3.5.4.2(c)** Edge of laminate from specified control surface or point (e.g.
15 vertical face or corner of beam), measured in direction transverse to member axis:
16 ± 1 in.

17 **3.5.4.3** FRP system with fiber orientation transverse to member axis:

18 **3.5.4.3(a)** Width of transverse laminate: $\pm 1/2$ in.

19 **3.5.4.3(b)** End of transverse laminate, measured from specified location: \pm
20 1 in.

21 **3.5.4.3(c)** Spacing between any two adjacent transverse laminates: ± 1 in.
22 from specified spacing.

23 **3.5.5 Material Testing**—If specified, contractor shall make witness panels per ASTM D
24 7565 every day of installation to verify material properties and comply with 3.5.5.1 through
25 3.5.5.9.

26 **3.5.5.1** A panel shall be a minimum of 12 in. x 12 in. and must be made of one or
27 two plies.

28 **3.5.5.2** One panel shall be made for every 5,000 ft² of material installed, with a
29 minimum of two panels per day. 3.5.5.3 Panels shall be cured for a minimum of 48 hours
30 in the same conditions as the installation.

31 **3.5.5.4** A minimum of 15% of all panels will be tested.

1 **3.5.5.5** Panels will be tested by testing agency in accordance with ASTM D7565.

2 **3.5.5.6** Sufficient coupons will be obtained from each panel to obtain five valid test
3 results.

4 **3.5.5.7** FRP system may be considered deficient if the value for tensile force per
5 unit width of two or more of the five valid test results is less than the value for the ultimate
6 tensile strength per unit width as stated on the material data sheet.

7 **3.5.5.8** FRP system may be considered deficient if the calculated average chord
8 tensile stiffness per unit width from the five coupons tested is less than 90% of the value
9 for chord tensile stiffness per unit width as stated on the material data sheet.

10 **3.5.5.9** When material properties are considered potentially deficient, the actions
11 given in 3.5.5.10(a) through 3.5.5.10(e) may be required by Architect/Engineer:

12 **3.5.5.9(a)** Test second panel made at the same time as the panel made with
13 potentially deficient material.

14 **3.5.5.9(b)** 25% of all panels shall be tested for the remainder of the project.

15 **3.5.5.9(c)** Potentially deficient material is removed.

16 **3.5.5.9(d)** Additional FRP material is installed at the affected location as
17 required by Architect/Engineer.

18 **3.5.5.9(e)** Submit calculations prepared by the specialty engineer
19 responsible for designing FRP system demonstrating that the portion of the
20 structure strengthened with the potentially deficient material possesses adequate
21 design capacity.

22 23 24 25 **NOTES TO SPECIFIER**

26 **General Notes**

27 G1. ACI Specification 440.X is to be used by reference in the Project Specification. Do not copy
28 individual sections, parts, articles, or paragraphs into the Project Specification because taking them
29 out of context may change their meaning.

30 G2. If sections or parts of ACI Specification 440.X are copied into the Project Specification or
31 any other document, do not refer to them as an ACI Specification.

1 G3. A statement such as the following will serve to make ACI Specification 440.X a part of the
2 Project Specification:

3 “Work on (Project Title) shall conform to all requirements of ACI (Specification number
4 with date suffix and title) published by the American Concrete Institute, Farmington Hills,
5 Michigan, except as modified by these Contract Documents.”

6 G4. Each technical section of ACI Specification 440.X is written in the three-part section format
7 of the Construction Specifications Institute, as adapted for ACI requirements. The language is
8 imperative and terse.

9 G5. If ACI Specification 440.X is referenced in Contract Documents along with another ACI
10 specification that contains overlapping provisions, identify which requirements are in conflict and
11 state in Contract Documents which requirements govern.

12

13 **Foreword to checklists**

14 F1. This foreword is included for explanatory purposes only; it is not a part of ACI Specification
15 440.X.

16 F2. ACI Specification 440.X may be referenced by the specifier in the Project Specification for
17 any building project, together with supplementary requirements for the specific project.
18 Responsibilities for the project participants must be defined in the Project Specification. ACI
19 Specification 440.X cannot and does not address responsibilities for any project participant other
20 than Contractor.

21 F3. Checklists do not form a part of ACI Specification 440.X. Checklists assist the specifier in
22 selecting and specifying project requirements in the Project Specification.

23 F4. The Mandatory Requirements Checklist indicates Work requirements regarding specific
24 qualities, procedures, materials, and performance criteria that are not defined in ACI Specification
25 440.X. The specifier must include these requirements in the Project Specification.

26 F5. The Optional Requirements Checklist identifies specifier alternatives or additions. The
27 checklist identifies the sections, parts and articles of ACI Specification 440.X and the action
28 required or available to the specifier. The specifier should review each of the items in the checklist
29 and make adjustments to the needs of a particular project by including those selected alternatives
30 or additions as mandatory requirements in the Project Specification.

1 F6. Cited references—Documents and publications that are referenced in the checklists of ACI
 2 Specification 440.X are listed below. These references provide guidance to the specifier and are
 3 not considered to be part of ACI Specification 440X.

4
 5 *International Code Council*

6 AC178 (2013)—Acceptance Criteria for Inspection and Verification of Concrete and Reinforced
 7 and Unreinforced Masonry Strengthening Using Externally Bonded Fiber Reinforced (FRP)
 8 Composite Systems.

9 *International Concrete Repair Institute*

10 ICRI 310.2-2013—Guideline for Selecting and Specifying Concrete Surface Preparation for
 11 Sealers, Coatings, and Polymer Overlays.

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13 **MANDATORY REQUIREMENTS CHECKLIST**

14

Section/Part/Article	Notes to Specifier
2.2.1 FRP system design	Indicate if Method 1 or Method 2 will be used for design of FRP system. If Method 1 is used, drawings shall indicate performance requirement for FRP system. If Method 2 is used, drawings shall indicate extent, number of layers, orientation, and all other required information for installation of a specific FRP system. If Method 2 is used and alternate FRP systems besides the one specified are allowed, Drawings shall indicate performance requirement for FRP and Contract Documents shall state in Section 1.6.4 that the requirements of 2.2.1.1 must be provided.
3.1.1 Existing Dimensions	Indicate dimension of members to be strengthened or state to field measure.
3.1.2.1 Deteriorated Concrete Repair	Include requirements on repair of deteriorated concrete in Contract Documents.

3.1.3.1 Crack Repair	Include requirements on how to repair cracks in Contract Documents.
3.1.6.1 Contact-critical members	Indicate on Contract Documents which members to be strengthened are contact-critical.
3.1.6.2 Bond-critical members	Indicate on Contract Documents which members to be strengthened are bond-critical.
3.3.5.1 Fiber orientation	Indicate fiber orientation on Contract Documents or refer Contractor to approved submittal.
3.3.5.3 Number of plies	Indicate required number of plies on Contract Documents or refer Contractor to approved submittal.
3.3.5.6 Lap splices and overlaps	Indicated required lap splices and overlaps on Contract Documents or refer Contractor to approved submittal.
3.5.1 Acceptance of Work	Indicate on Contract Documents all requirements for FRP system installation acceptance or refer contractor to approved submittal.

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OPTIONAL REQUIREMENTS CHECKLIST

Section/Part/Article	Notes to Specifier
1.6.4 Submittals	If Method 1 is chosen in Section 2.2 or alternate FRP materials are allowed for Method 2, items in 2.2.1.1 must be submitted.
1.8.3 Contractor Responsibilities	Indicate if the Contractor is not responsible for 1.8.3.1 or 1.8.3.2.

1.8.4 Inspection Agency	In the contract with the inspection agency, indicate if the duties in 1.8.4 will be required.
1.8.4.1 Inspection Reference	ICC-ES AC 178 may be referenced for Inspection.
3.1.6.2 Surface Profile	Specify for bond critical applications, a minimum CSP 3 shall be achieved in accordance with ICRI 310.2 or to the tolerances specified by the FRP manufacturer when using a grinder.
3.1.7 Corner Radius	Indicate if outside corners and sharp edges need to be rounded to a radius other than not less than ½”.
3.5.2.2 Bond testing requirements	Modify number of pull-off tests based on project requirements.
3.5.5 Material testing	Specify if tensile testing of materials is required.

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