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QUAKEWRAP FIBER-REINFORCED POLYMER (FRP) COMPOSITE SYSTEMS

CSI Sections:

- 03 01 00 Maintenance of Concrete
- 03 01 30 Maintenance of Cast-in-Place Concrete

1.0 RECOGNITION

The QuakeWrap FRP Systems recognized in this report have been evaluated for use to strengthen concrete structural elements. The structural, weather protection, and interior finish performance properties of the QuakeWrap FRP Systems comply with the intent of the provisions of the following codes and regulations:

- 2021, 2018, and 2015 International Building Code® (IBC)
- 2021, 2018, and 2015 International Residential Code® (IRC)
- 2018, 2015, and 2012 Uniform Plumbing Code® (UPC)
- 2018, 2015, and 2012 International Plumbing Code® (IPC)
- 2022 and 2019 California Building Code® (CBC) – attached Supplement
- 2022 and 2019 California Residential Code® (CRC) – attached Supplement
- 2020 Florida Building Code, FBC, Building (FBC, Building) – attached Supplement
- 2020 Florida Building Code, FBC, Residential (FBC, Residential) – attached Supplement
- 2020 Los Angeles Building Code (LABC) – attached Supplement
- 2020 Los Angeles Residential Code (LARC) – attached Supplement

2.0 LIMITATIONS

Use of the QuakeWrap FRP Systems recognized in this report is subject to the following limitations:

2.1 The design and installation shall be in accordance with this report, the IBC or IRC, the QuakeWrap, Inc. Installation Instructions No. QW/II-2020 dated November 2020, the QuakeWrap Quality Control Plan QW_QCP, dated November 2020, and QuakeWrap Design Manual, Version 1.0_1, dated January 2021. Where there is a conflict, the more restrictive requirements shall govern.

2.2. Plans, specifications, and calculations shall be submitted to the building official for approval. The plans, specifications, and calculations shall be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

2.3 Special inspections for the application of the QuakeWrap FRP Systems shall be provided in accordance with Section 3.4 of this report.

2.4 Use of the QuakeWrap FRP Systems on concrete members required or specified to be of fire-resistance-rated construction is beyond the scope of this report.

2.5 The QuakeWrap FRP Systems recognized in this report are produced by QuakeWrap, Inc. in Tucson, Arizona.

3.0 PRODUCT USE

3.1 General: The QuakeWrap FRP Systems are used to strengthen concrete structural elements and for use in contact with potable water. The QuakeWrap FRP System, when used with the IRC, an engineered design may be submitted as set forth in Section R301.1.3 of the IRC, is subject to approval from the building official as set forth in Section R104.11 of the IRC.

3.2 Design: The QuakeWrap FRP Systems shall be designed to resist tensile forces while maintaining strain compatibility between the composite and the substrate. The QuakeWrap FRP Systems shall not be relied upon to resist compressive forces. The strength design requirements for concrete shall be in accordance with Chapter 19 of the IBC. The owner and registered design professional shall be responsible for determining, through analysis, the capacities and demands of the structural elements to be strengthened by the QuakeWrap FRP Systems and shall be submitted to the building official for approval.

3.2.1 Composite Design Values: The design values for the QuakeWrap FRP Systems are as listed in Sections 4.3.1 through 4.3.6 of this report and documented in the QuakeWrap Design Manual, Version 1.0_1, dated January 2021.

3.2.2 Design Provisions: The design equations used in the QuakeWrap Design Manual, Version 1.0_1, dated January 2021 are based on structural testing and principles of structural analysis. All designs shall comply with the requirements set forth in the IBC and the QuakeWrap Design Manual, Version 1.0_1, dated January 2021.

3.2.3 Load Combinations: The strength design load combinations used in the design shall comply with IBC Section 1605. Strength reduction factors shall comply with

The product described in this Uniform Evaluation Service (UES) Report has been evaluated as an alternative material, design or method of construction in order to satisfy and comply with the intent of the provision of the code, as noted in this report, and for at least equivalence to that prescribed in the code in quality, strength, effectiveness, fire resistance, durability and safety, as applicable, in accordance with IBC Section 104.11. This document shall only be reproduced in its entirety.





IBC Chapter 19, ACI 318, and the QuakeWrap Design Manual, Version 1.0_1, dated January 2021.

3.2.4 Columns:

3.2.4.1 Potential Applications: The QuakeWrap FRP Systems are applied to columns to strengthen their ductility and their axial, flexural, and shear strengths.

3.2.4.2 Structural Design Requirements: Concrete column design shall comply with Chapter 19 of the IBC (ACI 318) and QuakeWrap Design Manual, Version 1.0_1, dated January 2021.

3.2.5 Beams and Slabs:

3.2.5.1 Potential Applications: The QuakeWrap FRP Systems B20C, U20C, U27C, and U41C are applied to concrete beams for gravity and wind loading applications, to strengthen their ductility and their flexural and shear strength. The QuakeWrap FRP Systems B20C, U20C, U27C, and U41C are applied to concrete slabs for gravity and wind loading application for flexural design.

3.2.5.2 Structural Design Requirements: Concrete design shall comply with Chapter 19 of the IBC (ACI 318) and QuakeWrap Design Manual, Version 1.0_1, dated January 2021.

3.2.6 Bond Strength: Where the bond is critical to system design, the bond strength of the system applied to a properly prepared surface shall exceed the tensile strength of the substrate. Bond strength shall be at least 200 psi (1378 kPa) for concrete. The number of tests and test locations shall be specified by the registered design professional and approved by the building official. Bond testing shall exhibit failure in the concrete substrate. Testing in accordance with ASTM C297, ASTM D7234, or ASTM D7522 may be used to estimate the bond strength of bond-critical installations.

3.3 Installation: Installation of the QuakeWrap FRP Systems shall be by QuakeWrap, Inc. trained and certified applicators. Installation of the system shall be in accordance with the QuakeWrap, Inc. Installation Instructions No. QW/II-2020 dated November 2020.

3.3.1 Saturation: The carbon and glass fibers, and the matrix shall be combined in compliance with the required weight-and-volume ratio described in the QuakeWrap, Inc. Installation Instructions No. QW/II-2020 dated November 2020. The saturation may be fulfilled with the QuakeWrap Saturating Machine or by handcrafted methods.

3.3.2 Application: The saturated fabrics shall be applied to the concrete substrate using hand-applied methods in accordance with the QuakeWrap, Inc. Installation Instructions No. QW/II-2020 dated November 2020 by personnel who have been trained and certified by QuakeWrap, Inc.

3.3.3 Finishing: The installed system shall receive a final protective layer of the thickened QuakeWrap 300 SR epoxy as described in Section 4.2.1.3 of this report.

3.3.3.1 Paint: Paint may be applied for additional aesthetic or weather protection considerations.

3.3.3.2 Cure Time Prior to Loading: The QuakeWrap FRP Systems shall be allowed to cure for a minimum of 72 hours at an average temperature of 70°F (21.1°C) prior to loading the structural member.

3.3.3.3 Interior Finish: Where required to comply with the IBC Section 803 for interior finish, the QuakeWrap FRP Systems U20C, U27C, and U41C composed of six layers that shall be applied with two coats of Albi FRL-X with a minimum of 20 mils (0.51 mm) wet film.

Where required to comply with the IBC Section 803 for interior finish, the QuakeWrap FRP System U27G composed of eight layers that shall be applied with two coats of Albi FRL-X with a minimum of 20 mils (0.51 mm) wet film.

3.3.3.4 Health Effects Exposure: The QuakeBond™ 300SR epoxy resin using QuakeWrap carbon fabric sheets B20C, U20C, U27C, and U41C complies with Sections 604.1 and 607.2 of the 2018, 2015, and 2012 UPC; Section 605 of the International Plumbing Code (IPC) and may be in contact with potable water based on testing in accordance with Section 5 of NSF 61. The QuakeBond™ 300SR epoxy shall be applied over the QuakeWrap carbon fabric sheets B20C, U20C, U27C, and U41C in two coats to a total dry film thickness of 90 mils (2.3 mm). Surfaces include concrete, masonry, and steel. The minimum pipe diameter is 8 inches (152 mm). All surfaces shall be clean, dry, and free of contaminants. The curing average temperature is 70°F (21°C). Mixing and application shall comply with the QuakeWrap, Inc. Installation Instructions No. QW/II-2020 dated November 2020.

3.4 Special Inspection: Special inspection under the IBC or IRC is required and shall comply with the applicable requirements in IBC Sections 1704 and 1705. Special inspection during the installation of the QuakeWrap FRP Systems shall be in accordance with AC178, Acceptance Criteria for Inspection and Verification of Concrete and Reinforced and Unreinforced Masonry Strengthening Using Fiber-reinforced Polymer (FRP) Composite Systems, the QuakeWrap, Inc. Installation Instructions No. QW/II-2020 dated November 2020, and the QuakeWrap Quality Control Plan QW_QCP, dated November 2020. Special inspectors shall provide written documentation demonstrating their qualifications for inspection of Fiber-Reinforced Polymer (FRP) systems in accordance with IBC Section 1704. The responsibilities of the special inspector shall be prepared in accordance with AC178 and ACI 440.2.



4.0 PRODUCT DESCRIPTION

4.1 General: The QuakeWrap FRP Systems are externally bonded fiber-reinforced polymer (FRP) applied to strengthen normal-weight concrete substrates. The system consists of carbon and glass fabrics combined with resins which, in combination, create the FRP composite system.

4.2 Material Information:

4.2.1 The QuakeWrap FRP Systems are comprised of QuakeWrap carbon fabric sheets B20C, U20C, U27C, and U41C and QuakeWrap glass fabric sheets B26G and U27G saturated with QuakeWrap 300SR epoxy matrix. All materials described in this section shall comply with the requirements listed in the QuakeWrap Quality Control Plan QW_QCP, dated November 2020.

4.2.1.1 The QuakeWrap carbon fabric sheets B20C, U20C, U27C, and U41C are composed of both unidirectional and bidirectional fibers. Standard fabric rolls measuring 100 yards (91 m) long by 24 to 50 inches (610 to 1270 mm) wide.

4.2.1.2 The QuakeWrap glass fabric sheets B26G and U27G are composed of both unidirectional and bidirectional fibers. Standard rolls measuring 100 yards (91 m) long by 24 to 50 inches (610 to 1270 mm) wide.

4.2.1.3 QuakeBond™ 300 SR Epoxy Resin: The QuakeBond™ 300 SR Epoxy Resin is a two-component epoxy resin used to saturate the fabrics to the concrete substrate. The QuakeBond™ 300 SR Epoxy Matrix comes in 1-gallon (3.8 L), 5-gallon (19 L), and 55-gallon (208L) drums containing Components A and B of the resin. The components are mixed in the field at a ratio of 2:1 as set forth in the QuakeWrap, Inc. Installation Instructions No. QW/II-2020 dated November 2020.

4.3 QuakeWrap Composites

4.3.1 QuakeWrap B20C Composite: In the primary direction (0°), the carbon fiber reinforced polymer has a minimum ultimate tensile strength of 145 ksi (1,002 MPa), a minimum tensile modulus of 9,200 ksi (63.6 GPa), and an elongation of 1.47 percent. In the secondary direction (90°), the carbon fiber composite has a minimum ultimate tensile strength of 129 ksi (891.8 MPa), a minimum tensile modulus of 7,700 ksi (53.5 GPa), and an elongation of 1.57 percent. The corresponding laminate thickness is 0.019 inches (0.48 mm).

4.3.2 QuakeWrap U20C Composite: The unidirectional (0°) carbon fiber reinforced polymer has a minimum ultimate tensile strength of 146.9 ksi (1,013 MPa), a minimum tensile modulus of 13,800 ksi (95.1 GPa), and an elongation of 0.94 percent. The corresponding laminate thickness is 0.04 inches (0.99 mm).

4.3.3 QuakeWrap U27C Composite: The unidirectional (0°) carbon fiber reinforced polymer has a minimum ultimate tensile strength of 159 ksi (1,096 MPa), a minimum tensile modulus of 15,800 ksi (108.9 GPa), and an elongation of 0.9 percent. The corresponding laminate thickness is 0.047 inches (1.19 mm).

4.3.4 QuakeWrap U41C Composite: The unidirectional (0°) carbon fiber reinforced polymer has a minimum ultimate tensile strength of 153 ksi (1,055 MPa), a minimum tensile modulus of 14,530 ksi (100.1 GPa), and an elongation of 0.99 percent. The corresponding laminate thickness is 0.067 inches (1.7 mm).

4.3.5 QuakeWrap B26G Composite: In the primary direction (0°), the glass fiber reinforced polymer has a minimum ultimate tensile strength of 64.8 ksi (446.9 MPa), a minimum tensile modulus of 4,090 ksi (28.2 GPa), and an elongation of 1.44 percent. In the secondary direction (90°), the glass fiber-reinforced polymer has a minimum ultimate tensile strength of 68.3 ksi (471 MPa), a minimum tensile modulus of 4,300 ksi (29.6 GPa), and an elongation of 1.42 percent. The corresponding laminate thickness is 0.022 inches (0.56 mm).

4.3.6 QuakeWrap U27G Composite: The unidirectional (0°) glass fiber reinforced polymer has a minimum ultimate tensile strength of 70.9 ksi (488.9 MPa), a minimum tensile modulus of 3,630 ksi (25 GPa), and an elongation of 1.80 percent. The corresponding laminate thickness is 0.045 inches (1.14 mm).

4.4 Albi Cote FRL-X: Albi Cote FRL-X is a water-based, co-polymer fire retardant paint (intumescent coating), delivered in 1-gallon, 5-gallon, and 55-gallon (3.8, 19, and 208 L) containers.

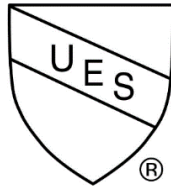
4.5 Storage Recommendations: For the resins, coatings, and fibers, there shall be no water contamination during storage. Shelf life is unlimited for the carbon and glass fabrics when the temperatures range from 45°F (7°C) to 95°F (35°C). The shelf life for the resin in unopened containers is for one year when stored in temperatures ranging from 65°F (18°C) to 85°F (29°C).

5.0 IDENTIFICATION

The QuakeWrap FRP System components shall be labeled with the QuakeWrap, Inc. name and address, product name, expiration date, and the evaluation report number (ER-828). The identification includes the IAPMO Uniform Evaluation Service Mark of Conformity.



The IAPMO UES Mark of Conformity may also be used as shown below:



IAPMO UES ER-828

6.0 SUBSTANTIATING DATA

6.1 Data in accordance with AC125, Acceptance Criteria for Concrete and Reinforced and Unreinforced Masonry Strengthening Using Externally Bonded Fiber-Reinforced Polymer (FRP) Composite Systems.

6.2 Test reports are from laboratories in compliance with ISO/IEC 17025.

7.0 STATEMENT OF RECOGNITION

This evaluation report describes the results of research completed by IAPMO Uniform Evaluation Service on The QuakeWrap FRP Systems to assess conformance to the codes shown in Section 1.0 of this report and serves as documentation of the product certification. The QuakeWrap FRP Systems are manufactured at the location noted in Section 2.5 of this report under a quality control program with periodic inspections under the supervision of IAPMO UES.

For additional information about this evaluation report please visit www.uniform-es.org or email us at info@uniform-es.org



CALIFORNIA SUPPLEMENT

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CSI Sections:

03 01 00 Maintenance of Concrete

03 01 30 Maintenance of Cast-in-Place Concrete

1.0 RECOGNITION

The QuakeWrap FRP Systems described in ER-828 and this supplement has been evaluated for use to strengthen concrete structural elements. The QuakeWrap FRP Systems as noted in this supplement is a satisfactory alternative structural system for use in building built under the following codes:

- 2022 and 2019 California Building Code® (CBC)
- 2022 and 2019 California Residential Code® (CRC)

2.0 LIMITATIONS

Use of the QuakeWrap FRP Systems recognized in this supplement is subject to the following limitations:

2.1 The QuakeWrap FRP Systems shall comply with the provisions applicable to the 2021 IBC or 2021 IRC (2022 CBC and CRC), or 2018 IBC or 2018 IRC (2019 CBC or 2019 CRC) in ER-828.

2.2 The QuakeWrap FRP Systems have not been evaluated in accordance with CBC Section 702A or CRC Section R337.2A for use in the exterior design and construction of new buildings located in a Very High Fire Hazard Severity Zone.

2.3 California Department of Health Care Access and Information (HCAi) (formerly OSHPD) and Division of State Architect (DSA) provisions shall be observed where applicable.

2.4 The QuakeWrap FRP Systems used in existing concrete structures under the jurisdiction of HCAi (OSHPD) shall comply with CBC Section 1911.3.

2.5 The QuakeWrap FRP Systems used in existing concrete structures under the jurisdiction of HCAi (OSHPD), DSA, or HCD shall comply with CBC Section 1911A.3.

2.6 This supplement expires concurrently with ER-828.

For additional information about this evaluation report please visit www.uniform-es.org or email at info@uniform-es.org



FLORIDA SUPPLEMENT

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1.0 RECOGNITION

The QuakeWrap FRP Systems described in ER-828 and this supplement report have been evaluated for use to strengthen concrete structural elements. The QuakeWrap FRP Systems as noted in this supplement is a satisfactory alternative for use in buildings built under the following codes:

- 2020 Florida Building Code, Building (FBC-Building)
- 2020 Florida Building Code, Residential (FBC-Residential)

2.0 LIMITATIONS

Use of the QuakeWrap FRP Systems recognized in this supplement is subject to the following limitations:

2.1 The QuakeWrap FRP Systems shall comply with the provisions applicable to the 2018 IBC or 2018 IRC as described in ER-828.

2.2 The use of QuakeWrap FRP Systems recognized with the High-velocity Hurricane Zone (HVHZ) is beyond the scope of this report.

2.3 For products falling under Section (5)(d) of Florida Rule 61G20-3.008, verification is required that the report holder's quality assurance program is audited by a quality assurance entity, approved by the Florida Building Commission (or the building official when the report holder does not possess an approval by the Commission), to provide oversight and determine that the products are being manufactured as described in this evaluation report to establish continual product performance.

2.4 This supplement expires concurrently with ER-828.

For additional information about this evaluation report please visit www.uniform-es.org or email at info@uniform-es.org



CITY OF LOS ANGELES SUPPLEMENT

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1.0 RECOGNITION

The QuakeWrap FRP Systems described in ER-828 and the California Supplement have been evaluated for use to strengthen concrete structural elements. The QuakeWrap FRP Systems as noted in this supplement is a satisfactory alternative structural system for use in buildings built under the following codes:

- 2020 Los Angeles Building Code® (LABC)
- 2020 Los Angeles Residential Code® (LARC)

2.0 LIMITATIONS

Use of the QuakeWrap FRP Systems recognized in this supplement is subject to the following limitations:

2.1 The design and installation of the QuakeWrap FRP Systems shall be in accordance with the applicable 2019 CBC or 2019 CRC provisions of the California Supplement to ER-828, the manufacturer's published installation instructions, and the City of Los Angeles Building Code. Where conflicts occur, the more restrictive shall govern.

2.2 Prior to installation, calculations and details demonstrating compliance with ER-828 and the 2020 LABC or 2020 LARC shall be submitted to the structural plan check section for review and approval. The calculations and details shall be prepared by a registered design professional, licensed in the State of California.

2.3 The design and installation of the QuakeWrap FRP Systems shall be in accordance with Chapters 16 and 17 of the 2020 LABC.

2.4 Special Inspections are required in accordance with LABC Section 1705.3, Concrete Constructions. The continuous special inspection shall be provided in accordance with AC178. The continuous inspection shall be performed by registered deputy building inspectors.

2.5 Structural Observation is required in accordance with LABC Section 1704.6, as applicable.

2.6 The QuakeWrap FRP Systems are permitted to strengthen existing concrete structures as set forth in Sections 1911.3 of the 2020 LABC.

2.7 The QuakeWrap FRP Systems are permitted to be used on the exterior side of concrete exterior walls without weather protection in accordance with Section 1402.2 of the LABC. However, the site-specific exposure conditions shall be evaluated by the registered design professional for each application.

2.8 This supplement expires concurrently with ER-828.

For additional information about this evaluation report please visit www.uniform-es.org or email at info@uniform-es.org