ICC-ES Evaluation Report

ESR-3506

Reissued April 2025

This report also contains:

- City of LA Supplement

Subject to renewal April 2026

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DIVISION: 03 00 00—CONCRETE Section: 03 01 00—Maintenance of Concrete DIVISION: 04 00 00—MASONRY Section: 04 01 20—Maintenance of Unit Masonry	REPORT HOLDER: SIMPSON STRONG-TIE COMPANY INC.	EVALUATION SUBJECT: SIMPSON STRONG-TIE COMPOSITE STRENGTHENING SYSTEMS (CSS)—FABRIC-REINFORCED CEMENTITIOUS MATRIX (FRCM)	

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2021, 2018, 2015, and 2012 *International Building Code*® (IBC)
- 2021, 2018, 2015, and 2012 *International Residential Code*® (IRC)

Property evaluated:

- Structural
- Durability
- Interior finish
- Fire Resistance

2.0 USES

The Simpson Strong-Tie Composite Strengthening Systems (CSS)—Fabric-Reinforced Cementitious Matrix (FRCM) are composite systems used as alternatives to systems described in the IBC as structural reinforcement to strengthen normal-weight reinforced concrete columns, beams and slabs, and unreinforced concrete masonry unit (CMU) walls. Both composite systems may also be used as an interior finish. For structures regulated under the IRC, the Simpson Strong-Tie FRCM system may be used where an engineering design is submitted in accordance with Section R301.1.3 and where approved by the building official in accordance with Section R104.11. The FRCM system can also be used as an interior finish.

3.0 DESCRIPTION

3.1 General:

The Simpson Strong-Tie Composite Strengthening Systems (CSS)—Fabric-Reinforced Cementitious Matrix (FRCM) consist of carbon grids combined with a cementitious mortar to create the FRCM composite system.

3.2 Materials:

3.2.1 Grids: FRCM grids are composed of carbon fibers.

3.2.1.1 CSS-UCG: CSS-UCG Unidirectional Carbon Grid come in 77-inch-x-164-foot (1.95 m x 50 m) rolls, and has a total nominal areal density of 281 gms.

3.2.1.2 CSS-BCG: CSS-BCG Bidirectional Carbon Grid come in 77-inch-x-164-foot (1.95 m x 50 m) rolls, and has a total nominal areal density of 80 gms in each direction.

3.2.1.3 CSS-HBCG: CSS-HBCG Heavy Bidirectional Carbon Grid come in 77-inch-x-164-foot (1.95 m x 50 m) rolls. Material properties vary with each grid designation, and have a total nominal areal density of 187 gms in each direction.

3.2.2 Cementitious Matrix:

3.2.2.1 CSS-CM: The CSS-CM cementitious matrix is a one-component, shrinkage-compensated, polypropylene-fiber-reinforced cementitious mortar used to install CSS FRCM grids. It is available in 55-pound (24.9 kg) bags and is mixed with water on-site. The recommended amount of mixing water is available on the product packaging.

3.2.2.2 Mixing Ratio: The water-to-matrix ratio for the cementitious matrix CSS-CM used for the preparation of the product is 0.76 to 0.85 gallons (2.8 to 3.2 L) of water to 55 lbs (25 kg) of dry matrix. Mixing must utilize a full bag.

3.2.3 FRCM Composites:

3.2.3.1 CSS-UCG Composites: In the primary direction (0º), the carbon grid composites have a minimum design ultimate tensile strength of 128.3 ksi (885 MPa), a minimum design cracked tensile modulus of 7,100 ksi (49,000 MPa) and a corresponding design elongation of 1.1 percent. The fabric area by unit width is 0.0062 $inch^2$/inch (157 mm^2/m).

3.2.3.2 CSS-BCG Composites: In the primary (0º) and secondary (90º) directions, the carbon grid composites have a minimum design ultimate tensile strength of 143 ksi (986 MPa), a minimum design cracked tensile modulus of 7,000 ksi (48,300 MPa) and a corresponding design elongation of 1.1 percent. The fabric area by unit width is 0.0017 $inch^2$/inch (44 mm^2/m). It is recommended that CSS-BCG installations include a minimum of two layers of grid.

3.2.3.3 CSS-HBCG Composites: In the primary (0º) and secondary (90º) directions, the carbon grid composites have a minimum design ultimate tensile strength of 130 ksi (896 MPa), a minimum design cracked tensile modulus of 6,100 ksi (42,100 MPa) and a corresponding design elongation of 1.0 percent. The fabric area by unit width is 0.0041 $inch^2$/inch (105 mm^2/m).

3.2.4 Storage Recommendations: All products of the FRCM system should be stored in temperatures between 41ºF and 95ºF (5ºC and 30ºC) with no exposure to moisture. Shelf life for CSS-CM is one year, and ten years for FRCM grids. All shelf life durations are based on undamaged and unopened packaging.

4.0 DESIGN AND INSTALLATION

4.1 Design:

4.1.1 General: Design of the FRCM composite system must be based on strength design in accordance with Chapter 19 (Concrete) or Chapter 21 (Masonry) of the IBC. The registered design professional is responsible for determining, through analysis, the strengths and demands of the structural elements to be enhanced by the FRCM composite systems, subject to the approval of the code official.

4.1.2 Design Strength: Structural design properties for the FRCM composite systems are found in the Design Manual (herein referred to as the DM), dated June 11, 2018.

4.1.3 Design Details: Design equations in the DM are based on test results and principles of structural analysis. Basis of the design includes strain compatibility, load equilibrium and limit stress. All designs must follow procedures as detailed in the IBC; in the ICC-ES Acceptance Criteria for Masonry and Concrete Strengthening Using Fabric-reinforced Cementitious Matrix (FRCM) Composite Systems (AC434), dated October 2018 (editorially revised December 2020); and in the DM.

4.1.4 Load Combinations: The load combinations used in design must comply with Section 1605 of the IBC. Strength reduction factors must comply with Chapter 19 or Chapter 21 of the IBC, as applicable.

4.1.5 Factors of Safety: The strength reduction factors, load factors and load combinations must be as prescribed in the IBC, as applicable and the DM.

4.1.6 Columns:

4.1.6.1 Potential Applications: The FRCM composite systems are applied to concrete columns to enhance their axial compressive strength under gravity loads only.

4.1.6.2 Structural Design Requirements: Concrete column design must comply with the DM and with Chapter 19 of the IBC.

4.1.7 Beams and Slabs:

4.1.7.1 Potential Applications: The FRCM composite system can be applied to slabs to enhance their flexural strength for gravity and wind-load resistance only. The FRCM system applied to beams can be used to enhance the flexural and shear strength for gravity or wind-load resistance only.

4.1.7.2 Structural Design Requirements: Concrete design must comply with the DM and with Chapter 19 of the IBC.

4.1.8 Walls:

4.1.8.1 Potential Applications: The FRCM composite system can be applied to CMU walls to enhance their out-of-plane flexural strength and in-plane shear strength.

4.1.8.2 Structural Design Requirements: Masonry wall design must comply with the DM and with Chapter 21 of the IBC.

4.1.9 Bond Strength: Where bond is critical to system design as determined by the registered design professional, the bond strength of the FRCM composite system applied to a properly prepared surface must be at least 200 psi (1.38 MPa). Bond testing in accordance with ASTM C1583 can be used to estimate bond strength of bond-critical installations. The test results can exhibit failure in the concrete or clay masonry substrate, as well as at the interface of the FRCM, and substrate. When failure is at the interface between the structural reinforcement grid and matrix within the FRCM, strength computed on the net matrix area (i.e., total area under the disk minus the area covered by the fiber mesh) must be at least 400 psi (2.76 MPa).

4.2 Installation:

The Simpson Strong-Tie FRCM composite system installations must be performed by approved applicators specific to this composite system. Installation recommendations are detailed in the approved applicator training program and published literature.

4.2.1 Application: Shotcrete methods must be used to apply the cementitious matrix to the substrate and manual methods must be used to apply the FRCM grids into the applied matrix prior to matrix cure. Surface preparation, grid orientation and removal of voids must be done in accordance with published literature and approved applicator training program.

4.2.2 Finishing: The FRCM composite systems can be typically painted to satisfy aesthetic and environmental considerations.

4.2.3 Cure Time Prior to Loading: The FRCM composite systems must be allowed a minimum of 28 days of cure time (depending on temperatures and humidity conditions) prior to application of superimposed loading onto the structural member. Final determination of required cure time must be made by the registered design professional.

4.2.4 Flame Spread: The CSS-UCG, CSS-BCG and CSS-HBCG FRCM systems yield a Class 1 and Class A flame-spread classification and smoke-developed classification in compliance with the UBC and IBC. The CSS-UCG, CSS-BCG and CSS-HBCG composites are limited to a maximum thickness of 3 layers, 5 layers and 2 layers of grid and associated CSS-CM cementitious matrix, respectively.

4.3 Fire Resistance Rating: The FRCM composite systems provide up to a four-hour fire-resistance rating in accordance with ASTM E119 when loaded up to 72 percent of the ultimate design load for the following structural systems. The FRCM composite system must be applied to concrete T-beams with the following properties: 12-inch-wide (305 mm) web thickness, 10-inch-deep (254 mm) web depth, 6-inch (152 mm) flange thickness, 48-inch (1219 mm) flange width, a 28-day concrete compressive strength between 3,500 psi (24 MPa) and 5,000 psi (34 MPa), reinforced with 2 No. 5 bottom longitudinal reinforcing steel in the web, flange short direction transverse reinforcement is No.3 at 6-inch o/c top and bottom, top longitudinal reinforcement is No. 3 at 6 inches o/c, and stirrup reinforcement No. 3 at 6 inches o/c with minimum 1.75-inch (44 mm) cover depth between reinforcement and concrete surface. The concrete surface to receive FRCM must be prepared to a minimum concrete surface profile (CSP) of 6, then thoroughly cleaned prior to FRCM installation. CSS-CM is applied by shotcrete over the prepared substrate to a minimum thickness of ¼ inch (6.4 mm) with a minimum average wet density of 140 lb/ft^3 (2242 kg/m^3). CSS-UCG grid is applied to the

bottom of the beam and the CSS-BCG grid is applied to the web at the ends of the T-beam in a U configuration. Grids are wet set into the first layer of CSS-CM. A final layer of CSS-CM with a minimum thickness of 1 inch (25 mm) is applied over the installed grids. Other assembly configurations are beyond the scope of this report

4.4 Special Inspection:

Special inspection during the installation of the FRCM systems must be in accordance with IBC Sections 1704 through 1709, and Appendix C of DM, dated June 11, 2018.

5.0 CONDITIONS OF USE:

The Simpson Strong-Tie Composite Strengthening Systems (CSS)—FRCM described in this report comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 Design and installation must be in accordance with this report; the manufacturer's instructions; the Design Manual (DM), dated June 11, 2018; and the IBC. A copy of the DM must be submitted to the code official for each project that is to use the systems.

5.2 Complete construction documents, including plans and calculations verifying compliance with this report, must be submitted to the code official for each project at the time of permit application. The construction documents must 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.

5.3 Special inspection for the jobsite application of the FRCM composite systems must be provided in accordance with Section 4.4 of this report.

5.4 Fire-resistance ratings of concrete assemblies strengthened with FRCM composite systems must comply with Section 4.3 of this report.

5.5 Application of the systems to concrete members at a fabricator's facility must be by an approved fabricator complying with Section 1704.2 of the IBC, or at a jobsite with continuous special inspections in accordance with Section 1704.4 of the IBC and with the DM.

5.6 The herein described FRCM strengthening composites systems are manufactured by Simpson Strong-Tie under a quality control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Masonry and Concrete Strengthening Using Fabric-reinforced Cementitious Matrix (FRCM) and Steel Reinforced Grout (SRG) Composite Systems (AC434), dated October 2018 (editorially revised December 2020).

7.0 IDENTIFICATION

7.1 Component material products of the FRCM strengthening composites systems are labeled, in accordance with the approved quality control documentation, with the company name (Simpson Strong-Tie), address, product name, expiration date, and evaluation report number (ESR-3506).

7.2 The report holder's contact information is the following:

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Section: 03 01 00—Maintenance of Concrete

DIVISION: 04 00 00—MASONRY
Section: 04 01 20—Maintenance of Unit Masonry

REPORT HOLDER:

SIMPSON STRONG-TIE COMPANY, INC.

EVALUATION SUBJECT:

SIMPSON STRONG-TIE COMPOSITE STRENGTHENING SYSTEMS (CSS)—FABRIC-REINFORCED CEMENTITIOUS MATRIX (FRCM)

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the Simpson Strong-Tie Composite Strengthening Systems (CSS)—Fabric-Reinforced Cementitious Matrix (FRCM), described in ICC-ES evaluation report ESR-3506, have also been evaluated for compliance with the codes noted below as adopted by the Los Angeles Department of Building and Safety (LADBS).

Applicable code editions:

- 2023 *City of Los Angeles Building Code (LABC)*
- 2023 *City of Los Angeles Residential Code (LARC)*

2.0 CONCLUSIONS

The Simpson Strong-Tie Composite Strengthening Systems (CSS)—Fabric-Reinforced Cementitious Matrix (FRCM) are composite systems, described in Sections 2.0 through 7.0 of the evaluation report ESR-3506, comply with the LABC Chapters 19 and 21, and the LARC, and are subjected to the conditions of use described in this supplement.

3.0 CONDITIONS OF USE

The Simpson Strong-Tie Composite Strengthening Systems (CSS)—Fabric-Reinforced Cementitious Matrix (FRCM), described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the evaluation report ESR-3506.
- The design, installation, conditions of use and identification of the composite strengthening systems are in accordance with the 2021 *International Building Code®* (IBC) provisions noted in the evaluation report ESR-3506.
- The design, installation and inspection are in accordance with additional requirements of LABC Chapters 16, 17, and 95 as applicable.
- The Simpson Strong-Tie Composite Strengthening Systems (CSS)—Fabric-Reinforced Cementitious Matrix (FRCM) must not be used as compressive reinforcement for strengthening concrete or masonry structure.
- Use of the Simpson Strong-Tie Composite Strengthening Systems (CSS)—Fabric-Reinforced Cementitious Matrix (FRCM) to strengthen concrete coupling beams or concrete wall piers is outside the scope of this supplement.
- The Simpson Strong-Tie Composite Strengthening Systems (CSS)—Fabric-Reinforced Cementitious Matrix (FRCM) may be used on exterior side of exterior walls without additional weather protection. However, the site-specific exposure conditions must be evaluated by the registered design professional for each application.
- Under the LARC, an engineered design in accordance with LARC Section R301.1.3 must be submitted.

This supplement expires concurrently with the evaluation report, reissued April 2025.