ICC-ES Evaluation Report

ESR-3403-NZ

Issued November 2024

Subject to renewal November 2025

DIVISION: 03 00 00 — CONCRETE **Section: 03 01 00 — Maintenance of Concrete** **Section: 03 01 30 — Maintenance of Cast-in-Place Concrete** **DIVISION: 04 00 00 — MASONRY** **Section: 04 01 00 — Maintenance of Masonry** **Section: 04 01 20 — Maintenance of Unit Masonry**	**REPORT HOLDER: SIMPSON STRONG-TIE COMPANY, INC.**	**EVALUATION SUBJECT: SIMPSON STRONG-TIE COMPOSITE STRENGTHENING SYSTEMS (CSSs)**	

1.0 EVALUATION SCOPE

Compliance with the following codes:

■ *New Zealand Building Code*: Building Regulations 1992 Version as at 15 November 2021. (2021 NZBC)

Compliance with the following functional and performance requirements:

Clause B1 Structure: NZBC Clauses B1.3.1, B1.3.2, B1.3.3 and B1.3.4.

Design of the Simpson Strong-Tie Composite Strengthening Systems (CSSs) described in this report must take into account physical conditions likely to affect the stability of the structure, including but not limited to imposed gravity loads arising from self-weight, use, and earthquake(See NZBC Clause B1.3.3 (a), (b) and (f)). See Section 4.1 of this report.

Clause B2 Durability: NZBC Clause B2.3.1(a).

The Simpson Strong-Tie Composite Strengthening Systems (CSSs), when maintained in accordance with this report, satisfies the performance of this code for the life of the building, being not less than 50 years. See Section 4.2 of this report.

Clause F2 Hazardous Building Materials: NZBC Clause F2.2.

The Simpson Strong-Tie Composite Strengthening Systems (CSSs) meet the functional requirements under Clause F2.2.

The Simpson Strong-Tie Composite Strengthening Systems (CSSs) members are not subject to a warning or ban under the New Zealand Building Act 2004, Version as at 7 September 2022.

2.0 USES

The Simpson Strong-Tie Composite Strengthening Systems (CSSs) are used to strengthen normal-weight reinforced concrete and reinforced masonry structural elements as alternatives to those systems described in the IBC. The CSS-CUCF and CSS-CUGF systems are also used as an interior finish.

3.0 DESCRIPTION

3.1 General:

The Composite Strengthening Systems (CSSs) are externally bonded fiber-reinforced polymer (FRP) systems applied to reinforced concrete and reinforced masonry structural elements. CSSs consist of carbon fabrics or glass fabrics combined with epoxy resin to create the FRP composite systems, or a carbon fiber precured laminate applied with an epoxy paste.

3.2 Materials:

3.2.1 General: All material must conform to the approved specifications outlined in the Simpson Strong-Tie CSS Quality Control Manual, dated June 18, 2015, Revision 1.

3.2.2 CSS Fabrics: The CSS fabrics are composed of carbon or glass fibers. CSS-CUCF11 and CSS-CUCF22 unidirectional carbon fabrics come in either 305 mm x 91.4 m (12-inch x 300-foot) or 610 mm x 45.7 m (24-inch x 150-foot) rolls. CSS-CUCF44 and CSS-CUCF44F unidirectional carbon fabrics come in either 305 mm x 45.7 m (12-inch x 150-foot) or 610 mm x 22.9 m (24-inch x 75-foot) rolls. CSS-CUGF27 unidirectional glass fabric comes in 635 mm or 1,270 mm x 100 m (25-inch or 50-inch x 150-foot) rolls. CSS-CBGF424 bidirectional glass fabric comes in 635 mm or 1,270 mm x 92 m (25-inch or 50-inch x 302-foot) rolls. Material properties vary with fiber type designation. The rolls of fabric are packaged in boxes.

3.2.3 Epoxy Saturants:

3.2.3.1 CSS-ES Epoxy Saturant: The CSS-ES epoxy saturant and primer is a two-component, ambient cure, epoxy resin system used to prime substrates and saturate CSS fabrics. It is available in 11.4 L (3-gallon) kits. Component A is packaged with 7.6 L (2 gallons) in a 18.9 L (5-gallon) bucket to allow enough room for mixing full kits of epoxy. Component B is packaged in 3.8 L (1-gallon) containers. Mixing ratio by volume is two-to-one for components A and B, respectively; by weight the ratio is 100 Part A to 38.8 Part B.

3.2.3.2 CSS-ESLPL Epoxy Saturant: The CSS-ESLPL is a two-component, long pot-life epoxy resin system used to prime substrates and saturate CSS fabrics. Component A is packaged with 7.6 L (2 gallons) in a 18.9 L (5-gallon) bucket to allow enough room for mixing full kits of epoxy. Component B is packaged in 3.8 L (1-gallon) containers. Mixing ratio by volume is 2.0 Part A to 0.96 Part B; by weight the ratio is 100 Part A to 38.8 Part B.

3.2.4 CSS-CUCL Precured Laminates: The CSS-CUCL unidirectional carbon laminates are comprised of carbon fibers, precured in an epoxy resin. CSS precured laminates come in 1.2 mm, 1.4 mm, and 2.8 mm (0.047 inch, 0.055 inch, and 0.110 inch) thicknesses and various widths ranging from 10 mm to 150 mm (0.39 inch to 5.90 inches), and a standard length of 150 m (492 feet).

3.2.5 CSS-EP Epoxy Paste: The CSS-EP epoxy paste is a two-component, epoxy paste system used to fill and transition irregular substrates and adhere CSS-CUCL precured laminates. CSS-EP is available in 11.4 L (3-gallon) kits. Components A and B are packaged in 3.8 L (1-gallon) containers and entire kits are packaged in one carton. Mixing ratio is two-to-one for components A and B, respectively.

3.2.6 CSS Composites:

3.2.6.1 CSS-CUCF Composites: In the primary direction (0°), the carbon fiber composites have a minimum ultimate tensile strength of 880 MPa (128,000 psi), a minimum tensile modulus of 97 GPa (14,200 ksi) and a corresponding elongation of 0.9 percent. Cured composites have a thickness of 0.5 mm (0.02 inch) for CSS-CUCF11, 1 mm (0.04 inch) for CSS-CUCF22 and 2 mm (0.08 inch) for CSS-CUCF44 and CSS-CUCF44F, respectively.

3.2.6.2 CSS-CUGF Composite: In the primary direction (0°), the glass-fiber composite has a minimum ultimate tensile strength of 386 MPa (56,000 psi), a minimum tensile modulus of 22 GPa (3,300 ksi) and a corresponding elongation of 1.7 percent. The cured composite has a minimum thickness of 1.3 mm (0.05-inch).

3.2.6.3 CSS-CBGF Composite: In both directions (±45° from the roll length), the glass fiber composite has a minimum ultimate tensile strength of 275 MPa (40,000 psi), a minimum tensile modulus of 20 MPa (2,900 ksi) and a corresponding elongation of 1.4 percent. The cured composite has a minimum thickness of 0.86 mm (0.034 inch).

3.2.6.4 CSS-CUCL Laminate Composite: In the primary direction, the precured laminate has a minimum ultimate tensile strength of 1,250 MPa (181,000 psi), a minimum tensile modulus of 163 MPa (23,600 ksi) and a corresponding elongation of 0.77 percent. The thickness of the precured laminate is 1.2 mm, 1.4 mm and 2.8 mm (0.047 inch, 0.055 inch and 0.110 inch).

3.2.6.5 RPS-207 Finish Coating: The Simpson Strong-Tie proprietary RPS-207 finish coating is a two-component, polymer-modified cementitious coating. Component A comes in a 3.8 L (1-gallon) container and Component B comes in an 18 kg (40-pound) bag. Pot life is 30 minutes.

3.2.7 GCP Z-106 HY Finish Coating: The GCP Applied Technologies Monokote Z-106 HY finish coating is a Portland cement based cementitious fireproofing coating. This product is available in 22.2 kg (49 lb) bags.

3.2.8 Firebond Concentrate Primer: The Firebond Concentrate Primer is a bonding agent used to bond GCP Applied Technologies Monokote Z-106 HY to the substrate or installed composite. This primer is available in either 19 L (5 gal) or 208.2 L (55 gal) containers.

3.2.9 Storage Recommendations: Epoxies, coating, fabrics and precured laminates should be stored in temperatures between 7°C and 35°C (45°F and 95°F) with no exposure to moisture. Shelf life is one year for coating, two years for epoxies and ten years for fabrics and precured laminates.

4.0 DESIGN AND INSTALLATION

4.1 Design:

4.1.1 General: Design of the Composite Strengthening Systems must be based on required tensile loads at designated concrete strain values. The strength design requirements for concrete and reinforced masonry must be in accordance with NZS 3101.1:2006 *Concrete Structures Standard* and NZS 4230:2004 *Design of Reinforced Concrete Masonry Structures Amend: 1, respectively,* and all applicable requirements in Section 4.1 of this evaluation report. The registered design professional must be responsible for determining, through analysis, the strengths and demands of the structural elements to be strengthened with CSS composites, subject to the approval of the code official.

4.1.2 Composite Design Properties: Composite structural design properties are found in the CSS NZ Design Manual, dated November 8, 2024.

4.1.3 Design Details: Structural design provisions for the composite system are based on test results and principles of structural analysis as set forth in Section 5 of AS/NZS 1170 Part 0:2022 *Structural Design Actions, General Principals*. Bases of design include strain compatibility, load equilibrium and limit states. All designs must follow procedures as detailed in the NZS 3101.1; in the ICC-ES Acceptance Criteria for Concrete and Reinforced and Unreinforced Masonry Strengthening Using Externally Bonded Fiber-reinforced Polymer (FRP) Composite Systems (AC125), dated October 2019 (editorially revised December 2020); and applicable procedures detailed in the CSS NZ Design Manual.

4.1.4 Design Strength: Design strengths must be taken as the nominal strength, computed in accordance with the applicable section the CSS NZ Design Manual, multiplied by the appropriate FRP reduction factor, ψ_f, provided in the CSS NZ Design Manual, and strength reduction factors provided in Section 2.3.2.2 of NZS 3101.1 for concrete design and Section 3.4.7 of NZS 4230 for reinforced masonry design.

4.1.5 Load Combinations: The load combinations used in design must comply with AS/NZS 1170.0, as applicable.

4.1.6 Columns:

4.1.6.1 Potential Applications: CSS-CUCF, CSS-CUGF and CSS-CBGF Composite Strengthening Systems are applied to circular or rectangular reinforced concrete columns to enhance their axial, flexural and shear strengths, and ductility.

4.1.6.2 Structural Design Requirements: Concrete column design must comply with the CSS NZ Design Manual and with NZS 3101.1.

4.1.7 Beams and Slabs:

4.1.7.1 Potential Applications: CSS-CUCF Composite Strengthening Systems are applied to beams to enhance their ductility, flexural and shear strengths. The CSS-CUGF and CSS-CUCL Composite System applied to beams is used to enhance the beam ductility and flexural strength. The CSS-CUCF, CSS-CUGF and CSS-CUCL Composite Strengthening Systems are also applied to slabs to enhance their out-of-plane flexural strength and their in-plane shear strength.

4.1.7.2 Structural Design Requirements: Concrete beam design must comply with the CSS NZ Design Manual and with NZS 3101.1.

4.1.8 Walls:

4.1.8.1 Potential Applications: CSS-CUCF and CSS-CUCL Composite Strengthening Systems are applied to reinforced concrete walls to enhance their out-of-plane flexural strength and in-plane shear strength. CSS-CUGF Composite Strengthening Systems are applied to reinforced masonry walls to enhance their out-of-plane flexural strengths.

4.1.8.2 Structural Design Requirements: Concrete design must comply with the CSS NZ Design Manual and NZS 3101.1, as applicable. Reinforced Masonry design must comply with the CSS NZ Design Manual and NZS 4230, as applicable.

4.1.9 Wall-to-Floor joints:

4.1.9.1 Potential Applications: CBGF Composite Strengthening Systems are applied to concrete wall-to-floor joints to enhance their shear strength.

4.1.9.2 Structural Design Requirements: Concrete design must comply with the CSS NZ Design Manual and NZS 3101.1, as applicable.

4.1.10 Concrete Diaphragms:

4.1.10.1 Potential Applications: CUCF Composite Strengthening Systems are applied to reinforced concrete diaphragms to enhance their in-plane shear strength and in-plane flexural strength (chords) for wind loading or seismic (dynamic) loading applications. CUCF Composite Strengthening Systems are also applied to reinforced concrete diaphragms to enhance the axial tension capacity of the collector element for wind loading or seismic (dynamic) loading applications.

4.1.10.2 Structural Design Requirements: Concrete design must comply with the CSS NZ Design Manual and NZS 3101.1as applicable.

4.1.11 Bond Strength: Where the performance of the CSS composite systems defined in this report depends on bond, the bond strength of CSS Composite material to concrete must not be less than 1378 kPa (200 psi). Bond testing must exhibit failure in the concrete substrate. Testing in accordance with ASTM D7234 or D7522 may be used to estimate the bond strength of bond-critical installations.

4.2 Durability (Clause B2):

4.2.1 General: The Simpson Strong-Tie CSS Composite Strengthening Systems have an expected life exceeding 50 years when designed, installed and maintained in accordance with this report, and the manufacturer's installation instructions.

4.2.2 Maintenance: Maintenance of the Simpson Strong-Tie CSS Composite Strengthening Systems will not normally be required during the expected life of the CSS Composite Systems.

4.3 Installation:

Simpson Strong-Tie CSS Composite Strengthening Systems installations must be performed by approved applicators specific to this composite system. Installation recommendations are detailed in the approved applicator training program and Section 2.0 of the Quality Control Manual dated June 18, 2015, Revision 1.

4.3.1 Saturation: CSS fabrics and saturating epoxy of the CSS Composites are combined in accordance with published literature and applicator training program using a calibrated mechanical saturator or manual saturation methods. CSS precured laminates come to the site in precured form ready to apply to substrate once cut to required length and cleaned.

4.3.2 Application: Manual methods must be used to apply saturated CSS Composite fabrics to the substrate prior to epoxy cure. Surface preparation, fiber orientation and removal of bubbles/voids must be done in accordance with published literature and approved applicator training program. For precured laminates, CSS-EP paste must be applied to the laminate with paste thickness of approximately $^1/_8$ in (3 mm).

4.3.3 Finishing: Composite Strengthening Systems are typically painted or coated for aesthetic, fire-resistance or environmental durability considerations.

4.3.3.1 Health Effects Coating: The CSS-ES epoxy saturant and CSS-EP are formulated for potable water contact and comply with ANSI/NSF 61 requirements. CSS-ES epoxy saturant must be applied over the CSS composites to a maximum thickness of 0.025 mm (10 wet mills). CSS-EP epoxy paste must be applied over the installed CSS precured laminates to a maximum thickness of 0.1 mm (40 wet mils). All surfaces must be clean, dry, and free of contaminants. Final cure is 72 hours at 21°C (70°F).

4.4 Inspection:

Inspections must be performed by an independent qualified person as listed in the building consent and as required by this report. The manufacturer shall provide inspection procedures to verify proper usage. Inspection during the installation of the system must be in accordance with the ICC-ES Acceptance Criteria for Inspection and Verification of Concrete and Unreinforced Masonry Strengthening Using Fiber-reinforced Polymer (FRP) Composite Systems (AC178), dated October 2017 (editorially revised December 2020).

5.0 CONDITIONS OF USE:

The Simpson Strong-Tie Composite Strengthening Systems (CSSs) 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 of the structural systems recognized in this report must be in accordance with this report, the CSS Quality Control Manual dated June 18, 2015, the CSS NZ Design Manual dated November 8, 2024, and the 2021 NZBC, as applicable.

5.2 Copies of the Simpson Strong-Tie Composite Strengthening Systems installation instructions and the CSS NZ Design Manual must be submitted to the code official for each project where these products are used.

5.3 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 the designer where required by the statutes of the jurisdiction in which the project is to be constructed.

5.4 When the Simpson Strong-Tie Composite Strengthening Systems (CSSs) are applied in areas of a building listed under 2021 NZBC Clause C3.4(a) *Fire affecting areas beyond the fire source* apply, protection of the composite strengthening systems satisfying the applicable performance requirement under Clause C3.4(a) shall be provided.

5.5 An RPS-207 finish coating or GCP Applied Technology spray applied fire resistant material may be provided as required for additional fire resistance.

5.6 Evaluation of the Simpson Strong-Tie Composite Strengthening Systems (CSSs) for 2021 NZBC Clause C6 *Fire Protection, Structural Stability* is outside the scope of this report. Inspection for application of the Composite Strengthening Systems products must be provided in accordance with Section 4.3 of this report.

5.7 Multi-layer applications and lap splices of CSS-CUCL precured laminates are outside the scope of this report. Composite Strengthening Systems (CSSs) must be manufactured by Simpson Strong-Tie Company, Inc. under a quality-control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Concrete and Reinforced and Unreinforced Masonry Strengthening using Externally Bonded Fiber-Reinforced Polymer (FRP) Composite Systems (AC125), dated October 2019 (editorially revised December 2020), including alkali-soil resistance, fuel-resistance and drinking water exposure tests.

7.0 IDENTIFICATION

7.1 The ICC-ES mark of conformity, electronic labeling, or the evaluation report number (ICC-ES ESR-3403) along with the name, registered trademark, or registered logo of the report holder, must be included in the product label.

7.2 In addition, the Simpson Strong-Tie Composite Strengthening Systems (CSSs) are identified with a label indicating the address of the manufacturer (Simpson Strong-Tie), the product name, expiration date.

The proprietary RPS-207 finish coating is labeled with manufacturer's name (Simpson Strong-Tie) and address, the product name, and expiration date.

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

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