

ICC-ES Evaluation Report

ESR-1746

Reissued November 2023


This report also contains:

- CBC Supplement

Subject to renewal November 2024

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<p>DIVISION: 03 00 00 — CONCRETE</p> <p>Section: 03 16 00 — Concrete Anchors</p> <p>Section: 03 41 00 — Precast Structural Concrete</p> <p>Section: 03 47 00 — Site-Cast Concrete</p>	<p>REPORT HOLDER: COMPOSITE TECHNOLOGIES, LLC dba THERMOMASS</p> <p>Leviat® A CRH COMPANY</p>	<p>EVALUATION SUBJECT: THERMOMASS® MC AND MS FIBER REINFORCED COMPOSITE WYTHE CONNECTORS FOR INTEGRALLY INSULATED WALL PANELS</p>	
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1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2021, 2018, 2015, 2012 and 2009 [International Building Code® \(IBC\)](#)
- 2013 *Abu Dhabi International Building Code (ADIBC)*[†]

[†]The ADIBC is based on the 2009 IBC. 2009 IBC code sections referenced in this report are the same sections in the ADIBC.

- 1997 *Uniform Building Code™ (UBC)*

Properties evaluated:

- Structural
- Environmental
- Physical and mechanical

2.0 USES

The MC and MS connectors are used in integrally insulated concrete walls (commonly known as sandwich walls) to resist static and transient tension and shear loads in uncracked, normal-weight concrete. The connectors are alternatives to cast-in-place steel anchors described in Section 1901.3 of the 2021, 2018, 2015 IBC, or Sections 1908 and 1909 of the 2012 IBC, or Sections 1911 and 1912 of the 2009 IBC, or Section 1923 of the UBC.

3.0 DESCRIPTION

3.1 Connectors:

MC and MS connectors are fiber-reinforced composite connectors with dove-tail anchors at both ends for anchorage into wet concrete with a plastic overmold in the middle of the connector. The connectors are illustrated in [Figure 1](#). The connectors are produced by a pultrusion process from a polymer composite consisting of epoxy vinylester resin reinforced with glass fibers. The overmold is injection-molded from polystyrene plastic.

The MC and MS connectors measure 0.224 inch (5.7 mm) thick and 0.393 inch (10 mm) wide.

3.2 Concrete:

Normal-weight concrete must conform to Section 1903 of the 2021, 2018, 2015 and 2012 IBC or 1997 UBC and Section 1905 of the 2009 IBC or UBC, as applicable and comply with the compressive strength requirements in [Table 2](#).

4.0 DESIGN AND INSTALLATION

4.1 Physical and Material Properties of the Connectors:

Design must be based on the physical and mechanical properties described in [Tables 1](#) and [2](#).

4.2 Design for Tension and Shear:

Design must be performed using the applicable sections of the applicable codes and using the allowable loads as noted in [Table 2](#). Allowable loads for MC or MS connectors subjected to combined shear and tension forces must be determined by the following equation:

$$(P_s/P_t) + (V_s/V_t) \leq 1$$

where:

P_s = Applied service tension load (lbf or N).

P_t = Service tension load (lbf or N).

V_s = Applied service shear load (lbf or N).

V_t = Service shear load (lbf or N).

4.3 Displacement of the Connector:

The displacement due to gravity loads must be limited to 0.1 inch (2.54 mm). When the connector displacement exceeds the limiting value of 0.1 inch (2.54 mm) due to the gravity loads, the free end of the connector must be supported to maintain fixity by other means. The displacement must be calculated as follows (neglecting any contribution from the insulation in the intended application):

$$\Delta_g = \frac{Q_g \cdot d_A^3}{12E_{Ab} \cdot I_A}$$

where:

Δ_g = Displacement due to gravity load (inch or mm).

Q_g = Gravity load on the connector, typically the weight of the fascia layer of the tributary area for the connector (lbf or kN), $Q_g = t \cdot a \cdot b \cdot \gamma$, where t = thickness of the fascia layer (feet or m); a = horizontal spacing of the connector (feet or m); b = vertical spacing of the connector (feet or m); γ = density of concrete (lbf/ft³ or kN/m³).

$$d_A = d_d + \frac{2h_v}{3} \left[1 - \frac{1}{1 + \frac{h_v}{d_d}} \right]$$

where:

d_A = Connector bending length, a function of insulation thickness and embedment (inch or mm).

d_d = Insulation thickness (inch or mm).

h_v = Embedment length of the connector in the concrete.

E_{Ab} = 0.95 times the flexural modulus of elasticity as given in [Table 1](#) (psi or MPa).

I_A = Moment of inertia of the connector as given in [Table 1](#) (in⁴ or mm⁴).

The deflection of the connector may be reduced by decreasing the connector spacing, but not less than 8 inches (203 mm) on center each way.

4.4 Installation:

Connector orientations and locations must comply with this report and the plans and specifications approved by the code official. MC and MS connectors must be installed in accordance with the instructions provided by Composite Technologies LLC dba Thermomass. The instructions are provided with each shipment of the connectors. The minimum embedment, critical edge distance, and critical spacings must comply with [Table 3](#) of this report.

The minimum concrete thickness must comply with the applicable code requirements or 1.5 times the connector effective embedment, whichever is greater. Within 20 minutes after the bottom layer of concrete is placed, code-complying rigid insulation board with holes sized to accept the connectors must be placed over the concrete while it is in the plastic state. The connectors, sized to match the insulation board thickness, are inserted through the holes in the insulation board into the bottom layer of concrete, until the prescribed embedment is reached. Concrete consolidation around the connectors must be conducted in accordance with the applicable code and Thermomass published instructions. The top layer of concrete is then placed over the insulation board, engaging the connectors and consolidated. Panels must cure in accordance with the applicable code.

4.5 Special Inspection:

Installations must be made under special inspection in accordance with Section 1705.1.1 of the 2021, 2018, 2015 and 2012 IBC, or Section 1704.15 of the 2009 IBC, or Section 1701.5.2 of the UBC. The special inspector must be on the jobsite continuously during connector installation to verify connector type, connector dimensions, and cleanliness, embedment depth, concrete type, concrete compressive strength, edge distance(s), connector spacing(s), concrete thickness, concrete consolidation, and concrete curing.

5.0 CONDITIONS OF USE:

The Thermomass MC and MS connectors 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 Connector sizes, dimensions, and installation must comply with this report and Thermomass published installation instructions. In case of a conflict between this report and other documentation, this report governs.
- 5.2 Allowable tension and shear loads must be as noted in the [Table 2](#).
- 5.3 Calculations and details demonstrating compliance with this report must be submitted to the code official for approval. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.
- 5.4 Design and installation of the concrete wall panels, except as specifically noted in this report, is outside the scope of this report and must comply with the applicable code.
- 5.5 Connectors may be recognized for interior exposure, exterior exposure, or damp environments.
- 5.6 Connectors must not be permitted in contact with preservative-treated and fire-retardant-treated wood.
- 5.7 Special inspection must be provided in accordance with Section 4.5 of this report.
- 5.8 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of connectors subjected to fatigue or shock loading is unavailable at this time, the use of these connectors under these conditions is beyond the scope of this report.
- 5.9 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of fiber-reinforced connectors in cracked concrete is unavailable at this time, the use of these connectors must be limited to installation in uncracked, normal-weight concrete. Cracking occurs when $f_t > f_r$ due to service loads or deformations.
- 5.10 Connectors must not be permitted for use in conjunction with fire-resistance-rated construction. Exceptions are:
 - Connectors resist wind loading only.
 - For other than wind loading, special consideration is given to fire exposure conditions.
- 5.11 Seismic or wind load under the IBC: Use of the connectors to resist seismic loads is beyond the scope of this report. When using the basic load combinations in accordance with 2021 IBC Section 1605.1, or 2018, 2015, 2012 and 2009 IBC Section 1605.3.1, allowable loads are not permitted to be increased for wind loading. When using the alternative basic load combinations in 2021 IBC Section 1605.2, or 2018, 2015, 2012 and 2009 IBC Section 1605.3.2 that include wind loads, the allowable shear and tension loads for connectors may be increased.
- 5.12 Seismic or wind load under the UBC: When using the basic load combinations in accordance with UBC Section 1612.3.1, allowable loads are not permitted to be increased for wind or seismic loading. When using the alternative basic load combinations in UBC Section 1612.3.2 that include wind or seismic loads, the allowable shear and tension loads for connectors are permitted to be increased by 33 $\frac{1}{3}$ percent.

5.13 Connectors are manufactured by Composite Technologies, LLC dba Thermomass, under a quality control program with inspections conducted by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the [ICC-ES Acceptance Criteria for Fiber-reinforced Polymer Composite or Unreinforced Polymer Connectors Anchored in Concrete \(AC320\)](#), dated October 2015 (editorially revised May 2021), including seismic tests, creep tests, and extreme temperature tests.

7.0 IDENTIFICATION

- 7.1 The ICC-ES mark of conformity, electronic labeling, or the evaluation report number (ICC-ES ESR-1746) 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 connectors must be identified in the field by dimensional characteristics and packaging. The packaging label indicates the Composite Technologies, LLC dba Thermomass name and address. Each connector is stamped with the lot number.
- 7.3 The report holder's contact information is the following:

COMPOSITE TECHNOLOGIES, LLC
dba THERMOMASS
1000 TECHNOLOGY DRIVE
POST OFFICE BOX 950
BOONE, IOWA 50036
(210) 612-2067
www.thermomass.com

TABLE 1—PHYSICAL AND MECHANICAL PROPERTIES

DESCRIPTION	MC CONNECTOR		MS CONNECTOR	
	Customary Units	SI Units	Customary Units	SI Units
Cross-sectional area	0.078 in ²	50.5 mm ²	0.078 in ²	50.5 mm ²
Average moment of inertia	0.0005858 in ⁴	243 mm ⁴	0.0005858 in ⁴	243 mm ⁴
Embedment depth	2 inches	51 mm	1.5 inches	38 mm
Bending elastic modulus (flexural modulus)	4,764,000 psi	32,846 MPa	4,764,000 psi	32,846 MPa

TABLE 2—ALLOWABLE TENSION AND SHEAR VALUES IN NORMAL-WEIGHT CONCRETE¹ (in pounds)

DESCRIPTION	MC CONNECTOR		MS CONNECTOR
	$f'_c = 6,000 \text{ psi}^2$	$f'_c = 4,000 \text{ psi}^2$	$f'_c = 6,000 \text{ psi}^2$
Static tension	707	577	608
Static shear, parallel to strong axis	197	126	148
Static shear, parallel to weak axis	152	113	104
Seismic tension ³	647	572	558
Seismic shear, parallel to strong axis ³	197	110	148
Seismic shear, parallel to weak axis ³	152	106	104
High-temperature tension (at 150°F)	707	N/A	472
Low-temperature tension (at -40°F)	707	N/A	608

For **SI**: 1 psi = 6.9 kPa, 1 pound = 4.45 N, °C = 5/9(°F - 32).

¹Allowable loads have been determined by applying a factor of safety of 4 to the test results.

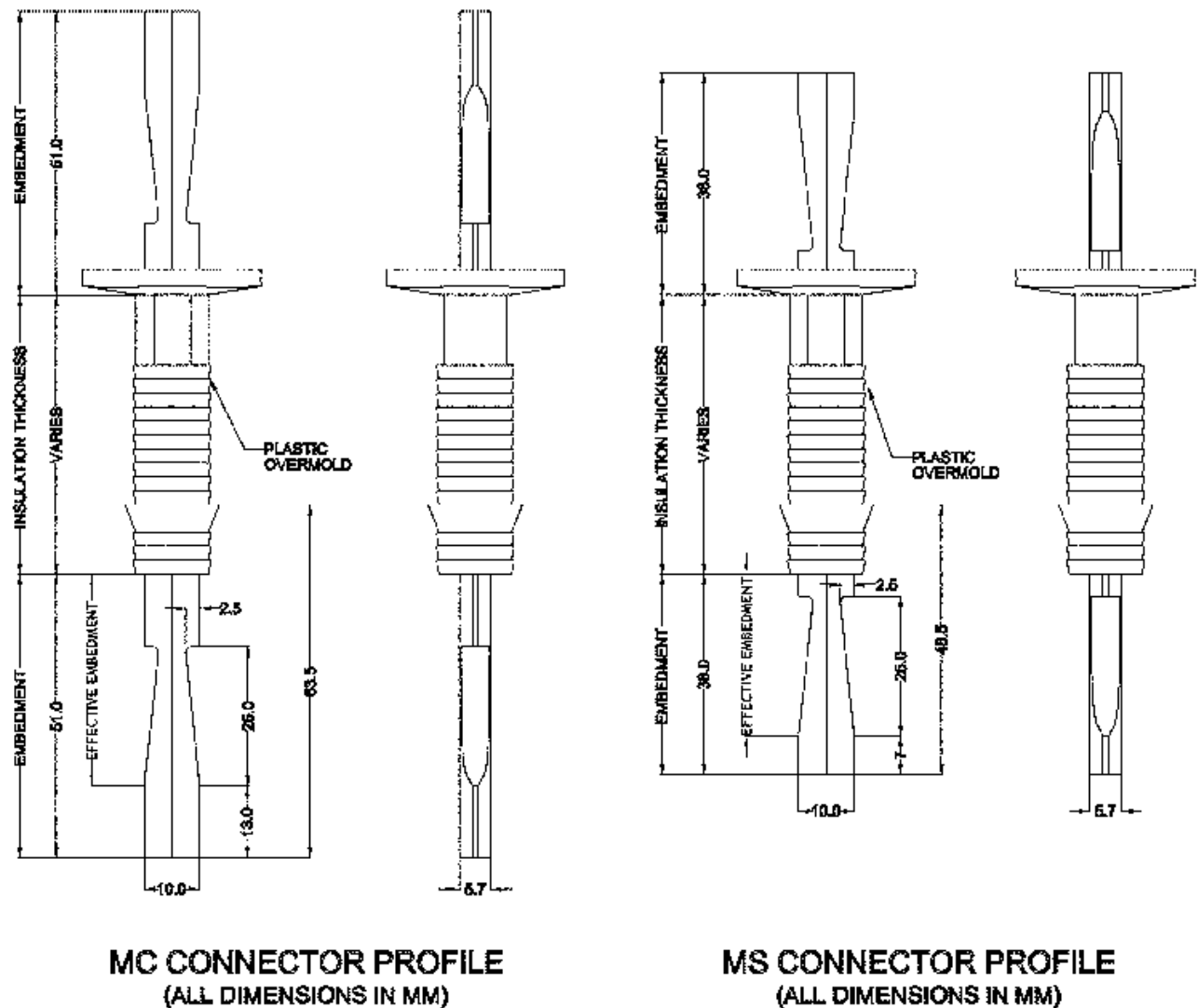
²Concrete must achieve this compressive strength before anchors are loaded [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

³For use under the UBC only.

TABLE 3—INSTALLATION PARAMETERS

DESCRIPTION	MC CONNECTOR (inches)	MS CONNECTOR (inches)
Embedment	2	1½
Critical edge distance	5.25	5.25
Critical spacing	8	8

For SI: 1 inch = 25.4 mm.



For customary units 25.4 mm = 1 inch.

FIGURE 1

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DIVISION: 03 00 00—CONCRETE

Section: 03 16 00—Concrete Anchors

Section: 03 41 00—Precast Structural Concrete

Section: 03 47 00—Site-Cast Concrete

REPORT HOLDER:

COMPOSITE TECHNOLOGIES, LLC dba THERMOMASS

EVALUATION SUBJECT:

THERMOMASS® MC AND MS FIBER REINFORCED COMPOSITE WYTHE CONNECTORS FOR INTEGRALLY INSULATED WALL PANELS

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the Thermomass MC and MS connectors, described in ICC-ES evaluation report ESR-1746, have also been evaluated for compliance with the code noted below.

Applicable code edition:

- 2022 California Building Code (CBC)

For evaluation of applicable Chapters adopted by the California Office of Statewide Health Planning and Development (OSHPD) AKA: California Department of Health Care Access and Information (HCAI) and the Division of State Architect (DSA), see Sections 2.1.1 and 2.1.2 below.

2.0 CONCLUSIONS

2.1 CBC:

The Thermomass MC and MS connectors, described in Sections 2.0 through 7.0 of the evaluation report ESR-1746, comply with CBC Chapter 19, provided the design and installation are in accordance with the 2018 *International Building Code*® (IBC) provisions noted in the evaluation report and the additional requirements of CBC Chapters 16, 17 and 19, as applicable.

2.1.1 OSHPD:

The applicable OSHPD Sections and Chapters of the CBC are beyond the scope of this supplement.

2.1.2 DSA:

The applicable DSA Sections and Chapters of the CBC are beyond the scope of this supplement.

This supplement expires concurrently with the evaluation report, reissued November 2023.