SPECIFICATION INSERTS AND COMMENTARY

FOR PROJECTS SPECIFYING



FOR PRECAST CONCRETE

This document is intended to assist designers, manufacturers, and owners in preparing specifications for projects incorporating the Thermomass system in precast insulated concrete sandwich wall panels. This document was prepared by the manufacturer and supplier of the Thermomass building insulation system: Leviat, Tampa, Florida.

The specification writer should consider the inserts below, individually, as additions or revisions to a master specification for precast insulated concrete sandwich wall panels. The text herein is generally presented according to the Masterformat™ Edition Numbers & Titles recommended by the Construction Specifications Institute (CSI).

The paragraph and subparagraph identification letters and numbers herein are presented consecutively and are arbitrary. The specifier should insert text at appropriate locations in the master specification and consecutively re-letter and re-number the paragraphs and subparagraphs accordingly.

Text appearing in **italics** is commentary for the specification writers’ careful consideration and should not be included in the project specifications as written. Many of the comments are based on experience with thousands of projects using Thermomass since 1980. Some commentary and suggestions do not necessarily relate directly to the insulation components, but rather to the construction practices for concrete sandwich wall systems. Although Leviat provides this information to improve the overall quality of the completed wall panels, it makes no warranties or claims for the specific recommendations. **This Guide Specification must be edited to fit the conditions of use.**

Commentary containing the words “No inserts or commentary” indicate that additional text is not required to further specify or identify the Thermomass system in that article or section.

The text appearing as **<SPECIFIER>** indicates that the specifier must supply data; text appearing within **[SPECIFIER]** indicates a selection may be needed.

This document is also available @: **https://thermomass.com/engineering/specifications/**

1. GENERAL
	1. RELATED DOCUMENTS

No inserts or commentary.

* 1. RELATED SECTIONS
		1. Related sections include the following:
			1. Division 03 Section “Precast Structural Concrete”
			2. Division 03 Section “Precast Architectural Concrete”
	2. DEFINITIONS
		1. Composite: A material or product comprised of two or more dissimilar components.
		2. Glass Fiber Reinforced Polymer (GFRP): A composite material made from glass fibers, using vinyl ester resin as a polymer.
		3. GFRP Shear Connectors: GFRP shear connectors transfer high shear forces that are generated due to longitudinal bending from one concrete wythe to the other, thus providing composite action. Composite action is achieved by transferring forces from one wythe to the other through an insulation core by use of GFRP shear connectors. GFRP shear connectors are used in the manufacturer of ‘*Partially composite*’ wall panels.
		4. GFRP Tension Connectors: GFRP tension connectors have sufficient shear capacity to transfer the dead load of a typical fascia wythe. They are not capable of transferring shear forces due to the longitudinal bending of the panel. Typically, a GFRP tension connector is flexible and will bend due to temperature induced forces. GFRP tension connectors are used in the manufacturer of ‘*Non-composite*’ wall panels.
		5. Insulated Wall Panels (IWP): There are three different types of integrally insulated, wall panel designs.
			1. *Non-Composite*: In non-composite panels, the concrete wythes act independently. The wythes are isolated by rigid insulation and are connected solely by thermally, non-conductive pin connectors. The interior structural wythe is usually much thicker than the exterior face wythe.
			2. *Fully-Composite*: In fully composite panels, the wythes act together as a unit for full horizontal shear transfer. A typical composite panel is eight times stiffer, can take three times the stress without cracking and has twice the ultimate strength of a non-composite panel of similar thickness. Unlike non-composite panels, composite panels often bow outward when exposed to direct sunlight, due to the temperature increase and subsequent expansion of the outer wythe. This characteristic is normal but should be considered.
			3. *Partially-Composite*: Partially composite panels provide less than full shear transfer between wythes. They behave in a manner in-between composite and non-composite. The degree of composite action is determined by calculations performed by the panel designer/wall manufacturer. Partial composite action provides sufficient strength for most applications.
		6. Delegated Design: The transfer of design responsibility of certain aspects of the project from the design professional to the general manufacturer or the wall panel fabricator.
		7. Design Assist: The design-assist process, a consultant specializing in the specific trade or system (such as sandwich panel systems) is brought into the team. This consultant assists the Architect/Engineer/General Contractor in staying ahead of potential constructability issues and identifies key interfacing design details but is not responsible for the final design.
		8. Acceptance Criteria (AC): For innovative products not specifically referenced in the code, existing or new Acceptance Criteria developed by ICC-ES are used as the basis for evaluation.
		9. ICC-ES Evaluation Report (ESR): Evaluation reports from ICC Evaluation Service® are the most preferred resource used by code officials to verify that new and innovative building products comply with code requirements.
	3. SUMMARY
		1. This section includes the following insulated wall panels:
			1. Precast Structural, **[Non-composite] [Partially-composite], [Load Bearing] [Cladding]** units.
			2. Precast Architectural, **[Non-composite] [Partially-composite], [Load Bearing] [Cladding]** units.
	4. REFERENCES
		1. AC 320 *Fiber-reinforced Polymer Composite or Unreinforced Polymer Connectors Anchored in Concrete*
		2. ANSI/ASHRAE/IESNA *Standard 90.1 Energy for Buildings*
		3. ASHRAE *Handbook of Fundamentals*
		4. ASTM D 3039 *Tensile Properties of Polymer Matrix Composite Materials*
		5. ASTM E 119 *Fire Tests of Building Construction and Materials*
		6. NFPA 285 *Evaluation of Fire Propagation Characteristics of Exterior Non-Load Bearing Walls*
		7. ASTM E 1225 *Thermal Conductivity for Solids*
		8. ASTM E 488 *Strength of Anchors in Concrete Elements*
		9. *Energy Policy Act of 1992*
		10. *Energy Independence and Security Act of 2007*
		11. *American Innovation and Manufacturing Act of 2020*
		12. ACI 318 *Building Code Requirements for Structural Concrete*
		13. ASTM C 581 *Determining Chemical Resistance of Thermosetting Resins*
		14. ASTM C 309 *Concrete Curing*
		15. ASTM D 790 *Flexural Properties of Unreinforced and Reinforced Plastics*
	5. PERFORMANCE REQUIREMENTS

Retain paragraph below if delegating design responsibility for the partially-composite, precast insulated concrete wall panels to the precast wall manufacturer. AIA Document A201 requires Owner or Architect to specify performance and design criteria*.*

* + 1. Structural Performance: Provide partially-composite wall panels (utilizing GFRP shear connectors) and connections capable of withstanding design loads indicated limits and under conditions indicated on drawings.
	1. ACTION SUBMITTALS
		1. Product Data: For each type of product.
		2. LEED Submittals:

*Retain subparagraph below if recycled content is required for LEED-NC Credits MR 4.1 and*

*MR 4.2. An alternative method of complying with Credit MR 4.1 and MR 4.2 requirements is to retain requirement in Division 01 SECTION “Sustainable Design Requirements” that gives the manufacturer the option and responsibility for determining how Credit MR 4.1 and MR 4.2*

*requirements will be met.*

Product Data for Credit MR 4.1 **[and Credit MR 4.2]:** For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content.

"Product Certificates for Credit MR 5" Subparagraph below applies to LEED-NC, LEED-CS, and LEED for Schools.

Product Certificates for Credit MR 5.1 **[and Credit MR 5.2]:** For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer within a 500-mile radius from project site.

* + 1. Thermal Calculations: Provide calculations complying with ASHRAE/IES Standard 90.1 and confirming the effective thermal resistance for the concrete sandwich wall system.
			1. Isothermal Planes (Series Parallel Path) Analysis:
				1. To follow this standard, all wall assemblies must be calculated as provided for in *The ASHRAE Handbook - Fundamentals - Chapter 23.*
			2. Building Envelope Performance Study:
				1. ASHRAE/IESNA STANDARD 90.1 - SYSTEM PERFORMANCE CRITERIA: R-value Performance and the Heating and Cooling Load Adjustments for the Effects of Concrete Mass within the Building Envelope.
		2. Moisture Calculations: Provide calculations complying with the ASHRAE Handbook of Fundamentals – Theory of Water Vapor Migration and confirming the requirements for effective moisture condensation prevention.
			1. Dewpoint Analysis:
				1. The construction of the wall panel and the building envelope must include adequate design to prevent the formation of frost or ice on any panel surface and must maintain inner-wall condensation potential below **<SPECIFIER>** oz./day/sq.ft. based on summer design extremes.

ASHRAE/IES Standard 90.1 requires that thermal performance be established using the isothermal planes analysis method. This standard is now incorporated by reference in model energy codes. Calculations must include the effects of any thermal bridges that penetrate the insulation, including concrete or metal connections.

Thermal bridges significantly compromise the thermal performance of insulated concrete sandwich wall panels. Envelope performance must account for varying insulation positions when it is not placed on the same side of an envelope construction. Standard 90.1 requires that, in addition to analysis of penetrations through insulation, analysis of thermal bridges created by the construction process is considered.

For example, buildings may be designed with insulation at the top of the wall, while others are designed with insulation located outside the wall for the first twelve feet and inside the wall for the remaining height up to the roof system. These designs create a thermal bridge (the wall) at the point where the two systems cross or the top insulation ends without physical intersection with an adjacent insulation system. The specifier should identify the acceptable R-value for the panels. Leviat can provide thermal calculations of the wall systems based on satisfying the International Energy Conservation Code at no cost.

* + 1. Insulation Shop Drawings
			1. Detail the fabricated insulation sheets and connector placement used for sandwich wall panels.
			2. Indicate location of openings with dimensions.
			3. Indicate any aesthetic intent including joints, rustications, and reveals that would come in contact or otherwise interfere with the installation of the GFRP connectors or their effectiveness.
			4. Include and locate only those openings greater than 10 square inches.
		2. Thermal Bowing and Crack Mitigation
			1. Provide details that indicate how panel bowing and concrete cracking can be mitigated if the concrete sandwich wall panels do not include full-thickness concrete sections or metallic connectors between the concrete wythes (surfaces).

Full-thickness concrete sections and metallic connectors can have serious detrimental effects on the thermal performance of sandwich panels. **Leviat strongly discourages the design or use of full-thickness concrete sections and/or metallic connectors at any location in the panels.**

If a panel manufacturer opts to use full-thickness concrete or metallic connections, consideration must be given to the effects those connections have on the panels and surrounding materials in the project. These negative effects can include concrete panel cracking and bowing induced by the constraint of the outer wythe movement relative to the inner wythe. Also, full-thickness concrete sections will allow condensation to form at the breaks in the insulation system, resulting in heating and cooling loss, moisture migration, inconsistent face appearance, coating failures on painted panels, and growth of mold and mildew.

* + 1. Fire Resistance
			1. Provide calculations showing compliance with a minimum fire resistance of **<SPECIFIER>** hours for TYPE **<SPECIFIER>** Construction.
	1. INFORMATIONAL SUBMITTALS
		1. Assurance Submittals:
			1. Quality Testing:
				1. ASTM D 785
				2. ASTM D 790
			2. Material Testing:
				1. ASTM D 3039
				2. ASTM E 1225
				3. ASTM D 790
				4. ASTM E 488
			3. Performance Testing:
				1. ASTM E 119
				2. NFPA 285
			4. Manufacturer’s installation instructions for sandwich wall system
	2. QUALITY ASSURANCE
		1. Panel Manufacturer Qualifications: A precaster/ manufacturer that complies with the following and is experienced in producing partially-composite concrete wall panels like those indicated in the drawings for this project prior start of design.
			1. Assumes responsibility for engineering partially-composite concrete sandwich panels to comply with performance requirements outlined in project drawings. This responsibility includes preparations of shop drawings indicating the number of GFRP shear connectors needed and comprehensive engineering analysis by a qualified professional engineer.
			2. Professional Engineer Qualifications: A professional engineer licensed in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of structural precast concrete that are like those indicated for this Project in material, design, and extent.

Retain the paragraphs above if panel fabricator is required to engage the services of a qualified professional engineer due to the walls being designed as partially-composite.

* + 1. IWP System Manufacturer’s Responsibility:
			1. Provide insulation shop drawings and detailing for sandwich wall system when specified by the wall manufacturer.
			2. Attend pre-construction meetings and initial sandwich wall insulation placement to instruct in the proper installation of the wall panel system when specified by the wall manufacturer.
			3. Provide quality assurance instruction and equipment for evaluation of connector installation.
			4. Provide connectors with traceable and verifiable quality assurance by a recognized third-party testing agency.
				1. Listing requirements vary with product; however, all require that the manufacturers established testing and evaluation procedures must be repeatable and open to third party review and verification. Thermomass connectors are evaluated for the following:

Material Hardness per ASTM D 785

Material Flexural Capacity per ASTM D 790

1. PRODUCTS
	1. CONCRETE MATERIALS

Division 3, Section 03 40 00, should provide reasonable minimum and maximum limits on concrete slump to ensure adequate concrete consolidation around the ends of the connectors for proper anchorage. The use of a super-plasticizer should be considered. The specifier should also consider the maximum concrete aggregate size for thin wythes to ensure adequate consolidation around the connectors and reinforcing steel and to reduce honeycombing in the concrete wythes.

* 1. REINFORCING AND ACCESSORIES

Division 3, Section 03 20 00, should contain requirements for the materials used for the bar supports to hold reinforcing steel or welded wire fabric away from the outside face of the exterior wythe. This is necessary to minimize surface spalling and other imperfections that may occur if incompatible materials are used. The bar support material must have approximately the same coefficient of thermal expansion as hardened concrete. The manufacturer should verify with the supplier of the bar supports that the selected product will not induce spalling and surface imperfections over time because of thermal movement, inadequate adhesion, or migration of moisture.

Division 3, Section 03 22 00, should require the use of welded wire fabric sheets as opposed to roll stock welded wire fabric to ensure the proper placement and cover of the fabric in the wythes.

The section below is separated into three options for specifying the insulation and insulation system. The first option uses a direct **proprietary** specification by proprietary name. The second option uses a direct **non-proprietary** specification by material properties. The Thermomass System includes both insulation, and non-conductive, non-corrosive, GFRP connectors, supplied as a “system”.

**Option No. 1:** Thermomass System Specification

* 1. INSULATION SYSTEM

Retain only one of the following wythe connector types and insulation types listed below. Specify the required thickness and select the density for the insulations listed. If your state has enacted laws against the use of HFC’s and other ozone depleting substances pay careful attention to your selection. Specify only one wythe connector.

* + 1. Thermomass Building Insulation System, as supplied by Leviat, consisting of these options of insulation and wythe connectors:
			1. Wythe connectors:
				1. GFRP Tension **[Series MS] [Series MC] [Series MS-T]** wythe connectors having been:

Designed to create a non-composite insulated wall panel, the system is unique in that it ties the two wythes or layers of concrete together yet allows the layers to work independently of one another. One layer is typically the structural element and the other is an architectural element.

Non-conductive, non-corrosive, GFRP connectors having a minimum tensile strength of 120,000 psi., minimum glass content of 76 percent by weight, and a coefficient of thermal expansion of 3.9 x 10⁻⁶ in/in/°F, nominal, per ASTM D 3039.

Tested and evaluated for structural capacities in accordance with requirements established within AC 320.

**-or-**

* + - * 1. GFRP Shear **[Series SC]** wythe connectors having been:

Designed to create a partially-composite concrete sandwich wall in plant-cast precast applications. The two wythes or layers of concrete to act together, thus providing composite action. The combined concrete layers serve as the structural element.

Non-conductive, non-corrosive, GFRP connectors having a minimum tensile strength of 120,000 psi., minimum glass content of 76 percent by weight, and a coefficient of thermal expansion of 3.9 x 10⁻⁶ in/in/°F, nominal, per ASTM D 3039.

Tested and evaluated for structural capacities in accordance with requirements established within AC 320.

* + - 1. Insulation
				1. Extruded Polystyrene Board Insulation: Complying with ASTM C 578, Type **[IV, 1.55 lb./ft3(25 kg/m3)]** and produced for HFC (**Hydrofluorocarbon)** regulated U.S. states and countries; **[square][shiplap]** edges; with thickness of **<Insert dimension>**; with regularly spaced holes and/or markings identifying connector placement locations.
				2. Extruded Polystyrene Board Insulation: Complying with ASTM C 578, Type **[IV, 1.55 lb./ft3(25 kg/m3)]** and produced for Non- HFC (**Hydrofluorocarbon)** regulated U.S. states and countries; **[square][shiplap]** edges; with thickness of **<Insert dimension>**; with regularly spaced holes and/or markings identifying connector placement locations.
				3. Expanded Polystyrene Board Insulation: Complying with ASTM C578, Type **[II, 1.35 lb./ft3(22kg/m3)]**, **[VIII, 1.15 lb./ft3(18kg/m3)]** & **[IX, 1.80 lb./ft3(29 kg/m3)]**; **[square][shiplap]** edges; with thickness of **<Insert dimension>**; with regularly spaced holes and/or markings identifying connector placement locations.

**-or-**

* + - * 1. Polyisocyanurate Board Insulation: Complying with ASTM C 1289, Type **[I, 1.8 lb./ft3(29kg/m3)]**, Class I; **[square][shiplap]** edges; with thickness of **<Insert dimension>**; with regularly spaced holes and/or markings identifying connector placement locations.

**-or-**

* + - * 1. Polyisocyanurate Board Insulation: Complying with ASTM C 1289, Type **[II, 1.8 lb./ft3 (29kg/m3)]**, Class 2; **[square][shiplap]** edges; with thickness of **<Insert dimension>**; with regularly spaced holes and/or markings identifying connector placement locations.
			1. Fire performance test standards:
				1. ASTM E 119
				2. NFPA 285

**END** 2.3 for **Option No. 1**: Thermomass System Specification

**Option No. 2:** Thermomass Specification System

* 1. CONNECTORS FOR CONCRETE SANDWICH WALL PANELS

*Specify whether the GFRP connector is to be used in the construction of non-composite or partially-composite wall panels.*

* + 1. Provide GFRP connectors designed to create **[Non-composite] [Partially-composite]** wall panelswhere the two concrete wythes act **[independently] [together],** respectively; each having a minimum glass fiber content of 76% by weight, in a thermoset vinyl-ester resin matrix and the following physical properties and attributes.
			1. Non-conductive; provide testing that shows connector having negligible thermal conductivity per ASTM E 1225: 2.1 Btu / (°F•ft**2**•h) per inch of length.

GFRP connectors are the only elements penetrating or crossing the insulation in the panels. They perform as insulators. The negligible conductivity of the connectors is vital to retaining over 90% of the insulation’s R-value. Thermal testing has been performed at Construction Technology Laboratories and at the Oak Ridge National Laboratory, United States Department of Energy to determine the effectiveness of the GFRP connectors in the elimination of loss of R-value in a sandwich wall construction. Go to **https://thermomass.com/engineering/approvals-test-reports**: for more information on these test programs.

* + - 1. GFRP connector embedment (pullout capacity per ASTM E 488) determined per project requirements for fascia wythes of 2 ½” or less the specified concrete embedment depth of the connector shall be 1 ½”, otherwise the concrete embedment depth of the connector shall be 2”.
			2. Non-corrosive, chemical resistant, alkali resistant, with proven accelerated testing and long-term shear capacity, as tested per ASTM C581 and ASTM D 3039.
			3. GFRP connectors having a minimum tensile strength of 120,000 psi and tested per ASTM D 3039.

The vinyl-ester resin matrix impregnates the glass fiber strands, creating a GFRP material that has been tested and shown to be resistant to chemical attack.

* + - 1. Coefficient of thermal expansion: 3.90 x 10⁻⁶ in/in/°F, nominal per ASTM E 228.

The coefficient of thermal expansion of the Thermomass connectors is very near that of hardened concrete. The Thermomass connector is the only connector on the market that achieves this. It is imperative that wythe connectors expand and contract similarly with the concrete during temperature cycles to significantly reduce the likelihood of concrete cracking or spalling.

* + - 1. Central body of connector shall be provided with a flange to limit insertion depth into insulation.
			2. Central body of connector shall have serrated or twisted profile to provide interference fit with insulation to prevent connector from backing out of insulation after installation.

The GFRP connectors of the Thermomass system create a superior seal at the interface between the insulation and the multiple circumferential ribs on the connectors’ sealing collars. This feature, combined with the significant resistance to vapor transmission and water absorption provided by the insulation, provides a barrier system without equal in concrete sandwich wall construction.

* + - 1. Proven fire resistance testing per ASTM E 119 and NFPA 285. Provide reports or analysis showing compliance with a minimum fire resistance of **<SPECIFIER>** hours for TYPE **<SPECIFIER>** construction.
	1. INSULATION FOR CONCRETE SANDWICH WALL PANELS
		1. Rigid Insulation for Concrete Sandwich Panels:
			1. Provide extruded polystyrene rigid board insulation having the physical properties defined by ASTM C 578 for Type **[IV, 1.55 lb./ft3(25 kg/m3)]**; **[square][shiplap]** edges; with thickness of **<Insert dimension>**; material with provisions as follows:
				1. Compressive resistance: 25 psi minimum at yield or at 10 percent deformation per ASTM D 1621.
				2. Water Absorption: 0.1 percent maximum by volume per ASTM C 272.
				3. ISR R-Value: 5.0°F•ft**2**•h/Btu per inch at 75° F minimum per ASTM C 518. Warranted R-Value to retain minimum of 90 percent of its published R-value for the lifetime of the building. Maximum use temperature of 165 °F.
				4. Manufactured with a blowing agent that provides at least a 70 percent reduction in potential for ozone depletion as compared to standard CFC blowing agents but does not comply with HFC regulations and protocols.
				5. Certified by Scientific Certification Systems to contain a minimum of 20 percent pre-consumer recycled content.
				6. Supplied with holes or markings to identify connector placements at designated spacing through insulation board surfaces. For field applied holes, provide rows of holes no less than four (4) inches and no more than twelve (12) inches from the edges of panels, doors and other panel openings.
				7. Follow the insulation manufacturer’s instructions on storing and handling the insulation:

Store insulation system in original wrapping to prevent surface oxidation. Store in a secure dry area, covered with u.v. rated polyethylene or in a location protected from direct sunlight.

Protect insulation from wind damage.

Protect insulation from open flame.

Avoid contact with petroleum-based solvents.

* + - 1. Provide expanded polystyrene rigid board insulation having the physical properties defined by ASTM C 578 for Type **[II, 1.35 lb./ft3(22kg/m3)]**, **[VIII, 1.15 lb./ft3(18kg/m3)]** & **[IX, 1.80 lb./ft3(29 kg/m3)]**; **[square][shiplap]** edges; with thickness of **<Insert dimension>**; material with provisions as follows:
				1. Compressive resistance: **[15 (II)], [13 (VIII)],** & **[25 (IX)]** psi minimum at yield or at 10 percent deformation per ASTM D 1621.
				2. Water Absorption: **[3.0 (II)], [3.0 (VIII)], & [2.0 (IX)]** percent maximum by volume per ASTM C 272.
				3. ISR R-Value: **[4.2 (II)], [3.9 (VIII)], & [4.4 (IX)]** °F•ft**2**•h/Btu per inch at 75° F minimum per ASTM C 518. Warranted R-Value to retain minimum of 90 percent of its published R-value for the lifetime of the building. Maximum use temperature of 165 °F.
				4. Provides resistance to termite infestation.
				5. Supplied with holes and/or markings to identify connector placements at designated spacing through insulation board surfaces. For field applied holes, provide rows of holes no less than four (4) inches and no more than twelve (12) inches from the edges of panels, doors, and other panel openings.
				6. Follow the insulation manufacturer’s instructions on storing and handling the insulation:

Store insulation system in original wrapping to prevent surface oxidation. Store in a secure dry area, covered with u.v. rated polyethylene or in a location protected from direct sunlight.

Protect insulation from wind damage.

Protect insulation from open flame.

Avoid contact with petroleum-based solvents.

* + - 1. Provide extruded polystyrene rigid board insulation having the physical properties defined by ASTM C 578 for Type **[IV, 1.55 lb./ft3(25 kg/m3)]**; **[square][shiplap]** edges; with thickness of **<Insert dimension>**; material with provisions as follows:
				1. Compressive resistance: 25 psi minimum at yield or at 10 percent deformation per ASTM D 1621.
				2. Water Absorption: 0.1 percent maximum by volume per ASTM C 272.
				3. ISR R-Value: 5.0°F•ft**2**•h/Btu per inch at 75° F minimum per ASTM C 518. Warranted R-Value to retain minimum of 90 percent of its published R-value for the lifetime of the building. Maximum use temperature of 165 °F.
				4. Manufactured with a blowing agent that complies with HFC regulations for reduction in potential for ozone depleting blowing agents.
				5. Certified by Scientific Certification Systems to contain a minimum of 20 percent pre-consumer recycled content.
				6. Supplied with holes and/or markings to identify connector placements at designated spacing through insulation board surfaces. For field applied holes, provide rows of holes no less than four (4) inches and no more than twelve (12) inches from the edges of panels, doors, and other panel openings.

The specifier should not allow fewer connectors per panel than designed. The Thermomass system is designed to allow for many variables inherent with concrete wall construction. The manufacturer should not be allowed to push connectors through the insulation as this could push a plug of insulation into the plastic concrete below resulting in loss of connector bond, damage to the exposed surface of the concrete and subsequent spalling and moisture issues.

* + - * 1. Follow the insulation manufacturer’s instructions on storing and handling the insulation:

Store insulation system in original wrapping to prevent surface oxidation. Store in a secure dry area, covered with u.v. rated polyethylene or in a location protected from direct sunlight.

Protect insulation from wind damage.

Protect insulation from open flame.

Avoid contact with petroleum-based solvents.

**-or-**

* + - 1. Provide polyisocyanurate board insulation: rigid, cellular polyisocyanurate thermal insulation with core formed by using hydrocarbons as blowing agents; square edged; complying with ASTM C 1289, Type **[I, 1.8 lb./ft3(29kg/m3)]** Class I; **[square][shiplap]** edges; with thickness of **<Insert dimension>**; with provisions as follows:
				1. Compressive resistance: 25 psi minimum at yield or at 10 percent deformation per ASTM D 1621.
				2. Water absorption: 0.02 percent maximum by volume per ASTM D 209.
				3. Aged R-value: 6.5°F•ft**2**•h/Btu per inch at 75° F minimum per ASTM C 518/ C 236. Maximum use temperature of 190°F.
				4. Polyisocyanurate insulation with an aluminum/polyester facer shall provide:

Water vapor permeance, ASTM E96, 1”, <0.01 perm, maximum.

Un-exposed metallic facing that is not susceptible to corrosion or chemical reaction with the concrete.

* + - * 1. Supplied with holes and/or markings to identify connector placements at designated spacing through insulation board surfaces. For field applied holes, provide rows of holes no less than four (4) inches and no more than twelve (12) inches from the edges of panels, doors, and other panel openings.
				2. Follow the insulation manufacturer’s instructions on storing and handling the insulation:

Store insulation in original wrapping to prevent surface oxidation. Store in a secure dry area, covered with u.v. rated polyethylene or in a location protected from direct sunlight.

Protect insulation from wind damage.

Protect insulation from open flame.

Avoid contact with petroleum-based solvents.

**-or-**

* + - 1. Provide polyisocyanurate board insulation: rigid, cellular polyisocyanurate thermal insulation with core formed by using hydrocarbons as blowing agents; square edged; complying with ASTM C 1289, Type **[II, 1.8 lb./ft3(29kg/m3)]**, Class 2; **[square][shiplap]** edges; with thickness of **<Insert dimension>**; with provisions as follows:
				1. Compressive resistance: 25 psi minimum at yield or at 10 percent deformation per ASTM D 1621.
				2. Water absorption: 0.7 percent maximum by volume per ASTM D 209.
				3. Aged R-value: 6.2°F•ft**2**•h/Btu per inch at 75° F minimum per ASTM C 518/ C 236. Maximum use temperature of 250°F.
				4. Polyisocyanurate insulation with a glass fiber facer shall provide:

Water Vapor Permeability, ASTM E96, 1”, 1.2 perms, maximum.

Facing that is not susceptible to corrosion or chemical reaction with the concrete.

* + - * 1. Supplied with holes and/or markings to identify connector placements at designated spacing through insulation board surfaces. For field applied holes, provide rows of holes no less than four (4) inches and no more than twelve (12) inches from the edges of panels, doors, and other panel openings.
				2. Follow the insulation manufacturer’s instructions on storing and handling the insulation:

Store insulation in original wrapping to prevent surface oxidation. Store in a secure dry area, covered with ultra-violet rated polyethylene or in a location protected from direct sunlight.

Protect insulation from wind damage.

Protect insulation from open flame.

Avoid contact with petroleum-based solvents.

Extruded polystyrene (XPS) insulation has a higher R-value and is more vapor and water-resistant than expanded polystyrene (EPS) insulation. Un-faced polyisocyanurate (PIR) and polyurethane insulation (PUR) are not acceptable replacements for extruded polystyrene or faced polyisocyanurate in general applications. Polyisocyanurate board insulation with triplex aluminum/poly facer or glass facer is moisture resistant and offers high thermal performance.

Expanded polystyrene insulation is subject to variances in density. The product is generally cut from a billet. Depending upon where the specific sheets originate in a billet, the density of the board may vary from 1.0 to 2.5 pounds per cubic foot (**lb./ft3**).

* 1. CONCRETE SANDWICH WALL SYSTEM
		1. Concrete sandwich panels tested to the following attributes:
			1. Panel having passed a minimum 90-minute time/temperature test when the fire event is located inside the structure per ASTM E 119
			2. Panel having passed a 90-minute time/temperature test when the fire event is located outside the structure per ASTM E 119
			3. Panel having passed a 30-minute fire propagation test per NFPA 285

**END** 2.3 for **Option No. 2**: Thermomass System Specification

As identified above, the wall manufacturer must provide calculations to verify the performance of the sandwich wall panels. The specifier should identify the “acceptable” R-value for the panels. Leviat can provide International Energy Conservation Code compliant calculations to satisfy this requirement at no cost.

1. EXECUTION
	1. DESIGN

Full-thickness concrete sections and metallic connectors can have serious detrimental effects on the performance of sandwich panels. **Leviat strongly discourages the design or use of full-thickness concrete sections and/or metallic connectors at any location within panels utilizing the Thermomass system.** If a panel manufacturer opts to use full-thickness concrete or metallic connections, consideration must be given to their effects on the panels and surrounding materials in the project. These negative effects can include concrete panel cracking and bowing induced by the constraint of the fascia outer wythe relative to the inner wythe. Also, full-thickness concrete sections will allow condensation to form at the breaks in the insulation system, resulting in heating and cooling loss, moisture migration, inconsistent face appearance, coating failures on painted panels, and growth of mold and mildew.

* 1. PRODUCT INSTALLATION
		1. Install insulation system over the entire area of the panel as soon as possible after leveling the first (lower) concrete wythe.
		2. Install the GFRP connectors through the insulation immediately after placing the insulation atop the plastic concrete. Follow system manufacturers’ installation instructions.
		3. Consolidate plastic concrete around the embedded ends of the connectors using one or more of the following methods to ensure complete consolidation around the connector ends:
			1. For insulation thicknesses less than 3 inches, provide careful walking foot pressure applied to top of insulation around each connector to develop fluid concrete pumping pressure.
			2. For insulation thicknesses 3 inches or greater provide mechanical vibration applied to each connector.
				1. Ensure that the concrete in the first layer is fully consolidated around each connector prior to placing the upper layers of concrete.
				2. Careful walking foot pressure applied to top of insulation around each connector to develop fluid concrete pumping pressure.
				3. Vibrating forms.
				4. Mechanical vibration applied to each connector.
		4. Maintain a maximum temperature of 165 °F in the bottom-cast concrete. Monitor the concrete temperature with thermal probes and adjust heat input for each panel cast.
		5. Ensure that the concrete is in the first cast layer is fully consolidated around each connector prior to placing the upper concrete layer.
		6. In plants not casting under roof, protect panels from exposure to rain before first layer of concrete reaches final set.

The Thermomass System is designed to cover the entire area of all wall panels. It is essential that personnel are made aware of the requirements for the system and that the installation complies with these requirements. Contact Leviat for full installation instructions.

SAFETY CAUTION - Since glass fibers may be present on the surfaces of the Thermomass connectors, it is recommended that gloves be worn during handling and that eye contact with gloves or hands be avoided.

* 1. FIELD QUALITY CONTROL
		1. Ensure that concrete does not reach initial set before installation of the insulation and connectors. Do not disturb the lower wythe concrete or the insulation layer after the lower wythe concrete has reached initial set or before the lower wythe concrete has hardened.

As the concrete hydration process progresses, the concrete will begin to stiffen. Vibrating or disturbing the connectors during this period may reduce the anchorage strength of the connectors. Either place concrete for the upper layer as soon as possible following installation of the insulation layer or after the initial concrete layer has hardened. See table within installation instructions which indicates the time required to obtain hardened concrete.

During panel casting, rain can damage the exposed surface of the concrete and/or cause the insulation boards to float and pull the connectors out of the plastic concrete. Panels containing un-hardened concrete should be covered if rain is expected. In the event water collects in the forms, holes should be drilled in the formwork at the level of the bottom side of the insulation to allow the water to drain.

Section 03 10 00 must refer to ASTM C 309 for release agent requirements. Improper selection or use of an agent may result in the wythe bonding with the concrete floor slab or casting. Most release agents should be applied at least 24 hours before the concrete is placed. Ensure that the release agent is compatible with the specified coatings to be applied to the concrete floors and wall panel surfaces.

* 1. DELIVERY, STORAGE, AND HANDLING

*The specifier should consult the PCI Design Manual as well as the supplying wall panel producer to determine the effective specifications for this section. The types of precast elements, transportation requirements and construction conditions should be considered.*

* 1. ERECTION

No inserts or commentary.

**END**

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