thermomass®
System SC

Q&A

Questions and Answers about System SC for Structurally Composite Concrete Sandwich Walls.

Topics include:

- General questions
- CC Series connectors
- Composite action
- Insulation and wythe thicknesses
- Wall finishes
- Engineering
- Connector testing and capacities
- Standard installation procedures

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Energy Efficiency in Concrete Terms™

General Questions

What is System SC?

Thermomass System SC is a patented connector and insulation system for creating structurally composite plant precast and site-cast tilt-up insulated concrete sandwich walls.

High-strength, low-conductivity, non-corrosive and chemically resistant connectors structurally tie two layers of concrete together through pre-drilled, extruded polystrene insulation (R-5 per inch of thickness) or polyisocyanurate insulation (R-6.5 per inch of thickness).

Thermomass supplies both components of the system - the CC Series connectors and the pre-drilled insulation. Thermomass is also equipped to provide insulation layout drawings and precision-cut foam panels (a service referred to as "fabrication") incorporating openings and edge conditions. Additionally, Thermomass can recommend qualified wall contractors in your area.

Why use System SC?

System SC places high-quality insulation between two layers of concrete and structurally connects the three layers in a single construction. This significantly improves the R-value of the constructed wall over concrete alone. An un-insulated, 200 mm (8 in) thick concrete wall achieves an R-value of 0.11 m^2•K/W (0.64 ft^2•h•°F/BTU) compared to 0.88 m^2•K/W or (5.0 ft^2•h•°F/BTU) for only 25mm (1 in) of extruded polystyrene insulation.

To be a viable building material in the majority of today's energy conscious regions, a concrete wall simply must be insulated. System SC provides building owners with cost-effective, durable and energy-efficient structures.

Why is it important to sandwich the insulation between two layers of concrete?

The concrete layers provide thermal mass. That is, the concrete is able to store significant amounts of thermal energy and delay heat transfer through the building walls. According to the Fundamentals Handbook of the American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE), this delay leads to three important results:

- First, the slower response time tends to moderate indoor temperature fluctuations under outdoor temperature swings.
- Second, in hot or cold climates, energy consumption is significantly reduced over that for a similarly sized low-mass building.
- Third, because the mass is adjacent to the interior of the building, energy demand can be moved to off-peak periods because energy storage is controlled through correct sizing of the mass and interaction with the HVAC system.

Thermomass can calculate the increased effective R-value attributable to the thermal mass in your projects using procedures confirmed by the Department of Energy, developed by ASHRAE and other leading energy-efficiency organizations.

What is a structurally composite sandwich wall panel?

A structurally composite sandwich wall panel is an insulated wall panel in which both the interior and exterior wythes act compositely to carry the external gravity and lateral loads. With a typical "non-composite" sandwich wall panel, the exterior wythe does not carry gravity load but does transfer lateral loads to the interior wythe, which is designed for both gravity and lateral loads.

In what applications can System SC be used?

System SC is used in precast (*plant cast, horizontally formed)* and tilt-up (*site cast, horizontally formed)* applications.

What is the main advantage of a structurally composite sandwich wall panel?

When both concrete wythes share the load, the panel can be made thinner as compared to a typical non-composite insulated wall panel, reducing material costs.

How long has Thermomass System SC been used in sandwich wall applications?

System SC has been used in projects since 2001. The first building constructed using a Thermomass insulation system was a nine-story condominium completed in 1980.

For what type of facility can structurally composite wall panels using Thermomass System SC be used?

Composite panels using System SC can be used as both load-bearing and cladding panels in ambient temperature facilities like schools, offices, retail stores, warehouses and distribution centers.

Connectors

What is a CC Series connector?

CC Series connectors are pultruted with 426,000 E-glass fibers, dipped in a vinyl-ester resin, formed under heat and pressure, cut to length and over-molded with a polymer collar.

Why can't the connectors be fabricated using other materials?

The connector material must be compatible with concrete, thermally non-conductive and exceptionally strong. Connectors susceptible to alkaline attack, that are hydrophilic, or have a thermal coefficient of expansion higher than that of concrete should not be used as sandwich wall wythe ties.

Why use fiber composite instead of steel?

The fiber composite bar used in the CC Series connector has a thermal conductivity of 1.0 W/m•°K (6.9 BTU•in/ft^2•h•°F). This compares to values of 40.68 W/m•°K (182 BTU•in/ft^2•h•°F) for stainless steel, 81.59 W/m•°K (365 BTU•in/ft^2•h•°F) for mild steel and 2.79 W/m•°K (12.5 BTU•in/ft^2•h•°F) for concrete, respectively.

Therefore, Thermomass fiber composite connectors minimize thermal components that would otherwise create a thermal bridge.

Will the alkalinity of the concrete attack the bars?

No. The vinyl-ester resin matrix protects the glass fibers in the bars from chemical attack. Independent tests show that CC Series connectors can withstand standard concrete alkalinity during the life of the structure.

How do the connectors hold the wall together?

The connectors' grooves develop a keying action within the concrete wythes. The pullout strengths of the embedded connectors are far greater than the forces experienced in normal loading conditions.

What is the connector spacing?

Typically, the connectors are spaced at 460 mm (18 in) on center transversely and 400 mm (16 in) on center longitudinally. Depending on panel dimensions and loading conditions, special spacing may be specified.

How is this spacing achieved in the field or plant?

All insulation boards supplied with System SC are delivered with pre-drilled slots. Instructions are available should slots need to be added on-site.

Composite Action

How is composite action achieved using CC Series connectors?

The CC Series connectors are 38mm (1.5in) wide and 9.5mm (0.375in) thick and have grooves at each end for anchoring within the concrete. The connectors are designed to provide a high shear transfer capacity from one wythe to the other, thus providing the composite action.

Is 100% composite action possible with System SC?

Wall panels designed using CC Series connectors do not provide 100% composite action. 100% composite action is not required for the panels to perform satisfactorily. Studies have shown that more thermal bowing occurs in a panel approaching 100% composite action than one that is partially composite with the same configuration and span.

If needed, how can we increase the composite action?

Composite action of the panels can be increased by adding additional connectors or solid concrete at pre-determined locations. Solid-through concrete sections could negatively affect the thermal performance of the panel.

Do the solid-through concrete sections create thermal bridging?

Yes. However, by taking additional steps, the thermal bridging can be minimized. Contact Thermomass for details where solid-through concrete sections are required.

Insulation and Wythe Thicknesses

What thickness of insulation can be used?

Insulation thickness values ranging from 50 mm (2 in) to 100 mm (4 in) are considered optimal. Contact Thermomass for other thicknesses of insulation.

What is the minimum thickness of a typical face and interior wythe?

A minimum thickness of 50 mm (2 in) is required. Thermomass recommends using equal thickness wythes in a composite sandwich wall. However, the face wythe thickness can be increased by the amount of thin brick or reveals thickness.

Wall Finishes

What types of concrete finishes are possible?

It is up to the capabilities of your local wall contractors. System SC can be used with any type of forming system, with or without form liners. Finishes can include natural concrete, paint, skim coat plaster, sandblasted, concrete exposed aggregate, colored concrete, thin brick or most forms of concrete treatment. Other materials may be secured to the wall with concrete anchors.

What about other design considerations?

There is no limit to the design possibilities when casting a panel in a form. Reveals, rustication, embossed logos and dimples in the finish are just a few examples.

Engineering

What type of reinforcement is required in a structurally composite wall panel?

Structurally composite sandwich wall panels can be built with just mild steel reinforcement or with pre-stressing strands in both wythes. Structurally composite sandwich panels can also be created with post-tensioning tendons placed in the insulation. Temperature and shrinkage reinforcement is required in both wythes. However, since the panels are structurally composite, the reinforcement required is up to 30% less compared to non-composite sandwich panels.

Do composite sandwich wall panels require special stripping and lifting hardware?

No, composite sandwich wall panels are relatively thin, but in most cases typical lifting hardware can be used in the panels by reducing the insulation thickness around the lifting hardware. It may also be necessary to increase the number of lifting inserts due to the allowable capacities of shallow lifting hardware.

Who has final design responsibility when using System SC?

Final design responsibility of the wall panels is given to the precast or tilt-up panel engineer or the project structural engineer. Thermomass can provide preliminary assistance during the design phase.

Connector Testing and Capacities

What types of tests have been performed on the CC Series connectors?

Extensive third-party testing has been conducted on the CC Series connectors, including static and dynamic (cyclic) tests and full-scale panel tests. Fire and aging tests have been carried out on wall panels having E-glass fiber composite connectors and show no degradation. Please contact Thermomass for complete test results.

What is the tensile strength of the composite material used in the connectors?

The tensile strength of the connector composite material is in excess of 827 Mpa (120,000 psi).

What is the strength of one connector?

A single CC Series connector has an ultimate tensile strength (pullout capacity) of 15.3 kN (3,440 lbs).

What is the shear capacity of the connectors?

The ultimate shear capacity of each connector is approximately 14.9 kN (3,360 lbs). The ultimate cyclic shear capacity is 16.9 kN (3,800 lbs).

Is System SC structurally proven?

Thermomass systems have been proven in the laboratory and in the field. Stork Twin City Testing Corporation extensively evaluated the CC Series connectors and deemed them in good accordance with International Code Council-Evaluation Services (ICC-ES) AC320 acceptance criteria. Also, Architectural Testing Inc. perfomed full scale System SC panel tests under both gravity and wind loads, resulting in the panels performing well beyond the necessary service load conditions.

How do the connectors perform in fire?

A test performed at a leading fire testing agency in the United States subjected a panel constructed with Thermomass fiber composite connectors to a temperature of over 1090 °C (2000 °F) for four hours with no degradation.

In separate tests, Thermomass connectors installed in only 75mm (3in) of concrete were exposed to a standard time-temperature profile while subjected to high tensile loads. Even under these extreme conditions, the connectors withstood over one hour of fire exposure.

Installation

How is System SC installed?

The precast and tilt-up systems are both installed with nearly identical practices:

- Once the forms have been secured, the surfaces cleaned and treated with a bond release agent, and reinforcing has been placed, the outer layer of concrete is placed in the forms.
- The pre-slotted insulation is then installed over the fresh concrete (which is placed at a 5 in – 7 in slump). This should be done immediately after the outer layer has been consolidated and leveled to thickness, but in any event, within 15 to 20 minutes after placement of the concrete to ensure the concrete mix is still plastic.
- The connectors should immediately be inserted through the pre-drilled slots.
- The concrete around the connectors should then be consolidated by applying a vibrator to the individual connector or to a group of connectors using "vibra-strike". In plant cast operations, consolidation may be achieved by bed vibration.
- The reinforcement and hardware for the inner concrete wythe shall then be placed.
- Finally, the inner wythe of concrete is placed. (Note: If the inner concrete wythe cannot be poured immediately, then it must be poured after the outer concrete wythe has fully set.)

Contact Thermomass for installation guides for specific applications.

What is the most important thing to remember about installation?

You must have concrete consolidation around the groove for the connector to develop its strength.

What if a row of slots is removed while trimming an insulation board to fit?

A new row of slots should be made in the insulation by drilling slots with a 12mm ($^{7}/_{16}$ in) diameter bit. The new row of slots should be no closer than 100 mm (4in) to and no farther then 200 mm (8 in) from the edge of the insulation.

What should be done if a connector hits a reinforcing bar or piece of aggregate?

Remove the connector and reinsert it at an angle to bypass the obstruction. If it is not possible to bypass the obstruction, add a new slot, no farther than 100mm (4in) from the old slot, and insert the connector.

Will applied curing heat affect System SC?

The connectors won't be affected. However, some insulation will soften at approximately 71 °C (160 °F). Extruded polystyrenes will expand and expanded polystyrenes can melt. Polyisocyanurates have slightly higher capacities (190 °F). Curing temperatures (the combination of heat of hydration and applied curing heat) in the lower concrete wythe should be carefully monitored near the center of the panel and not allowed to exceed 60 to 65 °C (140 to 150 °F).

Additional Q&A brochures are available for Thermomass non-composite sandwich walls (System NC) and cast-in-place applications (System CIP).

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