

SIPLAST LIGHTWEIGHT INSULATING CONCRETE

THE ZONOCEL SYSTEM



Siplast Lightweight Insulating Concrete Systems

Siplast Lightweight Insulating Concrete Insulations are composite systems that combine the unique properties of lightweight insulating concrete and Insulperm premium expanded polystyrene foam insulation board. The polystyrene insulation board can be installed in thicknesses necessary for high insulation values and in stair-step fashion, facilitating prompt drainage of water from the roof surface.

By design, Siplast Roof Insulation Systems encapsulate the insulation board in insulating concrete. All constructions provide superior fire protection and wind resistance in a stable, monolithic insulation system built for the long term.

The Zonocel System Concept

Key to the Zonocel System was the development of Zonocel Lightweight Insulating Concrete, which combines the best attributes of Insulcel Lightweight Insulating Concrete with ZIC Aggregate. This design creates a lightweight concrete that has a low moisture content from the time of placement, yet can be applied over slotted metal.

As with all Siplast Lightweight Insulating Concrete Systems, specific insulation values, from low to very high, can be achieved to meet design requirements simply through the adjustment of Insulperm thicknesses. Because Insulperm can be installed in stair-step fashion, slope-to-drain is much easier to achieve than creating slope with complicated tapered rigid board insulation systems. Given its inherent fire resistant quality, Zonocel remains an economical alternative to the expensive process of fireproofing the deck's underside necessary for other insulation systems to meet the same fire ratings Zonocel achieves.

Zonocel Lightweight Insulating Concrete

Zonocel Lightweight Insulating Concrete consists of Insulcel-PB pregenerated foam, Portland cement, and ZIC Aggregate. Zonocel Lightweight Insulating Concrete is placed at a minimum thickness of 2 inches (51 mm) over the top of the slotted metal decking or Insulperm when used. Zonocel Lightweight Insulating Concrete has a minimum dry density of 30 pcf (480.56 kg/m³) and provides a minimum compressive strength of 200 psi (1378.96 kPa).

Insulperm Insulation

Insulperm is a premium quality nominal 1 pcf (16 kg/m³) density expanded polystyrene insulation board. It serves as the primary insulator and, when used in a stair-stepped configuration, is the base for the system's slope-to-drain capability.

Insulperm insulation is supplied in 2-foot by 4-foot (.61 m x 1.22 m) boards in thicknesses from 1 inch (25 mm). This product is configured to give the system composite strength and ensure release of moisture vapor. Insulperm is a lightweight expanded polystyrene insulation board; it adds little dead load to the assembly.

Fire Rated Construction

The Zonocel System has excellent fire resistance properties and provides an economical method of creating insulated fire rated systems in steel deck construction. The Zonocel System is approved by Factory Mutual as a non-combustible rated roof substrate. Combining Zonocel Lightweight Insulating Concrete with up to a 12-inch (305 mm) thickness of Insulperm insulation board over slotted galvanized steel decks meets the requirements of a Factory Mutual Class I fire rating.

In the fire rated designs listed below and in the *Fire Resistance Directory*, Underwriters Laboratories lists Zonocel Roof Insulation as Siplast mix #3.

Metal Deck Roof Assembly Design No.	Hourly Rating	Concrete Deck Roof Assembly Design No.	Hourly Rating
P214	1	P708	2
P215	2	P810	2
P216	1	P812	2
P231	1 1/2	P905	2
P241	2	P910	2
P246	1	P913	2
P251	2	P916	2
P255	1	D916	3
P261	1	D922	3
P264	1	D916	3
P405	3	D923	3
P406	3	D925	3
P407	2	D927	3
P410	2		
P509	1		
P513	1 1/2		
P902	2		
P903	1		
P907	2		
P908	2		
P919	1 1/2		
P920	2		
P921	2		
P922	2		
P923	2		
P924	2		
P925	2		

Wind Rated Construction

Combining Zonocel Lightweight Insulating Concrete with up to a 12-inch (305 mm) thickness of Insulperm insulation board over slotted galvanized steel decks meets the requirements of Factory Mutual windstorm classifications. Underwriters Laboratories has approved the Zonocel System in Construction No. 110 for Class 90 windstorm construction. In each approved assembly, the roofing membrane was attached with Zono-tite, base sheet fasteners. The Zono-tite fastener includes a special disk for the 1-90 wind uplift approvals.

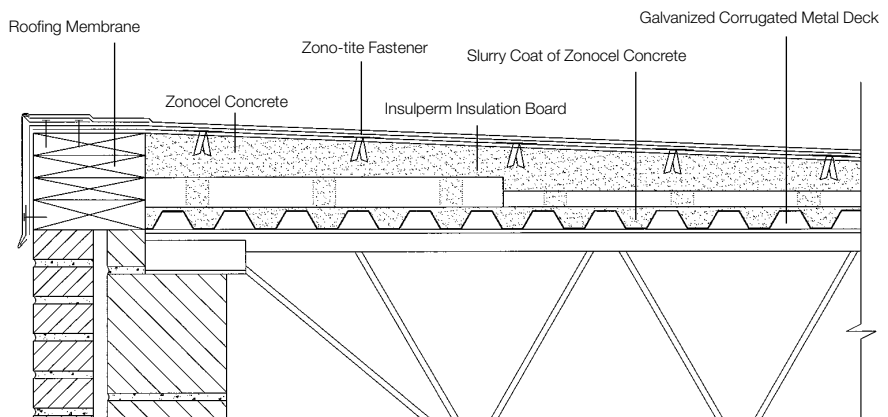
Seismic and Diaphragm Design

The Zonocel System may be designed and constructed to form an extremely effective and economical earthquake-resistant and wind-resistant system. Zonocel System designs over corrugated metal decks resist lateral loads caused by seismic motion or wind forces. Extensive testing has established a wide and comprehensive range of working shear values for these deck systems, and code approvals exist in certain areas where seismic and diaphragm design requirements are prevalent. The diaphragm design values and procedures may be found in the Siplast Lightweight Insulating Concrete Systems binder.

Approvals and Guide References

Underwriters Laboratories Listed
 Factory Mutual Approved
 Metro-Dade Product Control No. 07-0122.06 and 03-1211.06
 ICC Evaluation Service, Inc. Report Number 2309
 ICBO Report Nos. 3260
 Other local and regional approvals available.

The Zonocel System



Insulation Value Table for Corrugated Metal Designs

(Includes roof membrane, 2 inches of Zonocel Concrete and optional thicknesses of Insulperm over steel decking.)

Thickness of Insulperm	26 Ga. Metal – 15/16" Corrugation				24 Ga. Metal – 1-5/16" Corrugation				22 Ga. Metal – 1- 1/2" B-Decking			
	Weight of Metal, Insulperm & Zonocel Concrete (PSF)	U-Factor* No Ceiling Heat Flow		R-Factor	Weight of Metal, Insulperm & Zonocel Concrete (PSF)	U-Factor* No Ceiling Heat Flow		R-Factor	Weight of Metal, Insulperm & Zonocel Concrete (PSF)	U-Factor* No Ceiling Heat Flow		R-Factor
		Up	Down			Up	Down			Up	Down	
0"	7.4	0.266	0.241	2.7	8.0	0.256	0.232	2.8	8.1	0.026	0.026	2.7
1"	7.8	0.128	0.122	6.7	8.5	0.125	0.120	6.9	8.6	0.126	0.120	6.8
1 1/2"	7.9	0.103	0.099	8.6	8.6	0.101	0.097	8.8	8.7	0.102	0.098	8.7
2"	8.0	0.086	0.083	10.5	8.7	0.085	0.082	10.7	8.7	0.085	0.082	10.7
2 1/2"	8.1	0.074	0.072	12.4	8.7	0.073	0.071	12.6	8.8	0.073	0.071	12.6
3"	8.1	0.065	0.063	14.3	8.8	0.064	0.063	14.5	8.9	0.064	0.063	14.4
3 1/2"	8.2	0.058	0.057	16.2	8.9	0.057	0.056	16.4	9.0	0.057	0.056	16.3
4"	8.3	0.052	0.051	18.1	9.0	0.052	0.051	18.3	9.0	0.052	0.051	18.2
5"	8.4	0.044	0.043	21.8	9.1	0.043	0.043	22.0	9.2	0.043	0.043	22.0
6"	8.6	0.038	0.037	25.6	9.3	0.037	0.037	25.8	9.3	0.037	0.037	25.7
7"	8.7	0.033	0.032	29.3	9.4	0.033	0.032	29.5	9.5	0.033	0.032	29.5
8"	8.9	0.029	0.029	33.0	9.6	0.029	0.029	33.2	9.6	0.029	0.029	33.2
9"	9.0	0.026	0.026	36.7	9.7	0.026	0.026	37.0	9.8	0.026	0.026	36.9
10"	9.2	0.024	0.024	40.5	9.9	0.024	0.024	40.7	9.9	0.024	0.024	40.6
11"	9.3	0.022	0.022	44.2	10.0	0.022	0.022	44.4	10.1	0.022	0.022	44.4
12"	9.5	0.020	0.020	47.9	10.2	0.020	0.020	48.1	10.2	0.020	0.020	48.1

*Includes air films and roofing membrane.

Notes:

- Zonocel Lightweight Insulating Concrete properties are based on the material at minimum dry density. The thermal conductivity data is derived from independent testing of materials in accordance with ASTM Specification C 177. Thermal conductivity of roof insulation components is based on 40° F mean temperature. U-factors are based on series-parallel heat flow calculations defined in the ASHRAE Handbook of Fundamentals and are shown in constant thickness insulation. All values shown are intended only as guidelines. Insulation performance for all materials and/or systems is affected by building environment, installation and design procedures which may cause variations from calculated values.
- A roofing membrane will add the following typical weights to the system weight listed above:

Modified Bitumen	2 pounds per sf
4 ply built-up roof with gravel	6 pounds per sf
Mechanically fastened single ply	0.5 pounds per sf

When using the Zonocel System in re-cover or reroofing applications, Siplast strongly recommends that a registered structural engineer evaluate the design and verify that the existing structure is capable of supporting the added weight of the new assembly.

PART 1: GENERAL

1.01 SECTION INCLUDES:

- A. Lightweight Insulating Concrete Application to Prepared Substrate

1.02 RELATED SECTIONS

- A. Section [---] - Testing Laboratory Services
 B. Section [---] - Rough Carpentry
 C. Section [---] - Roof Deck
 D. Section [---] - Roofing
 E. Section [---] - Sheet Metal Flashing and Trim
 F. Section [---] - Sprayed Fire Protection

1.03 REFERENCE STANDARDS

References in these specifications to standards, test methods and codes, are implied to mean the latest edition of each such standard adopted. The following is an abbreviated list of associations, institutions, and societies that may be used as references throughout these specifications.

ASTM American Society for Testing and Materials
Philadelphia, PA

FM Factory Mutual Engineering and Research
Norwood, MA

UL Underwriters Laboratories
Northbrook, IL

1.04 SUBMITTALS

All submittals that do not conform to the following requirements will be rejected.

A. Submittal of Equals: Submit lightweight insulating concrete systems to be considered as equals to the specified roof system no less than 10 days prior to bid date. Primary lightweight insulating concrete systems that have been reviewed and accepted as equals to the specified system will be listed in an addendum prior to bid date; only then will equals be accepted at bidding. Submittals shall include the following:

- Submit manufacturer's instructions for proper placement of the proposed lightweight insulating concrete roof insulation system.
- Submit documentation confirming compliance with FM 1-[---] Windstorm Resistance Classification utilizing the specific roof membrane system proposed for use on this project.
 - Submit documentation confirming that the specific expanded polystyrene proposed for use on this project is approved by Factory Mutual for use in conjunction with the proposed lightweight insulating concrete system.
- Submit a letter from the supplier of the proposed lightweight insulating concrete system confirming that the expanded polystyrene used as a component in the lightweight insulating concrete system is to be furnished by the supplier of the proposed lightweight insulating concrete system.
- Submit shop drawings including a roof plan, roof slopes, and thickness of insulation.

- Submit a sample copy of the warranty covering the proposed lightweight insulating concrete system.

* NOTE: The above item is applicable when a performance warranty for the lightweight concrete is required.

- Submit a sample copy of the roof system guarantee covering the proposed lightweight insulating concrete system and roof membrane system.
- Submit a letter from the roof membrane manufacturer confirming the intention to issue the roof system guarantee covering the proposed lightweight insulating concrete system and roof membrane system at project completion.

* NOTE: The above items 6 and 7 are applicable when a single source roof system guarantee covering the lightweight insulating concrete system and roof membrane system is required.

- Submit a letter from the proposed lightweight insulating concrete system supplier confirming that the Contractor is approved to install the proposed lightweight insulating concrete system.

1.05 QUALITY ASSURANCE

A. Acceptable Contractor: The contractor must be certified in writing prior to bid by the supplier to install the proposed lightweight insulating concrete system.

B. Agency Approvals: The proposed lightweight insulating concrete system shall conform to the following requirements. No other testing agency approvals will be accepted.

- Underwriters Laboratories:** Tested by Underwriters Laboratories in accordance with the procedures of ASTM E 119 and listed in the most recent Underwriters Laboratories Fire Resistance Directory. Lightweight insulating concrete roof insulation components are defined by Underwriters Laboratories under sections CCVV for foamed plastic and CCOX and CJZZ for floor or roof - topping mixture in the latest edition of the Underwriters Laboratories Fire Resistance Directory.
- Factory Mutual:** Tested by Factory Mutual Research and listed in the most recent Factory Mutual Approval Guide as non-combustible or Class 1, and for 1-[---] windstorm classification utilizing the specific roof membrane system proposed for use on this project.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials in the supplier's original unopened packages, fully identified as to manufacturer, brand or other identifying data and bearing the proper Underwriters Laboratories label.

B. Storage: Store bagged concrete aggregate products in a dry location until ready for application. Store pregenerated foam at temperatures between 52°F and 80°F (11° - 27° C). Expanded polystyrene board should not be stored in areas of standing water prior to application but can be exposed to rainwater before application. Boards must be clean and free from foreign substances.

1.07 PROJECT/SITE CONDITIONS

A. Requirements Prior to Job

Start

- 1. Notification:** Give a minimum of 5 days notice to the Owner and manufacturer prior to commencing any work and notify both parties on a daily basis of any change in work schedule.
- 2. Permits:** Obtain all permits required by local agencies and pay all fees which may be required for the performance of the work.
- 3. Safety:** Familiarize every member of the application crew with all fire and safety regulations recommended by OSHA, NRCA and other industry or local governmental groups.

B. Environmental Requirements

- 1. Precipitation:** Do not apply materials during precipitation or in the event there is a probability of precipitation during application. Take adequate precautions to ensure that materials and building interiors are protected from possible moisture damage or contamination.
- 2. Temperature Restrictions:** When air temperatures of 40°F (4.4°C) or above are predicted to occur within the first 24 hours after placement, normal mixing and application procedures may be used. For concrete aggregate mixtures, when air temperatures of 32°F to 40°F (0°C - 4.4°C) are predicted to occur within the first 24 hours after placement, warm water may be used. The mix temperature should not exceed 100°F (37.8°C) at point of placement. For pregenerated foam mixtures, when air temperatures of 32°F to 40°F (0°C - 4.4°C) are predicted to occur within the first 24 hours after placement, the Contractor may opt to increase the Portland cement quantity 15% by weight. Do not install the lightweight insulating concrete system when air temperatures are below 32°F (0°C).

1.08 WARRANTY/GUARANTEE

- A. Insulation System Warranty:** Upon successful completion of the project, and after all post installation procedures have been completed, furnish the Owner with the insulation system manufacturer's 10-year labor and materials warranty. The insulation system warranty shall include the composite roof deck system consisting of pregenerated foam and polystyrene insulation panels. All repair or replacement costs covered under the guarantee shall be borne by the insulation system manufacturer. The guarantee shall be a term type, without deductibles or limitations on coverage amount, and be issued at no additional cost to the Owner. Specific items covered during the term of the insulation system warranty include:

1. The actual resistance to heat flow through the roof insulation will be at least 80% of the design thermal resistance; provided that the roofing membrane is free of leaks.
2. The roof insulation will remain in a reroofable condition should the roof membrane require replacement (excluding damage caused by fastener pullout during removal

of the old membrane.)

3. The Insulating Concrete Warranty will not limit, by geographic location, the owners rights for claims, actions, and/or proceedings.
 4. The roof insulation material will not cause structural damage to the building as a result of expansion from thermal or chemical action.
- > *Siplast Ten-Year Roof Insulation Performance Warranty*
* NOTE: The above specification item is applicable when a performance warranty for the lightweight concrete only is required.

- B. Roof System Guarantee:** Upon successful completion of the project, and after all post installation procedures have been completed, furnish the Owner with a labor and materials endorsement to the roof membrane manufacturer's guarantee confirming that a single guarantee covers both the lightweight insulating concrete system and the roof membrane/flashing system. The roof system guarantee shall include both the roofing and flashing membrane, and the specified new lightweight insulating concrete system consisting of pregenerated foam, patented-preformed polystyrene panels, base sheet, and base sheet fasteners. All repair or replacement costs covered under the guarantee shall be borne by the roof membrane/flashing manufacturer. The guarantee shall be for a 10-year term, without deductibles or limitations on coverage amount, and be issued at no additional cost to the Owner. Specific items covered under the roof system guarantee include:

1. The actual resistance to heat flow through the roof insulation will be at least 80% of the design thermal resistance, provided that the roofing membrane is free of leaks;
 2. The roof insulation will remain in a reroofable condition should the roof membrane require replacement (excluding damage caused by fastener pullout during removal of the old membrane).
 3. The roof insulation will remain in place even if the roof membrane sustains wind damage covered by the guarantee.
 4. The base sheet, base sheet fasteners and polystyrene panels will be covered by the guarantee.
 5. The roof system guarantee will not limit, by geographic location, the Owner's rights for claims, actions, and/or proceedings.
 6. The roof insulation material will not cause structural damage to the building as a result of expansion from thermal or chemical action.
- > *Siplast Ten-Year Roof System Guarantee*
* NOTE: The above specification item is applicable when a roof system guarantee covering both the lightweight concrete system and roof membrane system is required.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

- A. Acceptable Manufacturer:** Provide a lightweight insulating concrete roof insulation system incorporating vermiculite aggregate, pregenerated foam and expanded polystyrene board supplied by a single manufacturer.

> *Zonocel Roof Insulation System by Siplast, Inc., Irving, TX (800) 922-8800*

2.02 SYSTEM DESCRIPTION

- A. Lightweight Concrete System Description:** Provide materials used in the lightweight concrete roof insulation system conforming to the following.
 1. Galvanized Metal Deck: Corrugated steel decking incorporating a pre-applied galvanized coating conforming to a minimum Class G-60 as specified in ASTM A 525 and having slots in the flutes equal to a minimum of 0.75% of the deck area. Refer to general notes on the structural drawings and Specification Section 05300 for metal deck specifications and attachment requirements.
**NOTE: Modification of metal deck welding patterns may be required to meet specific design criteria.*
 2. Portland Cement: Portland cement conforming to Type I, II, or III as defined by ASTM C 150.
 3. Vermiculite Aggregate: Vermiculite concrete aggregate conforming to ASTM C 332
> *ZIC Concrete Aggregate by Siplast, Inc., Irving, TX*
 4. Foam Concentrate: Protein based foam concentrate conforming to ASTM C 869 and ASTM C 796.
> *Insulcel PB Foam Concentrate by Siplast, Inc., Irving, TX*
 5. Expanded Polystyrene Insulation Board: Expanded polystyrene (EPS) insulation board having a nominal density of 1 pcf (16 kg/m³) defined as Type I by ASTM C 578 and containing approximately 3% open area. Each bundle of board shall be delivered to the job site with clear identification as to manufacturer and shall carry the Factory Mutual approval label and the Underwriter's Laboratories Classified label on each bundle.
> *Insulperm Insulation Board by Siplast, Inc., Irving, TX*
 6. Water: Potable water that is clean and free of deleterious amounts of acid, alkali and organic materials.

2.03 MIX DESIGN

- A. Density:** Mix Portland cement, pregenerated foam and vermiculite concrete aggregate at the rate of 8 ft³ of aggregate per 1 yd³ of concrete (0.23 m³ of aggregate per 0.77 m³ of concrete) with water to achieve a wet density ranging from 43 to 53 pcf (689 to 849 kg/m³), resulting in a minimum dry density of 30 pcf (481 kg/m³) and minimum compressive strength of 200 psi (1380 kPa).



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PART 3: EXECUTION

3.01 EXAMINATION

A. General: Ensure that all surfaces to receive lightweight insulating concrete are free of oil, grease, paints/primers, loose mill scale, dirt, or other foreign substances. Where necessary, cleaning or other corrections of surfaces to receive lightweight insulating concrete is the responsibility of the party causing the unacceptable condition of the substrate.

B. Substrate Acceptance: With the general contractor present, examine surfaces to receive the roof insulation system and determine that the surfaces are acceptable prior to placement of the lightweight insulating concrete system.

3.02 PREPARATION

A. General: Remove water or any other substance that would interfere with bonding of the lightweight concrete system.

3.03 APPLICATION

A. General: Provide equipment and application procedures conforming to the material supplier's application instructions.

B. Applications Not Incorporating Expanded Polystyrene Panels: Place lightweight insulating concrete in a 2-inch (25 mm) minimum thickness over the top corrugation of the metal deck.

C. Applications Incorporating Expanded Polystyrene Panels: When the specified expanded polystyrene insulation panels are to be incorporated into the lightweight insulating concrete system, fill the flutes and place a 1/8-inch (3 mm) minimum slurry over the top corrugation of the metal deck before embedding the expanded polystyrene insulation panels. Place the thickness of expanded polystyrene insulation panels shown in the approved shop drawings within 30 minutes of applying the insulating concrete slurry coat to the substrate. Place the expanded polystyrene insulation panels in a brick-like pattern. The maximum allowable panel step in a stair-step design is 1 inch (25 mm). Fill the holes in the expanded polystyrene insulation panels and place a 2-inch (51 mm) minimum thickness of insulating concrete over top of the expanded polystyrene insulation panels. The preferred method is to apply the insulating concrete top fill the same day. Other regulatory or jobsite sequencing issues may require application of the top fill the next day.

D. Thermal Resistance: Install the specified lightweight insulating concrete system to provide for an **[average/minimum]** thermal value of R-**[---]** or as shown on the architectural details/drawings.

E. Slope: Install the specified lightweight insulating concrete system to provide for a minimum positive roof slope of **[---]** inch per foot (**[---]** %). See the structural drawings for slope provided by the roof framing system.

3.04 FIELD QUALITY CONTROL

A. Protection: Avoid roof-top traffic over the roof insulation system until one can walk over the surface without creating surface damage.

B. Compressive Strength Testing: The Architect has the option to select an independent testing laboratory to randomly sample the top placement of insulating concrete to verify the thickness and density, and to secure and test compressive strength cylinders in accordance with ASTM C 495. The Owner will be responsible for the cost and engagement of the independent testing laboratory services.

**NOTE: The above testing may be necessary when the lightweight insulating concrete system is designed as a diaphragm to resist seismic or wind loads.*

C. Application Monitoring: Monitor the thickness and wet density of the lightweight insulating concrete at the time of placement to determine conformance to the manufacturer's requirements. Monitor the placement of proper thickness of polystyrene insulation board in accordance with the contract documents.

D. Fastener Withdrawal Testing: Conduct a base ply fastener pull test 3 or more days following the application of the lightweight insulating concrete to ensure a minimum withdrawal resistance of 40 pounds (18 kg) per fastener.

3.05 PATCHING

A. Patching: Perform all patching and repairing of insulating concrete using Zono-Patch or other materials approved by the lightweight insulating concrete supplier.