

Technical Brief

Insulation Options for CarbonCast® Enclosure Systems



Five types of rigid foam insulation are generally available for precast insulated wall systems: expanded polystyrene (EPS), graphite polystyrene (GPS) extruded polystyrene (XPS), polyisocyanurate (ISO) and phenolic. Each foam has unique properties. The choice depends on performance requirements and project budget. CarbonCast® technology is one of the few enclosure systems that enables the use of any of the five options. The information here will help you decide which type of insulation is best suited for your application.

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 **C-GRID®**
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C-GRID is a trademark of Chomarat, NA

Left: Hilton Des Moines, Des Moines, Iowa

CarbonCast® technology is one of the few enclosure systems that enables the option of virtually any type of insulation.



Right: Carbon fiber grid connectors and EPS insulation

Insulation

Insulation Type	R-value/Inch	Permeance
Expanded polystyrene (EPS or Beadboard)	3.8–4.2	0.9–2.5
Extruded polystyrene (XPS)	5	0.8
Polyisocyanurate	6	low
Graphite polystyrene (GPS)	4.7	0.6–2.5
Phenolic	8.5	.79



Expanded Polystyrene (EPS)

Often known as “white board” or “beadboard,” EPS foam boards are available in a variety of thicknesses and in different densities, with correspondingly different R-values and permeance ratings per inch. EPS foam is produced by placing polystyrene beads into a mold. An inert gas is introduced into the mold and heated. The heating process causes the beads to expand and fuse into one solid piece. The EPS can then be sliced into desired thicknesses. Unfaced EPS foam generally costs less per point of R-value than XPS but has a lower permeance rating. Depending on density, EPS foam will deliver R-values ranging from 3.8–4.2 per inch.

EPS foam is more absorptive than XPS foam; however, EPS foam boards can

withstand repeated cycles of wetting and drying without adversely affecting their performance. In addition, they will not support mold growth.

Although EPS has a lower permeance coefficient rating than other insulation types, (0.9-2.5 per inch), the entire precast wall assembly will generally have an overall permeance rating of 1.0 or less based on a sandwich wall panel assembly of 2" concrete – 4" insulation – 2" concrete. (2"/4"/2")

The roughened surface of EPS foam provides a shear value and actually contributes to the structural performance of composite panels. This assembly delivers satisfactory structural, thermal and vapor drive retarding performance for many project requirements.

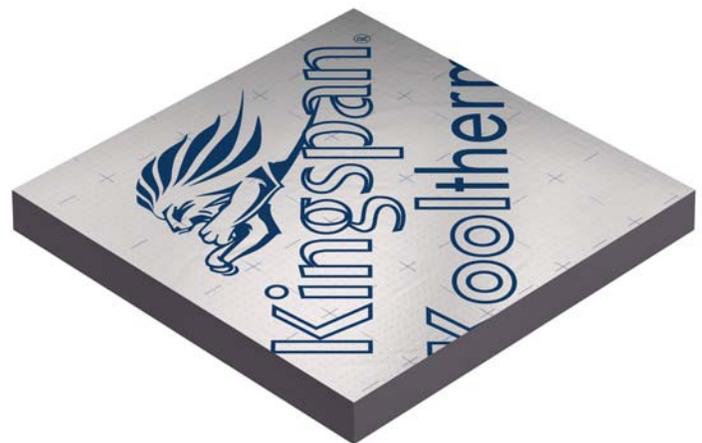


Extruded Polystyrene (XPS)

Extruded Polystyrene foam (XPS) is often called “green board, pink board or blue board” depending on the supplier. (Owens Corning markets XPS under the Foamular® brand.) It is produced by heating and expanding polystyrene beads through the use of a blowing agent to allow foam boards to be extruded under pressure, resulting in a light compacted, closed-cell matrix. XPS foam boards are available in thicknesses up to 4" and have a uniform R-value of 5 per inch with a permeance rating of 0.8. Its surface tends to be smooth when supplied by the manufacturer. However, it can be mechanically roughened to enhance the bond with concrete and improve the structural shear flow property values. In cases where a high R-value is desired and wall panel thickness is constrained, XPS may be the best choice. And, in uses where high indoor humidity is present (e.g., natatoriums, cold storage facilities, hospitals) and where the wall panel is being relied upon to perform as a vapor retarder, XPS could be a better choice. (Film-faced EPS is also an option.)

Graphite Polystyrene (GPS)

Graphite Polystyrene (GPS) is a step forward and the next generation of expanded polystyrene based rigid insulation. GPS displays all of the advantageous properties of plain EPS such as drying potential, a roughened surface for enhanced shear flow bond to concrete wythes and thicknesses available to meet any requirement in a single panel with improved R-value properties. Where traditional foams rely on increased densities, GPS forms utilize air and high-purity graphite to absorb and reflect heat energy to reduce thermal transmission. This results in a long-term and stable R-value of 4.7 per inch including Type I density where the profitability advantages of GPS are most obvious. (Marketed under the brand name Neopor.®)



Polyisocyanurate

Polyiso is a closed-cell, rigid foam board insulation. Polyiso has trilaminar facing on either side. It has a low permeance rating and an R-value of R-6 per inch. It tends to be the most expensive option per square foot for continuous insulation applications in precast wall panels. The facing provides a less-than-ideal surface for adhering to concrete in the wall panel, often resulting in the need for additional reinforcement or connectors. While it does offer higher R-value than EPS or XPS it is 25% lower than Phenolic per inch. Most precast insulated wall panels can achieve specified assembly R-value with a slightly thicker layer of lower cost EPS or XPS. (There are several major suppliers of polyiso servicing the precast and roofing segments.)

Phenolic

Phenolic insulation is a premium performance rigid thermoset fiber-free insulation manufactured with a blowing agent that has zero ozone depletion potential (ODP) and low global warming potential (GWP). This product has an R-value of R-17 on a 2" product and is available in thicknesses ranging from 1.57" (R-13.5) – 3.94" (R-33.5). This product offers the highest R-value per inch and can significantly reduce the required thickness of insulation. The closed cell structure resists both moisture and water vapor ingress with the air permeance specification being 0.000 (cfm/ft²) and the water vapor permeance being 0.79 perm. All this while offering superior fire and smoke performance as demonstrated by the E84 ratings of 5 on flame spread and 5 on smoke developed.

Choosing the best insulation for CarbonCast® panels

As with all building products, architects need to balance price and performance. If price is the main concern, EPS generally comes out ahead. It is generally less costly than the other three options while delivering commendable insulation value. It is also the preferred option if you need to achieve an R-value less than R-20. GPS can be used for applications that would benefit from its higher R-Value (4.7/inch).

XPS provides slightly more insulation value per inch (R-5.0) than GPS, resulting in slightly thinner panels and has better moisture resistance than EPS. Its ability to act as a vapor retarder makes it ideal for high-humidity applications.

ISO is often viewed as a premium option for insulated wall panels and with proper engineering, it can perform satisfactorily. Its R-value of R-6 per inch adds a benefit to thinning the assembly.

Phenolic has the highest R-value per inch and should be considered where gaining usable floor space is a concern. It should also be considered where high R-value specifications are in play whereas the phenolic can achieve high R-value in a single layer during the precast panel assembly.

What is Continuous Insulation?

Continuous insulation (c.i.) is defined in ASHRAE 90.1 as “insulation that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the building envelope.” The thermal performance of edge-to-edge insulated precast concrete sandwich wall panels with no or minimal thermal bridges and no solid zones maintains the R-values for continuous insulation as defined by ASHRAE 90.1, thereby lowering energy costs. The C-GRID connectors in CarbonCast® panels enable continuous insulation between the two wythes of concrete.

How is insulation integrated into CarbonCast® panels?

AltusGroup precasters pour the precast wall panel's face wythe in the form. Before the concrete cures, the rigid insulation boards are set side by side atop the poured wythe. This forms an edge-to-edge insulation layer that qualifies as continuous insulation. Low thermal conductivity C-GRID shear connectors are placed. They extend into the face wythe and beyond the top of the insulation board with a minimum embedment depth of $\frac{3}{4}$ " to ensure adequate anchorage. The back wythe is poured next, allowing the C-GRID to connect the face wythe and back wythe through the foam, providing structurally composite performance and consistent R-values of insulation.



For more information, go to altusprecast.com and learn how CarbonCast® can deliver resilience for your project as well as lasting performance that generate positive ROI.

Call us today to speak with a technical representative or request a lunch-and-learn program.



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(866) GO-ALTUS / (866) 462-5887

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