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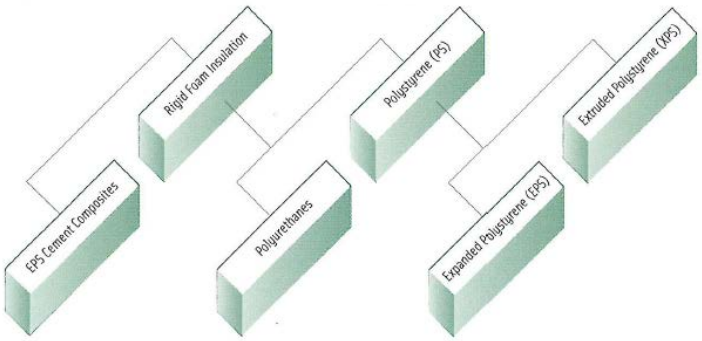
Concrete Homes: Technology Brief No. 4: *Plastic Foams for Concrete Homes*

Many of the benefits of concrete homes built with insulating concrete forms (ICFs) come from the plastic foams of which ICFs are made. Plastic foams are lightweight, easily cut, excellent insulators, and good barriers to air and moisture. They are also strong enough to hold concrete and serve as a backer for interior and exterior finishes.

What exactly are plastic foams?

The ICFs sold in North America are either made of expanded polystyrene (EPS), extruded polystyrene (XPS), or a cement-foam composite. By way of a variety of manufacturing methods and formulations, rigid foam insulation is typically produced by introducing a blowing agent into the manufacturing process, creating uniform air pockets throughout. This results in a lightweight foam material with superior thermal properties.



What foams are used for ICFs?

Expanded polystyrene and extruded polystyrene, while made from the same plastic, differ in manufacturing technique. EPS is a closed-cell foam made by an expansion process incorporating steam within a customized mold cavity. This produces unique shapes based upon the mold design. In this process, EPS can be molded in a variety of densities to meet specific ICF requirements. XPS is close-cell foam that uses an extrusion process creating a continuous "sheet" of foam that is produced in distinct densities and thicknesses.

Polyurethane foam results when two separate ingredients, an isocyanurate and a polyol, are mixed and react with one another. Cement-foam composites are a mixture of portland cement and individual EPS beads that have been partially expanded.

Most ICF Manufacturers select the foam material best suited to their proprietary form system based on performance properties and manufacturing efficiencies desired. But in several ICF systems, the formwork is assembled from standard flat sheets of foam, available from building suppliers. With these systems the buyer may also have a choice of different types of foam.

What's the difference between types of foam?

All types of rigid foam insulation deliver solid performance when used in ICFs for residential construction. Each foam material exhibits unique performance properties, dependent on the material density, dimensions, and other factors. With minor changes in the manufacturing process, different results—using the same type of plastic—can be achieved to meet exacting specifications. The minimum performance properties for rigid foam plastics and cement-foam composites serve as guidelines when selecting materials for an ICF system. EPS offers exceptional value, providing ample insulation and resistance to air and moisture infiltration. At

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Typical Properties of Plastic Foams				
	XPS	EPS	Polyurethane	Composite
Density (lbs/cu ft)	1.60-1.80	1.35-1.80	2.00	21
R-value per inch	3.86-5.00	4.00-4.20	5.90	3.00
Strength (psi) Compressive	20-40	15-25	30	70
Water absorption (%)	<0.5	<3.0	2.0	NA

lower densities, it provides moderate strength. It is also available in either custom molded components or sheet form. EPS can be engineered to deliver higher R-value per inch and increased strength by increasing the material density. XPS is typically more expensive (up to 50%) and may offer a higher insulating value per inch. It exhibits higher strength properties and a slightly greater resistance to water absorption. It is available in sheet form only. Polyurethane has a higher insulating value than either EPS or XPS and comparable strength, but is the most expensive rigid foam plastic. It is available in some molded ICF systems. A closely related foam, polyisocyanurate, is available in sheet form, but is not usually recommended for use in ICFs. Due to the use of cement, composite foam provides exceptional strength and possibly more durability with slightly lower insulating values. This type of ICF system is heavier than its rigid foam counterpart and typically requires more effort to cut and shape. Cost estimates are unavailable since the material is only available in completed, molded units.

Are These Materials Safe?

Rigid foam plastics are considered to be inert materials with no recognized health effects. Polystyrene and polyurethane are formaldehyde free and have not been linked to respiratory problems or skin irritations as have some fiber-based insulations. In tests for indoor air quality, no harmful emissions were detected in wall systems using expanded polystyrene foams.

All foams manufactured for use as insulation or other building applications incorporate a fire retardant intended to minimize flame spread in the event of fire. Research on the fire performance of EPS rigid foam plastic concludes that when it is forced to burn in a simulated fire test, emissions are no more toxic than those of burning wood.

How Do I Choose the Correct Foam Insulation?

When comparing the effectiveness of one ICF system to another, a basic understanding of the different foam materials can prove helpful. However, it is most important to choose the best ICF system for your specific needs, not a particular type of foam. The performance of an ICF is only partly determined by the choice of foam used. ICF systems offer an integrated and unique approach to residential building and should be evaluated in terms of their overall performance, not individual components, to fully appreciate their benefits.

What's the Bottom Line?

Rigid foam plastic insulation is an important feature of ICFs that contributes to a superior house. There is no one "best" material, but foams offer performance variables that can help explain the differences between ICF products.

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