EXPANDED POLYSTYRENE



The Green Insulation Alternative

Provider: K 031
Course EPS 103
1 LU HSW/SD

AIA Continuing Education

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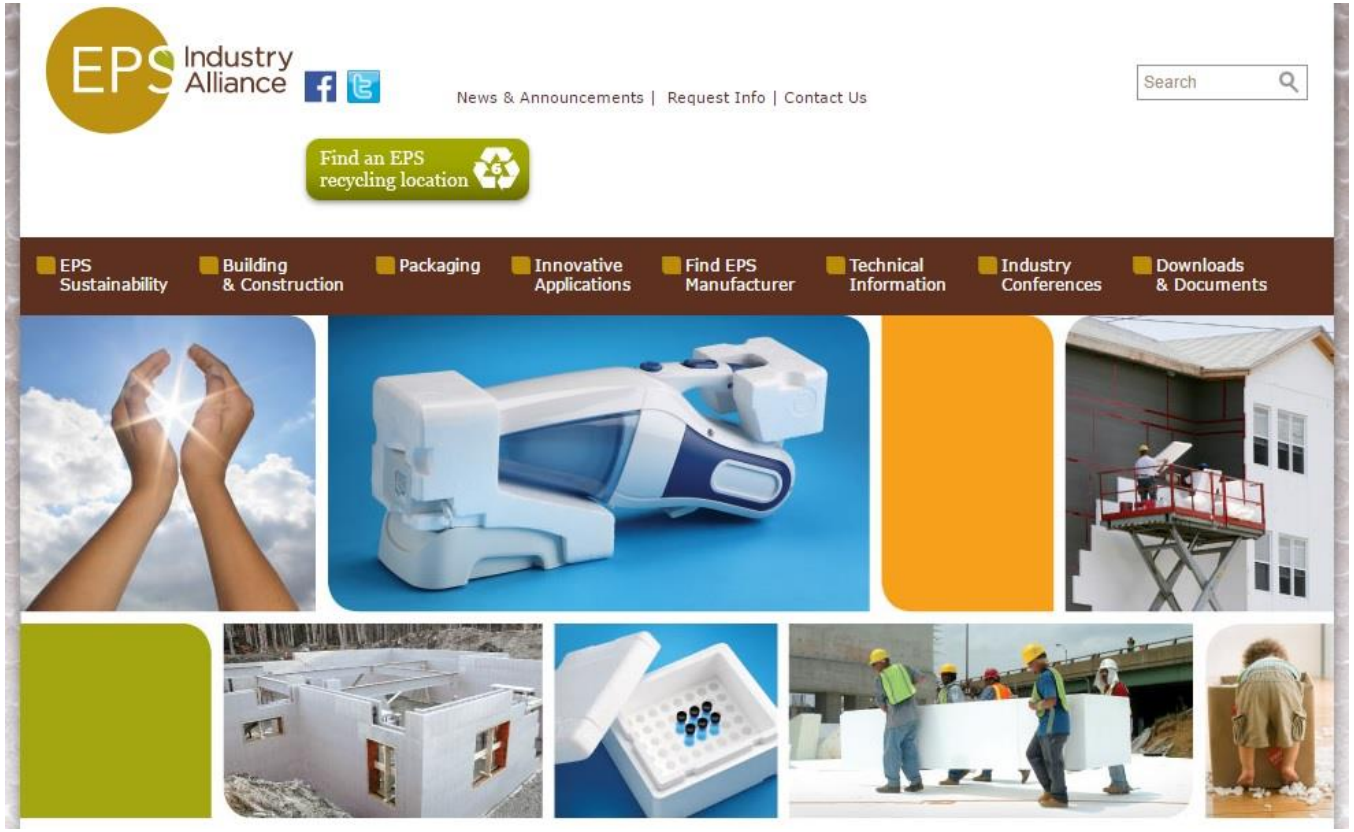
Learning Objectives

- Define and understand how Expanded Polystyrene (EPS) is manufactured
- Learn about environmental features and benefits of EPS insulation including recyclability, LEED, thermal performance, energy efficiency, global warming reduction and mold resistance
- Understanding ASTM C578, *Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation*
- Understanding key physical properties of EPS: R-value, Compressive Strength, and Moisture Absorption
- Understand the different applications of EPS – Roofing, Wall, Below Grade, Below Slab, Geofoam, Lightweight Void Fill and SIPs

EPSIA

Expanded Polystyrene Industry Alliance

- Helpful resource to help explain EPS in much greater detail
- www.EPSindustry.org



EPS Manufacturers

Many large and small manufacturers throughout North America produce EPS:

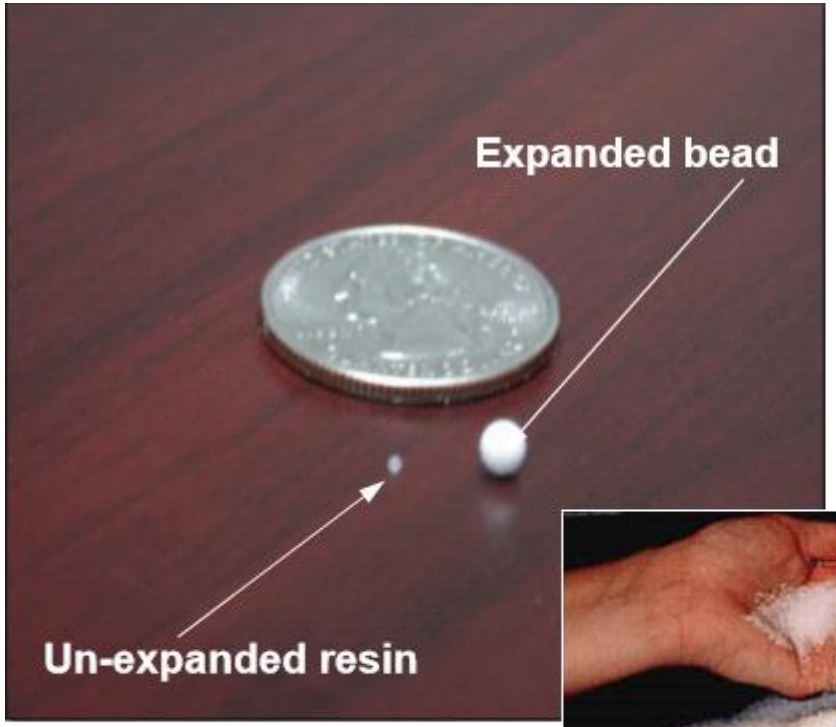
- Insulfoam
- Cellofoam
- Atlas
- Plastifab
- Carpenter
- ACH
- Many small local and regional companies

What is EPS?

Expanded polystyrene (EPS) is a versatile, lightweight material that can be manufactured into a variety of products. EPS offers a high-performance, yet economical, solution for a wide variety of construction applications.

EPS is NOT Styrofoam®

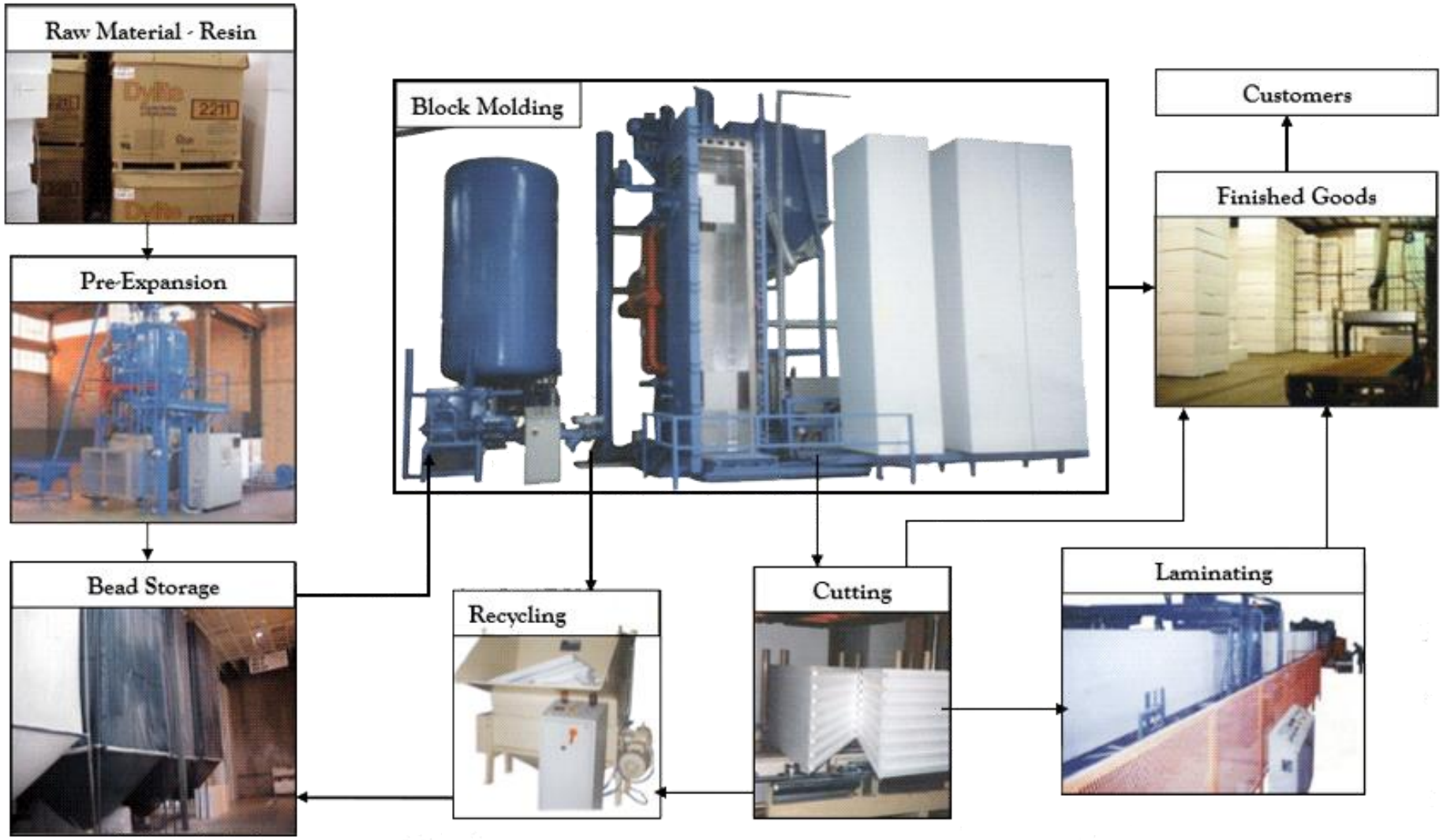
It Starts with Expandable Polystyrene



Many types…

- Modified and unmodified
- Various pentane contents
- Various sizes
- End uses

The Process


Raw Material - Resin
Pre-Expansion
Bead Storage
Block Molding
Recycling
Cutting
Laminating
Finished Goods
Customers

State-of-the-Art Molding

Block size varies from 14-24 ft. tall

Computer Controlled Vacuum Molding

Cutting or “Slabbing”

Sustainability and Environmental Benefits

- Environmentally Friendly
- Contains no HCFCs or formaldehyde
- 100% recyclable from jobsites
- Manufacturing option: contains up to 25% recycled content
- Reduces global warming
- Contributes towards LEED Certification credits
- Manufacturing option: additives to resist insects and mold

Recyclability

- EPS can be removed off jobsites and may be used in future manufacturing as long as it is not contaminated
- Can be introduced into the manufacturing of new product or returned to a styrene resin

Expanded Polystyrene Reduces Global Warming

EPS insulation can return up to 200 times the amount of energy required to produce it, and reduce emissions by up to 100 times the volume produced during the manufacturing process.

Expanded Polystyrene Reduces Global Warming

- The use of foam insulation on a building significantly increases the R-Value of walls to save energy
- Lower residential energy use translates into fewer emissions and reduced GWP

U.S. Model

Energy Savings Provided by Adding Exterior R-4 EPS Insulation Single Family Home - U.S.	Energy Investment	Millions Btu's
	EPS Production	8.90
	EPS Transportation	0.13
	Total Energy Invested	9.03

Energy Savings (Millions Btu's)	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	U.S. Average
Annual Energy Savings	11.37	9.58	7.84	5.58	5.00	6.58
Payback Period in Years	0.79	0.94	1.15	1.62	1.81	1.37
Savings Over 50 Years	568	479	392	279	250	329
Return on Investment (ROI%)	6,290	5,305	4,341	3,090	2,769	3,643

Global Warming Potential (GWP) Reductions Provided by Adding Exterior R-4 EPS Insulation Single Family Home - U.S.	GWP Invested	lbs. CO_2 Equiv.
	EPS Production	7.95
	EPS Transportation	24
	Total GWP Invested	819

GWP Reductions Compared to Base Wall	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	U.S. Average
Annual Reductions	1,669	1,354	1,155	831	777	982
Payback Period in Years	0.49	0.61	0.71	0.99	1.05	0.83
Savings Over 50 Years	83,473	67,682	57,739	41,257	38,867	49,095
Return on Investment (ROI%)	10,192	8,264	7,050	5,037	4,746	5,995

USGBC and LEED

Materials and Resources (MR Credits)

MR Credit 2.1 & 2.2 – Construction Waste Management:

Divert 20% or 75% from Disposal, 2 points possible

MR Credit 3.1 & 3.2 – Materials Reuse:

5% or 10%, 2 points possible

MR Credit 4.1 & 4.2 – Recycled Content:

10% or 20%, 2 points possible

MR Credit 5.1 & 5.2 – Regional Materials,

2 points possible

Sustainable Sites (SS Credits)

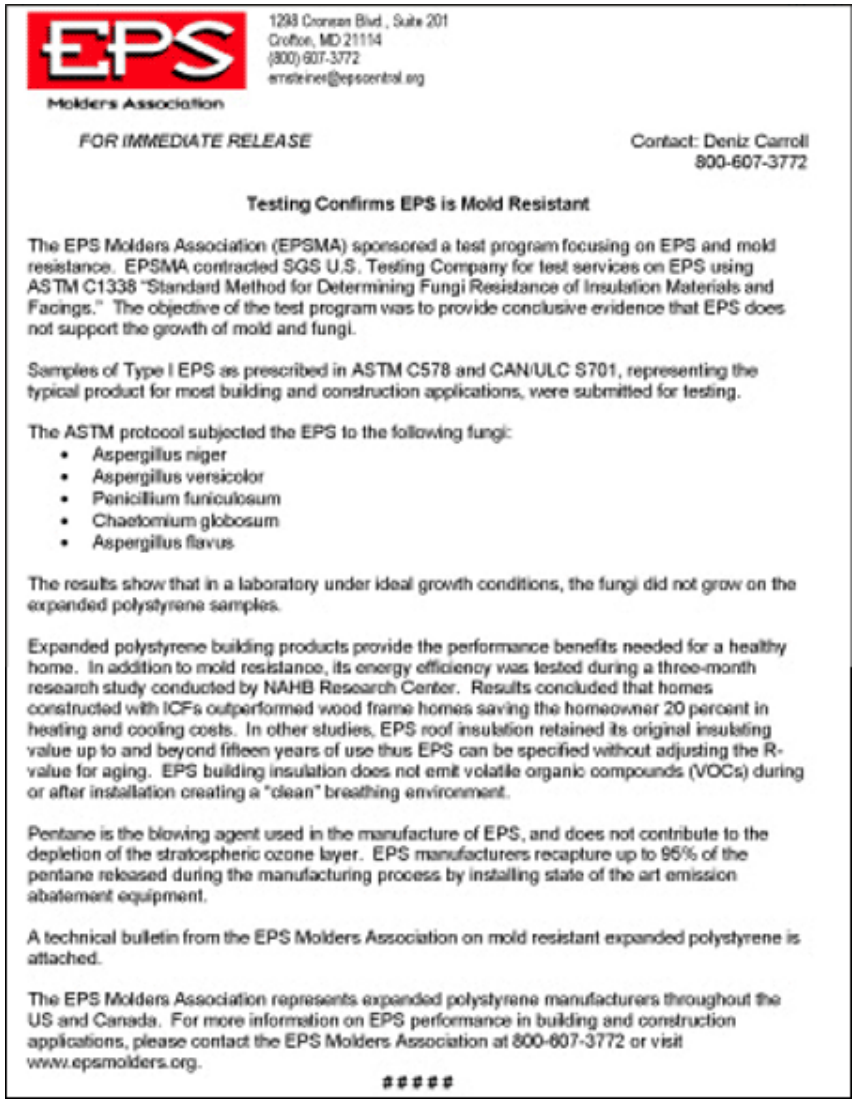
SS Credit 7.2 – Heat Island Effect Roof, 1 point possible

Energy and Atmosphere (EA Credits)

EA Credit 1 – Optimize Energy Performance, 10 points possible

EA Credit 5 – Measurement & Verification, 1 point possible

EPS is Mold Resistant



EPS Molders Association
1298 Cronson Blvd., Suite 201
Crofton, MD 21114
(800) 607-3772
emsteiner@epscentral.org

FOR IMMEDIATE RELEASE

Contact: Deniz Carroll
800-607-3772

Testing Confirms EPS is Mold Resistant

The EPS Molders Association (EPSMA) sponsored a test program focusing on EPS and mold resistance. EPSMA contracted SGS U.S. Testing Company for test services on EPS using ASTM C1338 "Standard Method for Determining Fungi Resistance of Insulation Materials and Facings." The objective of the test program was to provide conclusive evidence that EPS does not support the growth of mold and fungi.

Samples of Type I EPS as prescribed in ASTM C578 and CAN/ULC S701, representing the typical product for most building and construction applications, were submitted for testing.

The ASTM protocol subjected the EPS to the following fungi:

- Aspergillus niger
- Aspergillus versicolor
- Penicillium funiculosum
- Chaetomium globosum
- Aspergillus flavus

The results show that in a laboratory under ideal growth conditions, the fungi did not grow on the expanded polystyrene samples.

Expanded polystyrene building products provide the performance benefits needed for a healthy home. In addition to mold resistance, its energy efficiency was tested during a three-month research study conducted by NAHB Research Center. Results concluded that homes constructed with ICFs outperformed wood frame homes saving the homeowner 20 percent in heating and cooling costs. In other studies, EPS roof insulation retained its original insulating value up to and beyond fifteen years of use thus EPS can be specified without adjusting the R-value for aging. EPS building insulation does not emit volatile organic compounds (VOCs) during or after installation creating a "clean" breathing environment.

Pentane is the blowing agent used in the manufacture of EPS, and does not contribute to the depletion of the stratospheric ozone layer. EPS manufacturers recapture up to 95% of the pentane released during the manufacturing process by installing state of the art emission abatement equipment.

A technical bulletin from the EPS Molders Association on mold resistant expanded polystyrene is attached.

The EPS Molders Association represents expanded polystyrene manufacturers throughout the US and Canada. For more information on EPS performance in building and construction applications, please contact the EPS Molders Association at 800-607-3772 or visit www.epsmolders.org.

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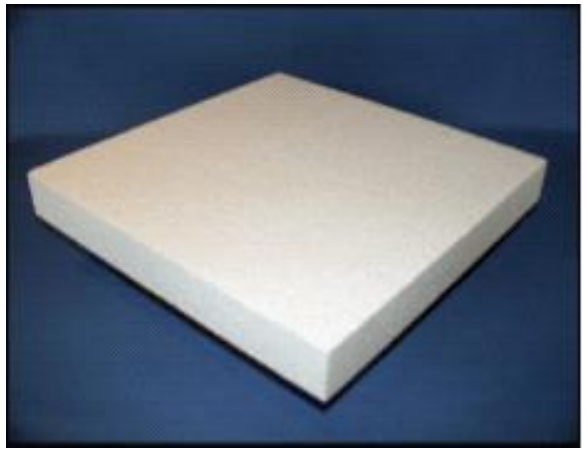
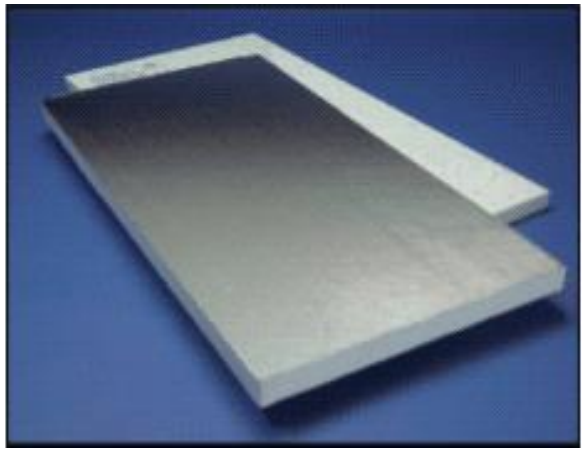
EPS Products

- Standard – Unfaced
  - Flat, tapered, special shapes
- Laminated or Composites – Faced
  - Flat Only

Standard EPS Products

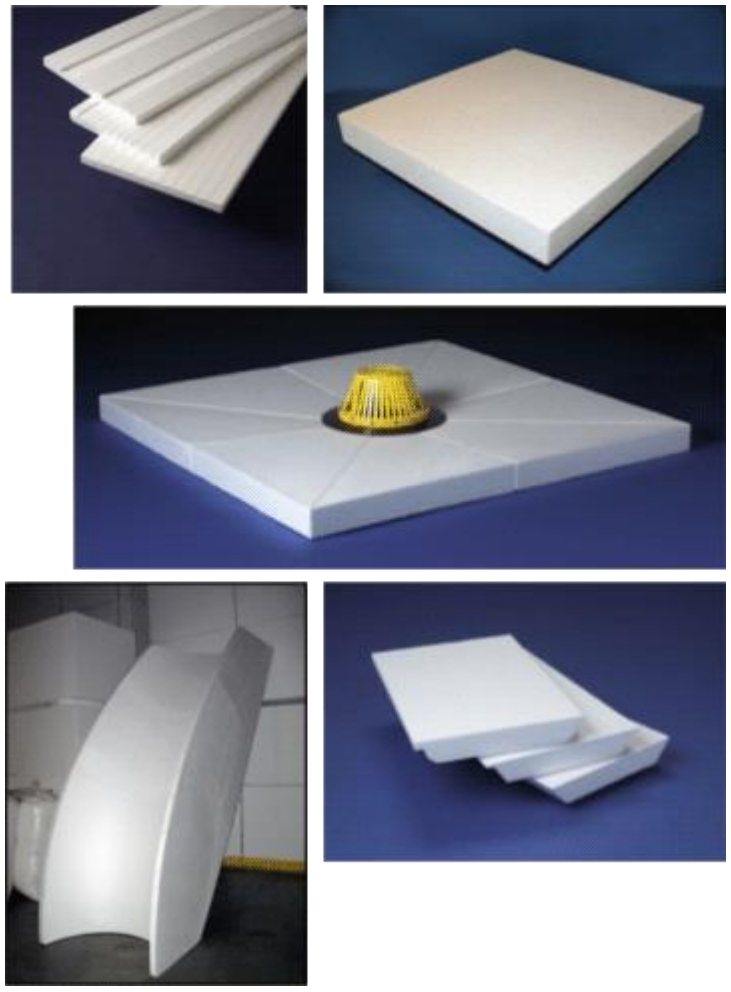
The most R-value per dollar

Product Features:

- 10-60 psi
- Panels, blocks, custom shapes
- Flat or tapered
- Bevel or straight cut edges
- 3/8” – 40” thick

Manufacturing:

- May contain recycled content (depending on the spec)
- 100% recyclable
- Contains no HCFCs or dyes
- Energy Star & LEED compliant



Standard EPS

Physical Properties

Typical Physical Properties							
Property	**Type I**	**Type VIII**	**Type II**	**Type IX**	**Type XIV**	**Type XV**	**Test Method**
Nominal Density (pcf)	1.0	1.25	1.5	2.0	2.50	3.0	ASTM C303
C-Value (Conductance) BTU/(hr•ft²•°F)							ASTM C518 or ASTM C177
@ 25° F	.230	.220	.210	.200	0.198	0.196	
(per inch) @ 40° F	.240	.235	.220	.210	0.206	0.198	
@ 75° F	.260	.255	.240	.230	0.222	0.217	
R-Value (Thermal Resistance) (hr•ft²•°F)/BTU							ASTM C518 or ASTM C177
@ 25° F	4.35	4.55	4.76	5.00	5.05	5.10	
(per inch) @ 40° F	4.17	4.25	4.55	4.76	4.85	5.05	
@ 75° F	3.85	3.92	4.17	4.35	4.50	4.60	
Compressive Strength (psi, 10% deformation)	10 - 14	13 - 18	15 - 21	25 - 33	40	60	ASTM D1621
Flexural Strength (min. psi)	25	30	35	50	60	75	ASTM C203
Dimensional Stability (maximum %)	2%	2%	2%	2%	2.0	2.0	ASTM D2126
Water Vapor Permeance (max. perm., 1 inch)	5.0	3.5	3.5	2.0	2.5	2.5	ASTM E96
Water Absorption (max. % vol.)	4.0	3.0	3.0	2.0	2.0	2.0	ASTM C272
Capillarity	none	none	none	none	none	none	–
Flame Spread	< 20	< 20	< 20	< 20	< 20	< 20	ASTM E84
Smoke Developed	150 - 300	150 - 300	150 - 300	150 - 300	150-300	150-300	ASTM E84

*Properties are based on data provided by resin manufacturers, independent test agencies and Insulfoam

Standard EPS Application

- Below Grade
- Below Slab
- Radiant Floors
- Roofing
- Wall
- EIFS







Premium Faced – EPS Product faced, laminated

Enhanced job site handling, durability and moisture resistance and enhanced fire resistance.

Facers

Factory laminated polymeric facer

Fabric and foil facers

Coated glass facer fiber reinforced facer

Product

10-60 psi

Panels, blocks, fanfold, snap feature, custom sizes

3/8” - 40” thick

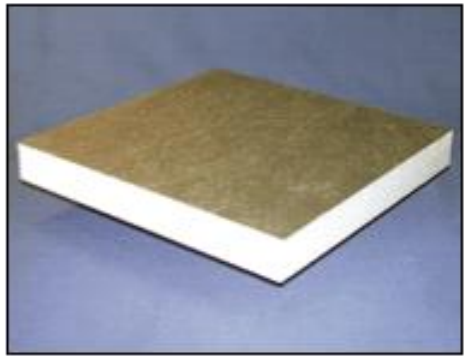
Manufacturing

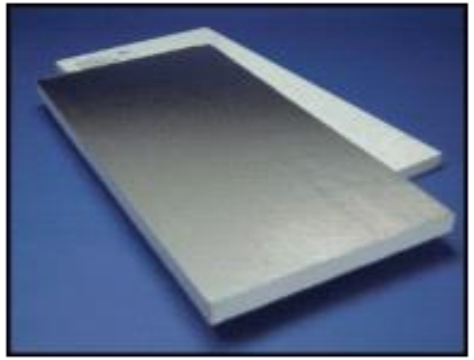
May contain recycled content depending on spec

EPS is 100% recyclable

Contains no HCFCs or dyes

Energy Star, LEED compliant



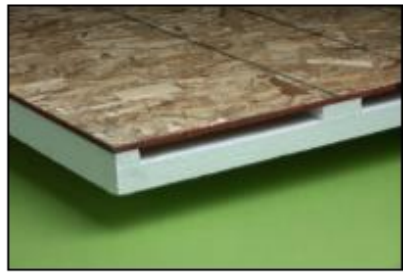


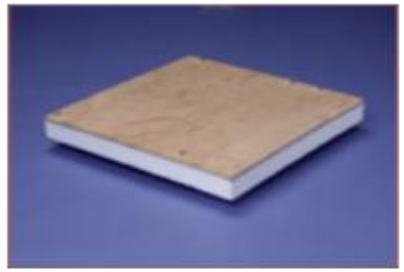
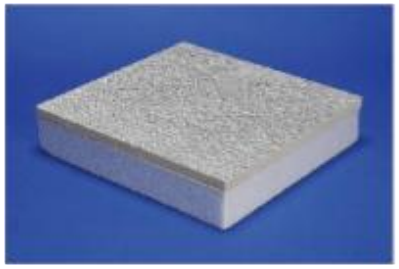
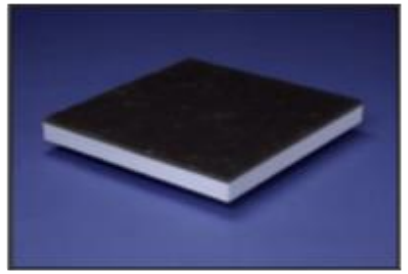
Premium Faced – EPS Application

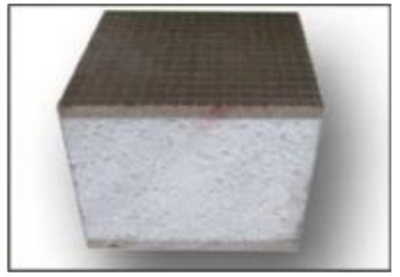
- Below Grade Insulation
- Waterproofing Protection Board
- Below/Between Slab
- Cavity Well Insulation
- Sheathing
- Siding Underlayment
- Roofing Underlayment
- Radiant Heat Floors
- Pre-cast Wall Panels

Premium Faced – EPS Composites

- EPS can be bonded to a variety of other rigid products depending on the application
  - OSB or Plywood High Density Polysio
  - Wood fiber or perlite Metal panels
  - SIPs
- Offers labor savings, additional durability and enhanced performance



Premium EPS Composite Applications

- SIPs
- Steep slope roofing
- Wall
- High traffic roofing
- Severe hail zones

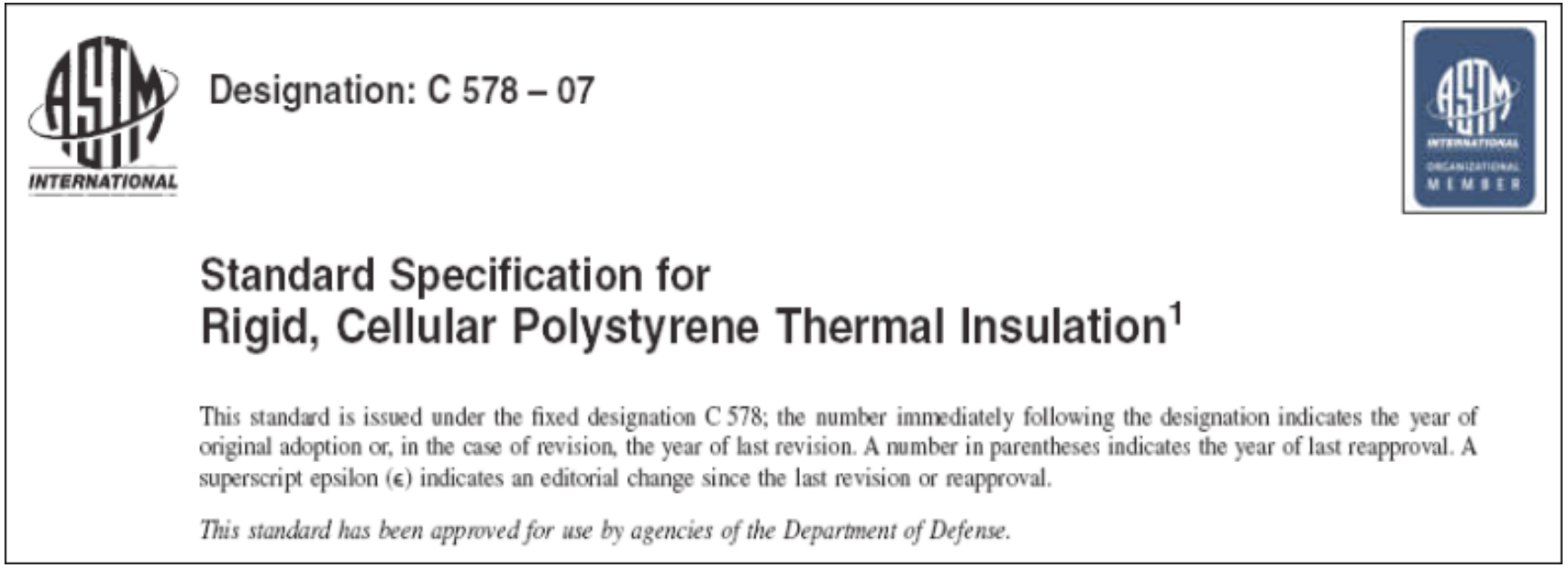
Physical Properties
Composite EPS

- Higher compressive strengths
- Higher R-values
- Greater fire rating
- Greater hail and high traffic ratings
- Better moisture absorption

Codes and Compliances

- FM
- UL
- ASTM
- ICC – ES
- IBC
- Miami Dade
- State of Florida
- Various Sate Approvals

ASTM C578



Designation: C 578 – 07

Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation[1]

This standard is issued under the fixed designation C 578; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

- The industry's consensus standard for expanded and extruded polystyrene
- Establishes the minimum and/or maximums for assorted physical properties

ASTM C578

Designation: C 578 – 07

Standard Specification for
Rigid, Cellular Polystyrene Thermal Insulation[1]

1. Scope

1.1 This specification[2] covers the types, physical properties, and dimensions of cellular polystyrene boards with or without facings or coatings made by molding (EPS) or extrusion (XPS) of expandable polystyrene. Products manufactured to this specification are intended for use as thermal insulation for temperatures from -65 to +165°F (-53.9 to +73.9°C). This specification does not apply to laminated products manufactured with any type of rigid board facer including fiberboard, perlite board, gypsum board, or oriented strand board.

ASTM C578

TABLE 1 Physical Property Requirements of RCPS Thermal Insulation

NOTE 1—The values for properties listed in this table may be affected by the presence of a surface skin which is a result of the manufacturing process. The values for Type XIII properties listed in this table must be generated on material with the surface skin removed. Where products are tested with skins-in-place, this condition shall be noted in the test report.

NOTE 2—Type III has been deleted because it is no longer available.

NOTE 3—In addition to the thermal resistance values in Table 1, values at mean temperatures of 25 ± 2°F (-4 ± 1°C), 40 ± 2°F (4 ± 1°C), and 110 ± 2°F (43 ± 1°C) are provided in X1.8 for information purposes.

NOTE 4—For Type XIII, in addition to the Thermal resistance property requirements shown in Table 1, there are Apparent Thermal Conductivity property values shown for informational purposes in Table X1.2 of Appendix X1.

NOTE 5—Values quoted are maximum value for 1.00 in. (25.4 mm) thick samples with natural skins intact. Lower values will result for thicker materials. Where water vapor permeance is a design issue, consult manufacturer.

NOTE 6—Types XI, I, VIII, II, IX, XIV and XV are typically EPS insulation. Types XII, X, XIII, IV, VI, VII and V are typically XPS insulation.

Classification	Type XI	Type I	Type VIII	Type II	Type IX	Type XIV	Type XV	Type XII	Type X	Type II	Type XIII	Type IV	Type IX	Type VI	Type XIV	Type VII	Type XV	Type V
Compressive resistance at yield or 10 % deformation, whichever occurs first (with skins intact), min, psi (kPa)	5.0 (35)	10.0 (69)	13.0 (90)	15.0 (104)	25.0 (173)	40.0 (276)	60.0 (414)	15.0 (104)	15.0 (104)	15.0 (104)	20.0 (138)	25.0 (173)	25.0 (173)	40.0 (276)	40.0 (276)	60.0 (414)	60.0 (414)	100.0 (690)
Thermal resistance of 1.00-in. (25.4-mm) thickness, min, $F·ft^2·h/Btu$ ($K·m^2/W$) Mean temperature:																		
75 ± 2°F (24 ± 1°C)	3.1 (0.55)	3.6 (0.63)	3.8 (0.67)	4.0 (0.70)	4.2 (0.74)	4.2 (0.74)	4.3 (0.76)	4.6 (0.81)	5.0 (0.88)	4.0 (0.70)	3.9 (0.68)	5.0 (0.88)	4.2 (0.74)	5.0 (0.88)	4.2 (0.74)	5.0 (0.88)	4.3 (0.76)	5.0 (0.88)
Flexural strength, min, psi (kPa)	10.0 (70)	25.0 (173)	30.0 (208)	35.0 (240)	50.0 (345)	60.0 (414)	75.0 (517)	40.0 (276)	40.0 (276)	35.0 (240)	45.0 (310)	50.0 (345)	50.0 (345)	60.0 (414)	60.0 (414)	75.0 (517)	75.0 (517)	100.0 (690)
Water vapor permeance of 1.00-in. (25.4-mm) thickness (See Note 5.), max, perm (ng/Pa·s·m^2)	5.0 (287)	5.0 (287)	3.5 (201)	3.5 (201)	2.5 (143)	2.5 (143)	2.5 (143)	1.5 (86)	1.5 (86)	3.5 (201)	1.5 (86)	1.5 (86)	2.5 (143)	1.1 (63)	2.5 (143)	1.1 (63)	2.5 (143)	1.1 (63)
Water absorption by total immersion, max, volume %	4.0	4.0	3.0	3.0	2.0	2.0	2.0	0.3	0.3	3.0	0.5	0.3	2.0	0.3	2.0	0.3	2.0	0.3
Dimensional stability (change in dimensions), max,%	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Oxygen index, min, volume %	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Density, min, lb/ft^3 (kg/m^3)	0.70 (12)	0.90 (15)	1.15 (18)	1.35 (22)	1.80 (29)	2.40 (38)	2.85 (46)	1.20 (19)	1.30 (21)	1.35 (22)	1.60 (26)	1.55 (25)	1.80 (29)	1.80 (29)	2.40 (38)	2.20 (35)	2.85 (46)	3.00 (48)

EPS R-Value
Economical, Stable, Warranted

- EPS provided the most R value per dollar of any insulation
- EPS products do not have thermal drift; they do not lose R-value over time
- EPS R-values are warranted at the published values; the “full” R-value is covered for the entire warranty term

Moisture Resistance

Technical *bulletin*

15-Year In-Situ Research Shows EPS Outperforms XPS in R-Value Retention

Studies show that as much as 25% of energy loss from a structure can be attributed to a lack of insulation on below-grade foundations, crawl spaces and under slabs. Insulation R-value is directly correlated to maximum energy efficiency in a building envelope; higher R-values translate into increased savings. In below grade applications, foam insulation is exposed to moisture and could lose r-value over time if this moisture is absorbed.

As shown in an independent, third-party test program expanded polystyrene (EPS) maintains its R-value even after long-term exposure in cold, wet climates. A competing insulation material, extruded polystyrene (XPS) was shown to have lost R-value over time. The results of this test program demonstrate that EPS insulation is a perfect choice to reduce energy loss.

IN-SITU TEST RESULTS

In August 2008, independent testing[1] evaluated the field performance of EPS and XPS insulation in a side-by-side, below grade application following a continuous 15-year installation period. EPS Type I and XPS Type X test samples were excavated from the exterior of a commercial building in St. Paul, MN at a depth of approximately 6 feet below grade.

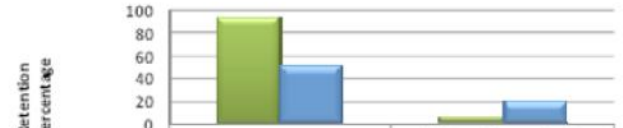
Specimens were tested for thermal resistance using ASTM C518 *"Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Apparatus"* immediately after excavation. Moisture content was determined by measuring the sample weight at the time of removal and again after being oven dried.

Excavation Site Minneapolis, MN Climate Zone 1

Side-by-Side Installation

Technical *bulletin*

In-Situ R-Value Retention & Water Absorption



	% R-Value Retention	% Water Absorption by Volume
EPS Type I (1.0 pcf)	94	4.8
XPS Type X (1.6 pcf)	52	18.9

The results demonstrate that EPS Type I outperforms XPS Type X in both R-value retention and decreased water absorption. Further, whereas the in-service R-value of the XPS insulation is reduced by half, expanded polystyrene still delivers 94% of its specified R-value of 3.6 per inch after 15 years. These long term performance advantages make EPS insulation a preferred choice when compared to the competition.

This testing further confirms that water absorption results determined using ASTM C272 cannot be correlated to the in-service performance of foam insulation. The main reason for the lack of correlation is that the laboratory test procedures call for partial or full submersion conditions which are not encountered in field applications. In fact, laboratory test methods were not developed for predicting actual performance, but were intended for use in specifications as a means of comparing relative physical properties of different cellular plastics and for product evaluations and quality control.

To find out how EPS can meet your future project needs contact the closest EPS Molders Association member manufacturer. For a list of participating companies visit www.epsmolders.org or call (800) 607-3772.

EPS Molders Association
1298 Cronson Blvd., Suite 201
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www.epsmolders.org

Superior Moisture Resistance

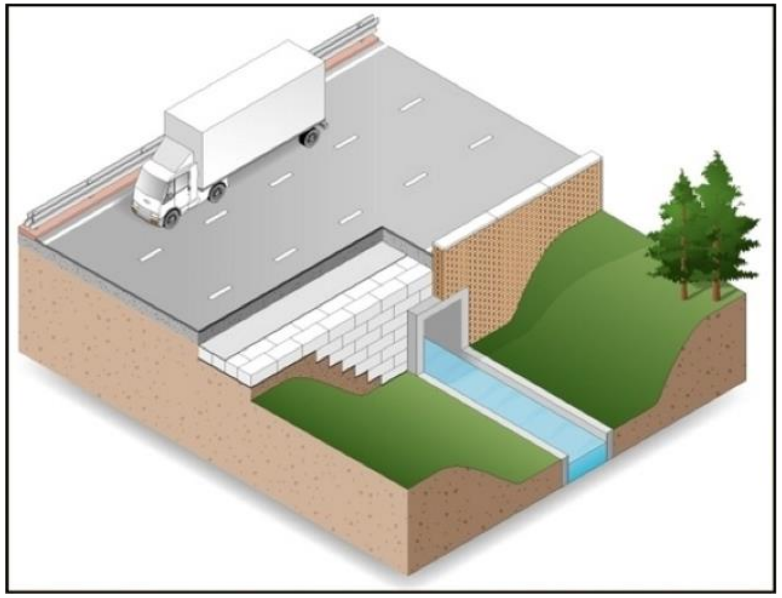
	15 Yr. In-situ Test Results				ASTM C578 Values	
	Results Upon Extraction		Results after 30 days @ 72° F & 50% R.H.			
	EPS	XPS	EPS	XPS	EPS	XPS
R-Value/inch	3.4	2.6	3.7	2.8	3.6	5.0
Moisture Content (Volume %)	4.8	18.9	0.7	15.7	4.0	0.1

Unlike the Type I EPS, when exposed to dry conditions for four weeks, the XPS did not approach the values expected per ASTM C578, *Standard Specification for Rigid Polystyrene Thermal Insulation*.

Compressive Strength and Resistance

- Don’t Over Specify – match the compressive strength (psi) to your application

Example…
Type I EPS @ 10-15 psi
Has been used under roadways



EPS Market Segments

Insulation Applications

Roofing
- Commercial
- Residential

Wall Systems
- Sheathing
- EIFS and One-Coat
- Siding Backer & Profiles
- Cavity Wells
- SIPs

Perimeter & Below Slab

Pre-cast panels

Radiant Heating

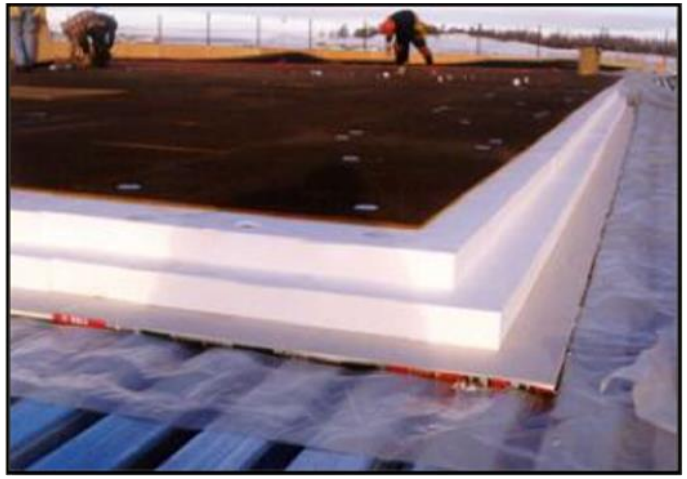
Non-Insulation Applications

Geofoam
- Highways & Bridges
- Lightweight Void Fill
- Levees
- Garden Roofing
- Pools and Pool Decks
- Concrete Block-outs
- Theaters & Stadiums

Floatation

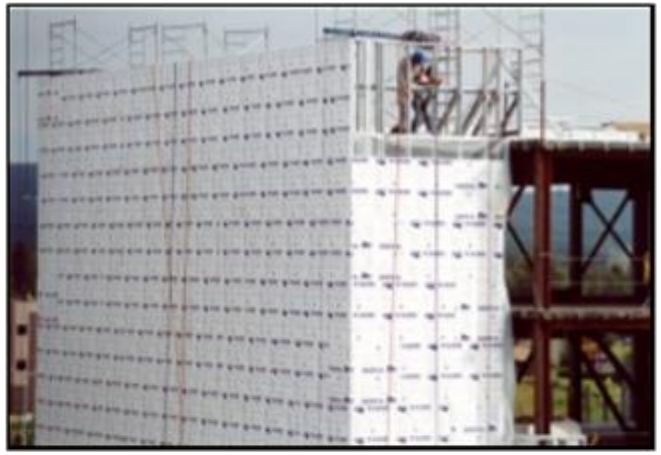
Packaging

Roofing Applications






Wall Systems / Applications



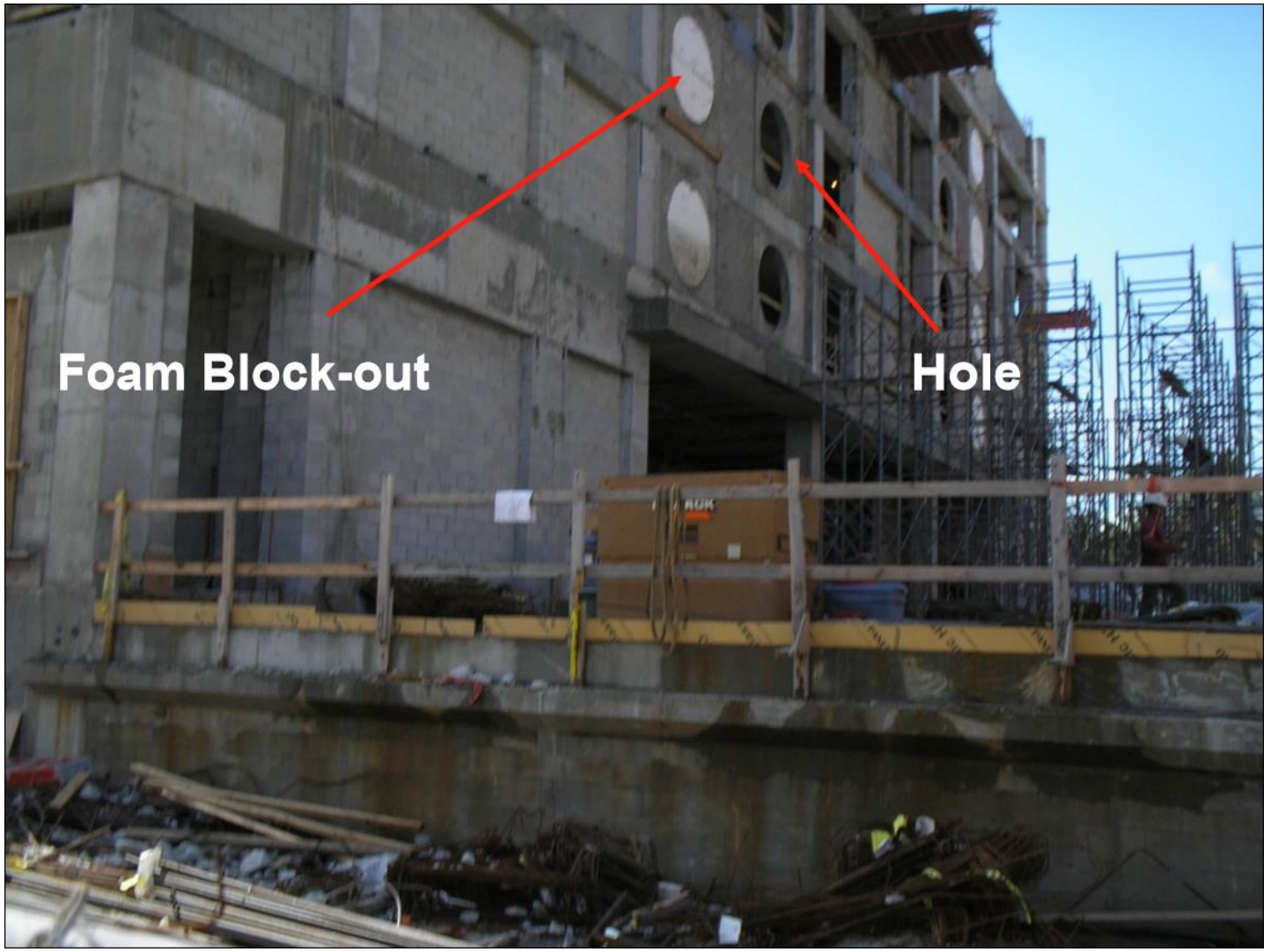
Perimeter & Below slab

Geofoam – Lightweight Void Fill

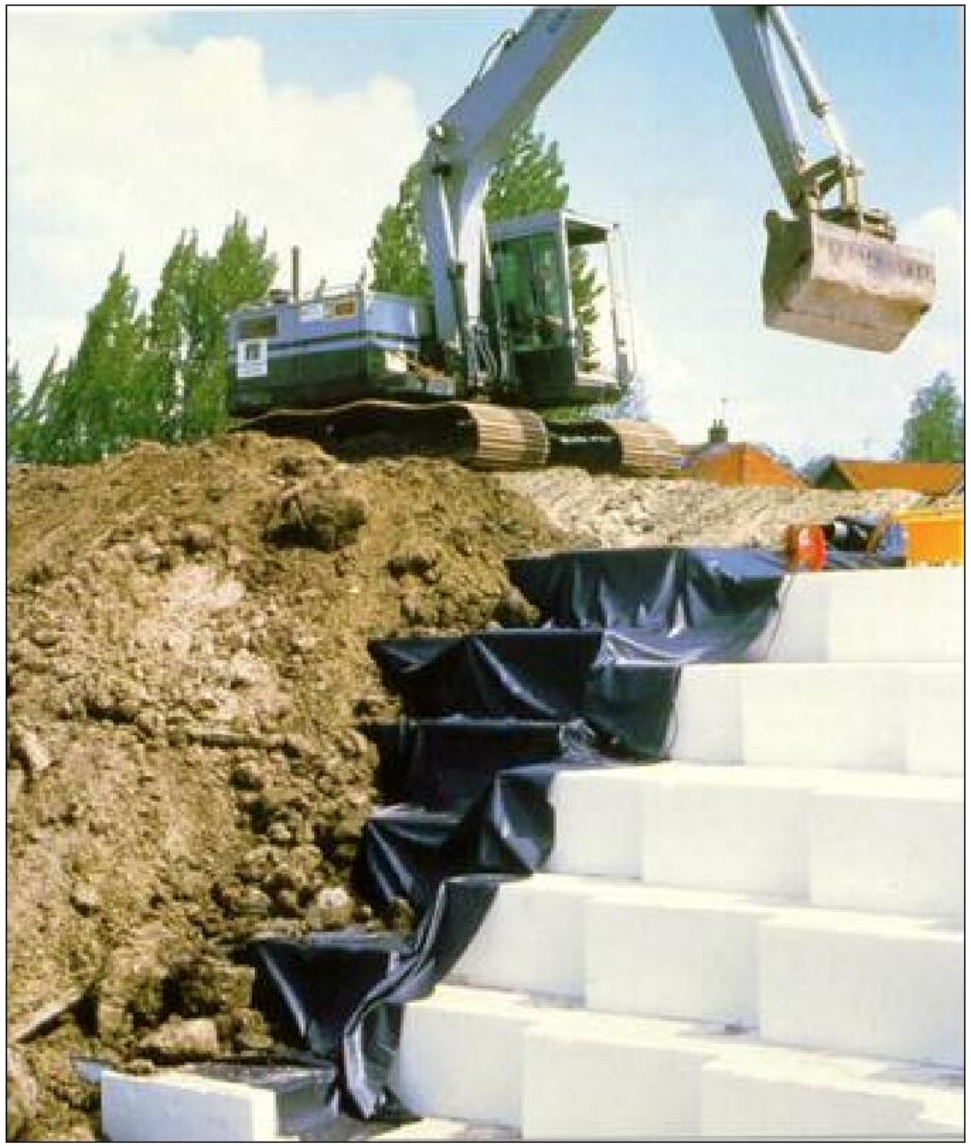
Ramps, Driveways and Highway Systems

Pools, Pool Decks and Floatation

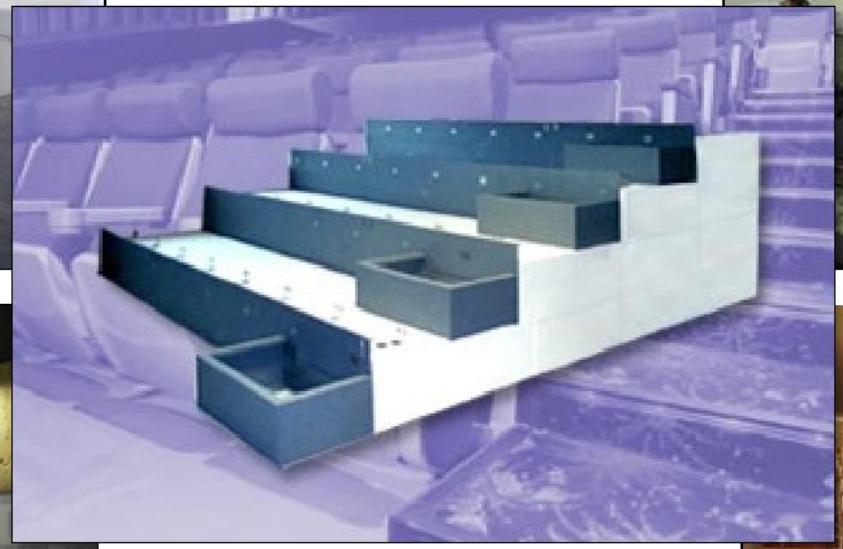
Concrete Block-outs



Retaining Walls



Theater / Stadium Seating



SIPs

References

- EPSIA

  www.EPSindustry.org
- EPS Industry Alliance
- Geofoam Facebook

  Managed by all EPS Geofoam manufacturers as a resource for Q and A

Wrap-up

Thank you for your time.

LINK TO TAKE 10-QUESTION QUIZ

you will provide your information and, upon passing quiz, a link will provide access to your participation certificate.

Insulfoam will submit AIA credits for those providing their member number.

Questions for Insulfoam? Contact us