LT30

FOAMULAR® Extruded Polystyrene Insulation

For Cold Storage Applications

FOAMULAR extruded polystyrene insulation is suitable for virtually all cold storage insulating needs, including floors, walls and roofs. FOAMULAR insulation is adaptable to all types of wall construction including tilt-up, precast concrete, prefabricated metal-faced panels and concrete masonry unit construction. It is suitable for use in conjunction with single-ply roofing membranes, modified bitumen and built-up roofing membranes over virtually any type of roof deck, including steel or concrete. Durable FOAMULAR insulation also performs well under cold storage concrete floor slabs.

Superior Performance, Compressive Strength and Applications

FOAMULAR extruded polystyrene insulation is a closed-cell insulation made using Owens Corning's exclusive HYDROVAC® manufacturing process. FOAMULAR insulation's resistance to water absorption and water vapor transmission allows it to maintain low thermal conductivity in the presence of the severe water vapor characteristics of cold storage applications. FOAMULAR extruded polystyrene insulation is manufactured to comply with ASTM C 578. See FOAMULAR Insulation Physical Properties chart below.

Owens Corning offers a variety of FOAMULAR products for use in cold storage applications depending on the specific needs of the design and engineering process.

LT30 insulations with minimum compressive strengths of 30 psi are suitable for use in insulating cold storage facility floors with modest loading requirements.

Excellent Resistance to Freeze/ Thaw Cycling

FOAMULAR extruded polystyrene insulation has been tested for its ability to retain critical structural properties in a severe freeze/thaw environment. It has been demonstrated that FOAMULAR insulation retains its load carrying ability (minimum compressive resistance) after 1,000 freeze/thaw cycles. (See Table 1.)

FOAMULAR Insulation Physical Properties*

Property	ASTM Method†	Product/ASTM C 578 Type FOAMULAR LT30
Thermal conductivity – "k" (BTU x in/°F x ft^2 x h)* @ 40°F mean temperature	C518	0.18
Thermal resistance "R-value" per inch, min. (°F x ft2 x h/BTU)* @ 40°F mean temperature	C518	5.4
Compressive strength min. (specification) value (lb/in^2)‡	D 1621	30.0
Flexural strength (lb/in^2 min.)*,§	C 203	100
Water absorption, max. (% by volume)*	C 272	0.10
Water vapor permeance, max. (perm)*,◊	E 96	1.1
Water affinity*	–	
Water capillarity*	–	
Dimensional stability, max. (% linear change)*,#	D 2126	2.0
Linear coefficient of thermal expansion, max. (in/in/°F)*	–	2.7×10^{-5}
Flame spread*,**,††	E 84	5
Smoke developed*,**,††,‡‡	E 84	45-175
Oxygen index, min.*,**	D 2863	24

* Properties shown are representative values for 1" thick material based upon most recent product quality audit data. † Modified as required to meet ASTM C 578. ‡ Value at yield or 10%, whichever occurs first. § Value at yield or 5%, whichever occurs first. ◊ Actual water vapor permeance for 1" thick material, value decreases as thickness increases. # Value ranges from 0.0 to value shown.
** These laboratory tests are not intended to describe the hazard presented by this material under actual fire conditions. †† Data from Underwriters Laboratories, Inc. Classified. See Classification Certificate U-197. ‡‡ ASTM E 84 is thickness-dependent, therefore a range of values is given.

Determining Thickness

Thickness of insulation, which determines heat flow rate, can be determined using the FOAMULAR Insulation Thickness graph and the temperatures found in the Summer Design Temperatures for Selected U.S. Cities. Refer to Owens Corning Cold Storage Technical Guide, Pub. #1-FO-43746.

Design of Concrete Slabs on Grade Supported by FOAMULAR Insulation

Insulated concrete slabs are common in cold storage facilities. These slabs and the layers below must be capable of supporting the live and dead loads imposed by vehicles, stationary and/or moving equipment, loaded storage racks and pedestrian traffic. FOAMULAR extruded polystyrene insulation provides support beneath insulated concrete floor slabs. The slab and supporting layers must be designed with consideration given to the rigidity of each layer. Proper design avoids excessive deflection which can result in cracking. *Note: It is recommended that final concrete slab design be specified by a professional architect or engineer.*

Allowable Stress on FOAMULAR Insulation Layers

A concrete slab must be capable of distributing loads over an area of sufficient size so that pressure on underlying layers do not exceed allowable limits. When FOAMULAR extruded polystyrene insulation is used below the slab, allowable stress limits are defined based upon a percentage of FOAMULAR insulation's minimum compressive strength, see Technical Guide, Pub. #1-FO-43746.

Determining Stress

To determine the stress that FOAMULAR insulation will experience, you will need to know the deflection of the concrete slab (see Concrete Slab Design Formulas) as well as the foundation modulus.

Foundation modulus is a measure of how much a substrate deflects under a given load, expressed as inches deflection per inch of thickness or "pci." The foundation modulus for various thicknesses of FOAMULAR insulation can be found in Table 3.

Cold Storage Design Notes

- Cold storage facility temperatures should be lowered gradually to the operating temperature range to minimize the possibility of damage to the structure. Doors should remain partially open during temperature reduction to relieve internal pressure. Complete any necessary joint caulking after temperature reduction to allow for surface contraction.
- Cold storage facilities designed to operate below freezing should have an installed heat source below the facility floor to protect from frost heave. Heating capacity must be designed based on the heat flow rate of the floor slab assembly, the operating temperature inside the facility and the efficiency of the heating source.

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- Cold storage building envelope assemblies should be evaluated for effectiveness and location of vapor retarders to avoid condensation and subsequent deterioration of insulation performance.
- Install multiple layers of FOAMULAR insulation with joints staggered and edges tightly butted.
- Select primers, sealers, caulking and adhesives with care. Coal tar pitch sealants should not be used with FOAMULAR insulation.
- Avoid penetrating the FOAMULAR insulation envelope around the facility with steel beams, large pipes, or conduits. Where penetration is necessary, insulate the intruding object as fully as possible to avoid creating excessive thermal shorts through the FOAMULAR insulation envelope.
- FOAMULAR extruded polystyrene insulation is suitable for cold storage building roofs but should be covered with roof membrane and/or ballast on the same day of installation. This will prevent potential damage from heat build-up by excessive exposure to direct sunlight.
- Combustible. FOAMULAR extruded polystyrene will ignite if exposed to a fire of sufficient heat and intensity. Although it does contain a flame retardant additive to inhibit ignition from small fire sources, this product should be installed only with a fire barrier such as 1/2" thick gypsum board, masonry or concrete coverings of 1" minimum thickness or equivalent. Cold storage facilities may be subject to special allowances which permit the use of metal facings as fire barriers. Consult your local building code authority or property insurer for specific information.
- FOAMULAR insulation should be covered to prevent discoloration caused by excessive exposure to direct sunlight.
- FOAMULAR insulation is not recommended for use where sustained temperatures exceed 165°F. Do not use in contact with chimneys, heater vents, steam pipes or surfaces with temperatures over 150°F.

Table 1
FOAMULAR Insulation Recommended Stress Limits (psi)

Recommended	LT30
Minimum compressive strength	30.0
Live Load (<20 of minimum)	6.0
Dead Load (<33 of minimum)	10.0

Table 2
FOAMULAR Insulation Available Sizes

Insulation	2'x8'	4'x8'
LT30	2", 3", 4"	2", 3", 4"

Table 3
FOAMULAR Insulation Foundation Modulus "K" (psi)

	Thickness		
Insulation	2"	3"	4"
LT30	700	570	515

Notes: For multiple layer insulation systems, assuming layers are identical, the foundation modulus for the system (KT) equals the foundation modulus for one (1) of the layers (K1) divided by the total number of layers (L). KT=K1/L. For insulation systems which utilize a variety of thicknesses, the system foundation modulus (KT) is determined by adding the reciprocal of the foundation modulus for the individual layers (1/K1). The total is the reciprocal value for the foundation modulus of the entire insulation system.

Concrete Slab Design Formulas

- **Stress Under Point Load in Field of Slab**

$$fb = 0.316 \frac{P}{h^2} [\log h^3 - 4 \log (\sqrt{1.6a^2 + h^2} - 0.675h) - \log k + 6.48]$$

- **Deflection**

$$D = \frac{P}{8 \sqrt{K \frac{Eh^3}{12 (1 - \mu^2)}}}$$

Nomenclature

- a Radius of load contact area (in)
- D Deflection (in)
- E Modulus of Elasticity, concrete (psi) $E \approx 57{,}000 \sqrt{Fc}$
- fb Tensile stress, bottom of slab (psi)
- Fc Concrete compressive strength min (psi)
- ft Tensile stress, top of slab (psi)
- Ft Concrete tensile strength, allowed (psi) $Ft \approx 4.6 \sqrt{Fc}$
- h Slab thickness (in)
- K Insulation foundation modulus (pci)
- L Radius of relative stiffness (in) $L = \sqrt[4]{\frac{Eh^3}{12 (1 - \mu^2)k}}$
- P Load (lb)
- μ Poisson's Ratio, .20 for concrete

Estimating Stress in FOAMULAR Insulation Layer

The stress that FOAMULAR insulation will experience under a concrete slab can be estimated by multiplying the insulation's foundation modulus (K) by the deflection of the concrete slab (D).

F (Stress)= K x D

Deflection of the concrete slab can be determined by using the Concrete Slab Design Formulas to the left.

Discussion of Design Examples

Example 1 – The conditions listed result in a stress of 3.42 psi on the insulation layer. The stress is acceptable when related to the live or dead load recommendations for the chosen insulation. The actual stress in the concrete slab is also below that which is allowed.

Example 2 – Changing the insulation layer from Example 1 results in reduced stress on the insulation layer. However, the increased insulation layers are prone to more deflection and are less capable of supporting the load. Therefore, deflection in the concrete slab increases, which results in a concrete stress that is too high.

Example 3 – Increasing the thickness of the concrete slab in Example 2 reduces the concrete stress under the point load to an acceptable level. Other variable changes that reduce concrete slab tensile stress to acceptable levels include reducing load, increasing area of load contact, using a stronger concrete, adding steel reinforcements or increasing the insulation foundation modulus.

Example 4 – Changing to an insulation with a substantially greater foundation modulus and compressive strength results in a reduction in concrete tensile stress. Note that the foundation modulus in the example increased by 75% over that used in Example 2 to cause only a 7% reduction in concrete slab tensile stress. Variation of insulation foundation modulus within a small range has little impact on the final concrete slab design.

Example 5 – Excessive stress levels in the concrete slab can also be corrected by increasing the area of load contact. Note the decrease in concrete slab tensile stress from Example 2, which results from distributing the load over a larger area.

Example 6 – All of the previous examples focus on reducing the tensile stress in the concrete slab to an acceptable level. This example shows the effect of increasing the load to a level which places maximum allowable compressive strength on the insulation. Note the excessive tensile stress which results on the concrete slab.

More Information

For more information on FOAMULAR, please contact your Owens Corning representative to request the following publications:

THERMAPINK Product Data Sheet
5-FO-23546

DURAPINK® Product Data Sheet
15-FO-23550

DURAPINK PLUS Product Data Sheet
5-FO-23551

Disclaimer of Liability

This FOAMULAR insulation technical guide is not intended to be a cold storage design manual. The examples discussed herein focus on a limited number of design considerations regarding insulation. Total construction and system detailing of a building requires the attention of a professional architect or engineer to ensure that all building components are functionally compatible and appropriate for the given application. We shall not be liable for incidental and consequential damages, directly or indirectly sustained, not for any loss caused by the application of these goods not in accordance with current printed instructions or for other than intended use. Our liability is expressly limited to replacement of defective goods. Any claim shall be deemed waived unless made in writing to us within thirty (30) days from date it was or reasonably should have been discovered.

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