HIGH DENSITY EXTRUDED POLYSTYRENE RIGID INSULATION

AIRPORT RUNWAYS
COLD STORAGE INSTALLATIONS
UNDER CONCRETE FLOORS
RAIL BEDS
FOUNDATIONS
PLAZA AND PARKING DECKS
PERMAFROST PROTECTION
UNDER ROADWAYS

FOAMULAR® C-300 AND FOAMULAR® 400, 600, 1000 EXTRUDED POLYSTYRENE RIGID INSULATION BOARDS

For more information call
1-800-GET-PINK®
or visit www.owenscorning.ca
**PRODUCT DESCRIPTION**

**Engineering applications requiring:**
- High compressive strength
- Long-term thermal performance
- Hydrophobic insulation, closed cell structure
- No food value for rodents
- Ability to retain critical structural properties in severe freeze thaw environments
- Excellent resistance to water
- Handles and installs easily

**COMPOSITION AND MATERIALS:**

**FOAMULAR® Extruded Polystyrene Rigid Insulations’** unique closed cell structure and continuous skin surface yield outstanding moisture resistance properties. A high R-value retained even after prolonged exposure in high moisture environments. Our patented process technology helps to ensure that FOAMULAR® insulation products will not corrode or decay over time. FOAMULAR® C-300 and FOAMULAR® 400, 600, 1000 are Type 4 closed-cell thermal insulating foams (CAN/ULC-S701 superseded CAN/CGSB512.0-M87).

**Sizes and Thermal Properties:** FOAMULAR® insulation is available in a variety of thicknesses and standard sizes. Compressive strengths from 30 psi to 100 psi (210 kPa to 690 kPa) to meet the requirements of nearly every application.

**Thermal Resistance:** The long term design thermal resistance of FOAMULAR® insulation is 5.0 ft² hr°F/BTU for 1 inch thickness or RSI 0.88 (m² °C/W) for 25mm thickness according to CAN/ULC-S770.

**STANDARD SIZES AVAILABLE ACROSS CANADA:**

<table>
<thead>
<tr>
<th><strong>FOAMULAR® C-300</strong></th>
<th><strong>FOAMULAR® 400</strong></th>
<th><strong>FOAMULAR® 600</strong></th>
<th><strong>FOAMULAR® 1000</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard sizes</td>
<td>24” x 96”</td>
<td>24” x 96”</td>
<td>24” x 96”</td>
</tr>
<tr>
<td>Thickness</td>
<td>1”, 1 1/2”, 2” , 3”, 4”</td>
<td>1”, 1 1/2”, 2”, 3”, 4”</td>
<td>1”, 1 1/2”, 2”, 3”</td>
</tr>
<tr>
<td>Edges</td>
<td>Shiplap/butt edge</td>
<td>Shiplap/butt edge</td>
<td>Shiplap/butt edge</td>
</tr>
<tr>
<td><strong>Drainage channels</strong></td>
<td>Drainage channels upon request</td>
<td>Drainage channels upon request</td>
<td>Drainage channels upon request</td>
</tr>
</tbody>
</table>

**LIMITATIONS:**

**FOAMULAR® Extruded Polystyrene Rigid Insulation Boards** are combustible. Local codes may require a protective or thermal barrier. Contact your local building inspector or consult applicable Building Code for more information.

For more information contact Owens Corning (1-800-GET-PINK).

Not recommended where sustained temperatures exceed 74° C (165° F).

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**BASIC USE:**

A series of high strength extruded polystyrene rigid insulation boards used for civil engineering and other commercial applications. Available in a range of compressive strengths to suit different construction needs. For use in cold storage installations; under concrete floors; foundations; plaza and parking decks; under roadways; rail beds; permafrost protection; airport runways; transmission line tower foundations; underground utility lines; walkways; fountain foundations; light weight fill and suited for diverse high load-bearing applications.

For use in Industrial, Commercial and Institutional (ICI) applications. In permafrost regions the insulation is used to maintain the sub-grade in a frozen state during the summer period.

For use in both interior and exterior applications.

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See Typical Physical Properties Table on page 3

Look at the following text and convert it into a readable format:

**TECHNICAL DATA**

**FOAMULAR® Extruded Polystyrene Rigid Insulation Board** has been tested for its ability to retain critical structural properties in a severe freeze/thaw environment. It has been demonstrated that it retains its load carrying ability (min. compressive resistance) after 1,000 freeze/thaw cycles carried out in accordance with ASTM C-666, procedure A (see chart below). Procedure A involves alternating freeze/thaw cycles with the test specimen totally submerged in water and exposed to freezing temperatures around the entire specimen. Freezing conditions are a factor in all parts of Canada. Freeze/thaw cycles testing helps to determine which insulations have the correct physical characteristics to withstand the severe site conditions of Canada.

**RECOMMENDED STRESS LIMITS, kPa (psi):**

<table>
<thead>
<tr>
<th></th>
<th>FOAMULAR® C-300</th>
<th>FOAMULAR® 400</th>
<th>FOAMULAR® 600</th>
<th>FOAMULAR® 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. compressive strength</td>
<td>210.0</td>
<td>275.0</td>
<td>415.0</td>
<td>690.0</td>
</tr>
<tr>
<td>Live load, &lt;20% OF MIN.</td>
<td>42.0</td>
<td>55.0</td>
<td>83.0</td>
<td>138.0</td>
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<tr>
<td>Dead load, &lt;33% OF MIN.</td>
<td>70.0</td>
<td>90.0</td>
<td>137.0</td>
<td>228.0</td>
</tr>
</tbody>
</table>

**WATER ABSORPTION IN FREEZE/THAW CYCLING:**

- Faced PIR (aluminum)
- Faced PIR (FG)
- Expanded PS, Type 3
- OC Extruded PS, Type 3

**Moisture Effects Comparison**

- Retention of R-value after repeated exposure to moisture and freeze/thaw conditions
- Moisture Effects Comparison

- Thermal Resistance: ft² hr °F/BTU; (m² °C/W)
  - @75 °F (24 °C)
    - 5.0 (0.88) 5.0 (0.88) 5.0 (0.88) 5.0 (0.88)
  - @40 °F (4.4 °C)
    - 5.6 (0.95) 5.6 (0.95) 5.6 (0.95) 5.6 (0.95)
  - @25 °F (-4 °C)
    - 5.6 (0.99) 5.6 (0.99) 5.6 (0.99) 5.6 (0.99)

(1) Thermal resistance for 1 inch (25mm) thickness. (2) At 10% deformation or yield. (3) At 5% deformation or yield. (4) Value for 2” (50 mm) thickness.
INSTALLATION

DELIVERY:

FOAMULAR® Extruded Polystyrene Rigid Insulation are packaged in bundles of 2’ wide x 2’ high x 8’ in length. Four bundles are arranged into units (pallets) of 4’ wide x 4’ high x 8’ in length for ease of shipping and handling.

PRODUCT IDENTIFICATION:

Each board is identified by product name and type. The physical properties, thermal properties, and applicable standards are also marked on each board. Owens Corning™ product is recognized by its registered trademarked PINK colour.

PACKAGING:

Units shipped in protective stretch-wrap bundles.

STORAGE:

If long-term exposure to the elements is expected extruded polystyrene should be protected from excessive UV exposure to prevent discolouration.

INSTALLATION DESIGN EXAMPLES

DESIGN OF CONCRETE SLABS ON GRADE FOR COLD STORAGE APPLICATIONS

Note: Only Imperial values are used in design calculations in this section. Treat following design calculations as preliminary estimations, it is recommended that final concrete slab design be specified by a professional architect or engineer.

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® 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.

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® insulation is used below the slab, allowable stress limits are defined based upon a percentage of FOAMULAR® insulation’s minimum compressive strength. (Please refer to the Recommended Stress Limits table on Page 4).

DETERMINING STRESS

Use the following charts and formulas to determine the stress present on the concrete slab and insulation layers. 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 on page 7) 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 the table below:

| FOAMULAR® EXTRUDED POLYSTYRENE RIGID INSULATION FOUNDATION MODULUS “K” (pci) |
|---------------------|-----|-----|-----|-----|-----|
| Insulation          | 1”  | 1.5”| 2”  | 2.5”| 3”  | 4”  |
| Thickness           | 400 | 600 | 800 | 1000| 1200| 1400|
|                     | 1100| 1520| 1940| 2360| 2780| 3200|
|                     | 1000| 1400| 1800| 2160| 2520| 2880|
|                     | 900 | 1275| 1650| 1925| 2200| 2475|
|                     | 780 | 1150| 1525| 1800| 2075| 2350|
|                     | 680 | 1040| 1405| 1680| 1945| 2210|
|                     | 650 | 910 | 1270| 1530| 1790| 2050|
|                     |     |     |     |     |     |     |

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 (K) divided by the total number of layers (L). KT = K/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/KL). The total is the reciprocal value for the foundation modulus of the entire insulation system.
Deflection of the concrete slab can be determined by using the Concrete Slab Design Formulas (see above).

\[ F(\text{Stress}) = K \times D \]

where \( K \) is the insulation's foundation modulus and \( D \) is the deflection of the concrete slab. The stress that results from this can be reduced by changing the insulation layer from Example 1, which increases the area of load contact, using a stronger concrete, adding steel reinforcement or increasing the insulation foundation modulus.

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.

### DESIGN EXAMPLES TABLE

<table>
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<tr>
<th>Variable Input</th>
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<td>7200</td>
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<td>Radius of Contact area (in)</td>
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<tr>
<td>Insulation Properties</td>
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<tr>
<td>&quot;K&quot; Foundation Modulus (pci)</td>
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<tr>
<td>Number of layers</td>
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<td>Thickness per layer (in)</td>
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<td></td>
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<tr>
<td>Concrete slab deflection (in)</td>
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<td>0.0078</td>
<td>0.0068</td>
<td>0.0063</td>
<td>0.0078</td>
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<tr>
<td>Concrete tensile stress, actual (psi)</td>
<td>279</td>
<td>306</td>
<td>263</td>
<td>289</td>
<td>282</td>
<td>922</td>
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<tr>
<td>Insulation compressive stress, actual (psi)</td>
<td>3.75</td>
<td>2.65</td>
<td>2.30</td>
<td>2.18</td>
<td>2.65</td>
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</tr>
</tbody>
</table>

Steel reinforced concrete slabs will distribute imposed loads differently than unreinforced slabs; therefore, the calculation techniques used to estimate stresses are different than those shown in this section. However, the concept of balancing stress levels between concrete and the insulation is the same.

Many types of concrete slab exist for different purposes and design techniques for each vary greatly. This section discusses stress levels between concrete and the insulation is the same. This is the intent of this section to provide a comprehensive design guidance. Rather it is to demonstrate the importance of the relationship between a concrete slab and its supporting underlayers, and to identify the FOAMULAR® insulation's physical properties which will be important to the slab designer regardless of the type of slab involved. In all cases, Owens Corning recommends that final concrete slab design be specified by a professional architect or engineer. The professional architect or engineer will assess the need for steel reinforcement due to structural shrinkage or temperature requirements, the need for expansion or contraction joints and other important concerns relating to slab durability. The examples in this section relate to interior slab loadings only, which are loadings placed on the surface of the slab in a position removed from free slab edges. Edge loading design becomes more complicated because it requires consideration of bending stresses in the top of the slab as well as the effects of slab edge curling. The interaction between the slab and the insulation below is similar regardless of load location, although rarely does interior loading govern design.

### DESIGN EXAMPLES TABLE

<table>
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<tr>
<th>Point load (lb)</th>
<th>7200</th>
<th>7200</th>
<th>7200</th>
<th>7200</th>
<th>7200</th>
<th>21700</th>
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<tr>
<td>Concrete Properties</td>
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</tr>
<tr>
<td>Compressive Strength (min psi)</td>
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<td>4000</td>
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<td>4000</td>
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<tr>
<td>Slab thickness (in)</td>
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<td>340</td>
</tr>
<tr>
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<tr>
<td>Thickness per layer (in)</td>
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<td>Calculations</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Concrete slab deflection (in)</td>
<td>0.0055</td>
<td>0.0078</td>
<td>0.0068</td>
<td>0.0063</td>
<td>0.0078</td>
<td>0.0235</td>
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<tr>
<td>Concrete tensile stress, actual (psi)</td>
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<td>263</td>
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<td>922</td>
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<tr>
<td>Insulation compressive stress, actual (psi)</td>
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<td>2.30</td>
<td>2.18</td>
<td>2.65</td>
<td>8.00</td>
</tr>
</tbody>
</table>
TYPICAL APPLICATIONS

PERIMETER OF FOUNDATION WALLS:

To reduce the heat flow through the floor slab and prevent frost penetration, insulation that is installed on the outside of the foundation will increase the temperature of the floor slab. Insulation may be installed on the outside of the foundation wall to reduce the heat flow and prevent frost penetration. Insulation that is installed on the inside of the foundation wall will increase the temperature of the floor slab. Insulation may be installed on the inside of the foundation wall to reduce heat loss and prevent frost penetration.

Insulating to prevent normal and tangential frost heave is easily accomplished with FOAMULAR® C-300. The thickness and location of insulation in a shallow foundation is dependant on whether the building is heated or unheated, the type of soil and building location.

UNDER CONCRETE SLAB APPLICATIONS:

To reduce heat loss and possible heaving of slab. Define the performance requirements for the wearing surface (slab); frequency, design, climatic, and construction loads. For slab-on-grade applications review the subgrade material modulus. Insulation may be placed vertically or horizontally out from the foundation. Insulation dramatically reduces heat loss and returns geothermal heat in ground. The moisture resistant and hydrophobic nature of FOAMULAR® insulation provides excellent thermal performance even when placed directly in moist soil or covered in wet concrete.

PRODUCT:
- FOAMULAR® C-300, 30 psi (210 kPa) Type 4
- FOAMULAR® C-300, 40 psi (275 kPa) Type 4
- FOAMULAR® C-300, 60 psi (415 kPa) Type 4
- FOAMULAR® C-300, 100 psi (690 kPa) Type 4

WATER PROOFING APPLICATIONS:

To reduce heat flow and protect the waterproofing membranes. Insulation is typically installed above the waterproofing membrane. FOAMULAR® may also be supplied with grooves for additional drainage channels. Higher compressive strength insulation used in areas of frequent pedestrian or vehicular traffic and ideal for plaza deck construction.

PRODUCT:
- FOAMULAR® C-300, 30 psi (210 kPa) Type 4
- FOAMULAR® C-300, 40 psi (275 kPa) Type 4
- FOAMULAR® C-300, 60 psi (415 kPa) Type 4
- FOAMULAR® C-300, 100 psi (690 kPa) Type 4

RECREATION CENTRE/ICE RINKS:

To reduce frost penetration in subsoil and potential for heaving of slab. Insulation dramatically reduces energy costs and refrigeration requirements. Reduces ice making and de-icing time.

The thickness of insulation is based on ice temperature and whether facility is run as a seasonal or continuous operation. Significant energy cost can be avoided through the use of insulation below the ice slab in continuous operations.

PRODUCT:
- FOAMULAR® C-300, 30 psi (210 kPa) Type 4
- FOAMULAR® C-300, 40 psi (275 kPa) Type 4
- FOAMULAR® C-300, 60 psi (415 kPa) Type 4
- FOAMULAR® 1000, 100 psi (690 kPa) Type 4

ROAD APPLICATIONS:

To prevent frost action on highways, airport runways and railroad beds. Use granular base over insulation installed directly over an existing traffic surface or new compacted sub-grade soil. In regions where soil normally thaws in spring and summer the layer of insulation works to conserve the natural heat in the subgrade thereby slowing the penetration of frost during the winter. With proper design frost heave and thaw weakening (spring break-up) can be eliminated. In permafrost regions the insulation is used to maintain the subgrade in a frozen state during the summer period.

PRODUCT:
- FOAMULAR® C-300, 30 psi (210 kPa) Type 4
- FOAMULAR® 400, 40 psi (275 kPa) Type 4
- FOAMULAR® 600, 60 psi (415 kPa) Type 4
- FOAMULAR® 1000, 100 psi (690 kPa) Type 4

UTILITY APPLICATIONS:

To offer thermal protection, reduce compressive loads on underlying soils. Protect systems such as sewer and water.

See Owens Corning’s Utility Line Design Information.
- Utility lines
- Walkways
- Fountain foundations
- Light weight fill
- Bridge approaches
- Retaining walls
- Landscaping applications.

PRODUCT:
- FOAMULAR® C-300, 30 psi (210 kPa) Type 4
- FOAMULAR® 400, 40 psi (275 kPa) Type 4
- FOAMULAR® 600, 60 psi (415 kPa) Type 4

*Compressive strength requirements should be verified by a Structural Engineer.
*Design guidelines are available through organizations such as the Ontario Recreation Facilities Association Inc.
Determine the insulation thickness required to prevent freezing temperatures from occurring underneath the layer of insulation for the application. Reference climatic data for the selected region:
- Air freezing index
- Average frost penetration
- Soil type/profiles

Air temperature records can be used to gauge the severity of ground freezing by using the degree-day concept. (If the daily mean air temperature is -1°C this will be one degree-day.) The “Freezing Index” is simply the accumulated total of degree-days of freezing for a given winter.
Winter air temperatures vary substantially from year to year at all locations in Canada. Therefore, it is generally inappropriate to use the long term mean air freezing index for design purposes. Common engineering practice is to choose some recurrence interval and to estimate the most severe winter likely to occur within that period. For example, W.T. Horne, in 1987, developed a simple relationship between design freezing index, taken as the coldest over the last 10 year period, and mean freezing index by curve fitting data for 20 cities across Canada. Horne’s relationship is:

\[ I_s = 100 + 1.29 I_m \]

Where
\[ I_s \] = Design Freezing Index (°C-days)
\[ I_m \] = Mean Freezing Index (°C-days)

= a dimensionless coefficient

= volumetric latent heat which can be estimated from relationship:

\[ L_s = 334 \text{ kJ/kg} \]

Where
\[ L_s \] = latent heat of fusion of water to ice which can be taken as 334 kJ/kg.
\[ w \] = water content of the soil expressed as a fraction and
\[ L \] = volumetric latent heat, and
\[ k \] = thermal conductivity of the frozen soil (W/m.K)

The conventional approach for protection of building foundations against frost heave action is to locate shallow foundations at a depth greater than the design depth of frost penetration. An example is the modified Berggren equation above which can be used to establish the minimum depth of soil cover over an external footing. The depth of perimeter foundation walls for heated structures may be reduced somewhat due to the heat loss from the building using local building codes or local experience. However, a designer should exercise caution where a significant depth of the footing cover is comprised of dry, coarse-grained soil as frost depths can exceed local experience.

Conditions such as high groundwater table or particularly deep predicted frost penetration may make it impractical to excavate for footings below the design depth of frost penetration. For these and other areas where shallow foundations are desired, thin soil cover and extruded polystyrene insulation may be used in designs. The design methodology for insulated foundations was developed by Robinsky and Bespflug in 1973. Summaries of their design charts for heated and unheated structures have been adapted and are shown in Figures 15.8 and 15.9 respectively, used by permission from Canadian Foundation Engineering Manual 3rd Edition.

Note, the design curves for minimum insulation requirements for heated structures are used to just prevent frost heave damage, higher insulation levels are desirable for energy efficiency and occupant comfort reasons. The Canadian Foundation Engineering Manual 3rd Edition has specific recommendations where structures have a greater risk of frost heave and in certain cases these structures must be separated from the primary structure. Buildings without basements are often supported on cast-in-place concrete piles with perimeter grade beams. Perimeter concrete grade beams formed and cast on the ground are particularly susceptible to damage by frost action. Since foam insulation has a high compressive strength it cannot be used as a void former to absorb heave movement. A proper minimum thickness of well drained and well compacted clean granular fill as well as foam insulation is used by permission from Canadian Foundation Engineering Manual 3rd Edition.