STYROFOAM™ Extruded Polystyrene Insulation In Soil Applications

A Change in the National Building Code of Canada

In October 1998, the National Building Code of Canada 1995 (NBCC) was modified to remove Sentence 9.25.2.2.(4). This sentence restricted the use of Type 1 low-density expanded polystyrene (EPS) insulation in below-ground and protected membrane roofs in housing and small buildings covered by Part 9 of the code. The Canadian Commission on Building and Fire Codes approved the modification on the grounds that the restriction created a hardship for the EPS insulation industry.

Contrary to popular belief, this change does not constitute approval by the NBCC to use EPS insulation in below-grade applications. In fact, the NBCC 1995 still contains the following:

9.25.2.2.(3) Insulation in contact with the ground shall be inert to the action of soil and water and shall be such that its insulative properties are not significantly reduced by moisture.

Designers are encouraged to examine available data and specify insulation materials based on the performance they require. STYROFOAM™ extruded polystyrene insulation, with high moisture resistance and long-term insulating performance, is ideally suited to below-grade applications.

Insulation Performance in Soil Applications

Insulation that comes in contact with the soil is subjected to severe conditions, including long-term exposure to water, high soil humidity and freeze-thaw action. These environmental factors can diminish an insulation's effectiveness. Common applications where insulation/ soil contact occurs include perimeter walls of building foundations, beneath highways and runways, and under artificial ice rinks.

STYROFOAM™ extruded polystyrene insulation is well-suited to these applications. Several studies specific to below-grade applications indicate STYROFOAM insulation is superior to other foam insulation because moisture does not appreciably reduce its R-value* or cause it to break down. STYROFOAM insulation is the material of choice when insulating efficacy and long life are desired.

Proven Performance

Extruded polystyrene, such as STYROFOAM™ insulation, has been proven effective in the harshest environments.

BUILDING FOUNDATIONS

Insulating building foundations of poured concrete, block or wood is perhaps the most common use of foam insulation in below-grade applications. An 18-month study in one Canadian province and one U.S. state demonstrated that extruded polystyrene, like STYROFOAM™ insulation, exhibited the least amount of moisture pickup (Figure 1) and

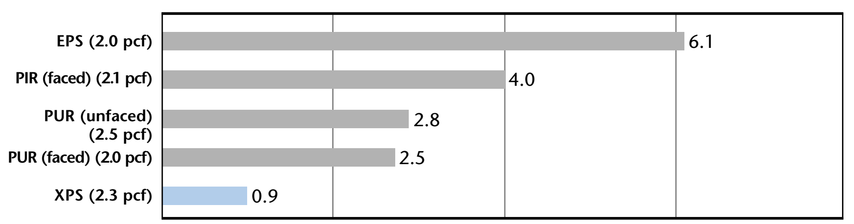

Figure 1: Percent by Volume Moisture Pickup[1]

Legend: EPS = molded expanded polystyrene PIR = faced polyisocyanurate PUR = faced and unfaced polyurethane XPS = extruded polystyrene

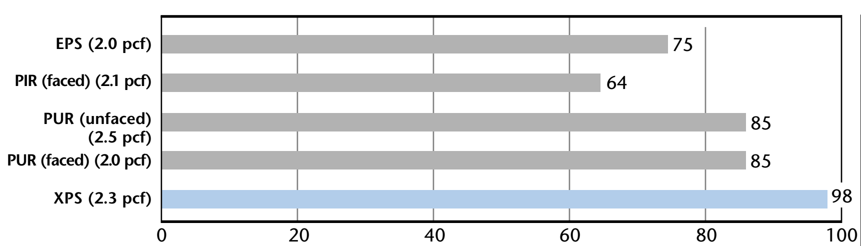

Figure 2: Percent Retained R-Value[1]

Legend: EPS = molded expanded polystyrene PIR = faced polyisocyanurate PUR = faced and unfaced polyurethane XPS = extruded polystyrene

*R or RSI means resistance to heat flow. The higher the R-value, the greater the insulating power.

the greatest percent of retained R-value[1] (Figure 2). Data obtained from the five materials studied indicate significant differences among the materials, with extruded polystyrene clearly superior as an insulating material.

On average, four materials retained just 77.25 percent of rated insulation value while extruded polystyrene retained 98 percent at the end of evaluation. Foam insulation density is just as important as R-value and moisture resistance when insulating frost-protected shallow foundations. Heavy soil loads, building loads and surface loads can compress low-density foam insulation materials, destroying their insulating ability. The American Society of Civil Engineers prohibits foam insulation having densities of 1.35 pcf or less from use under building footings[2]. Only high-density Type 3 & 4 foam polystyrene insulations should be considered in such applications.

ROAD AND AIRFIELD

Highway engineers in Alaska chose extruded polystyrene as their first use of polystyrene insulation foam in 1967. Since then, over 8.3 million miles of highway have been protected with plastic foam materials, primarily extruded polystyrene. Experience with these products has led engineers to these findings[3]:

- Extruded polystyrene insulation has demonstrated superior performance and longevity.
- Molded polystyrene beadboard has a lower R-value (RSI) and should be installed at a thickness at least 30 percent greater than extruded polystyrene.
- Foamed-in-place polyurethane insulation is not acceptable as a sub-grade insulation.

FREEZE-THAW CYCLES

The U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) has studied the effects of repeated freeze-thaw cycles on five insulating materials. Its conclusion in a study covering 948 cycles[4]: Freezing has little or no harmful effect on insulation that remains dry, i.e., does not absorb moisture from the surroundings. Conversely, insulation that gets wet does not perform as well. This is an important consideration when specifying an insulating material where freeze-thaw cycles are common, as they are in many North American cities. Weather data demonstrate that many locations in North America will experience several hundred freeze-thaw cycles over a 10- to 20-year period.

In its testing, CRREL reports that only extruded polystyrene insulation is suitable for use in wet environments, such as below-grade or roofing applications, where freeze-thaw cycles are typical. In all, CRREL studied five insulating materials (Figure 3). Note: XPS products for wet environment and PMR roof applications were tested.

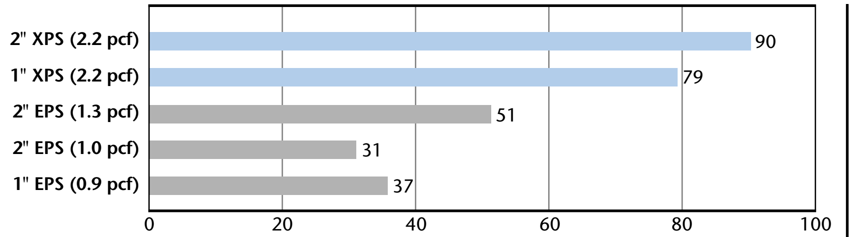

Figure 3: Retained R-Value (%) After 948 Freeze-Thaw Cycles[4]

Note: Freeze in air at -23°C; thaw in water at 16°C. "Not all climates experience freeze-thaw conditions and not all applications are affected in the same manner."[4]

Legend: XPS = extruded polystyrene EPS = molded expanded polystyrene

[1] Ovstaas, G., Smith, S., Strzepek, W., and Titley, G., "Thermal Performance of Various Insulations in Below-Earth-Grade Perimeter Application, Thermal Insulation, Materials, and Systems for Energy Conservations in the '80s," ASTM STP789, F.A. Govan, D.M. Greason, and J.D. McAllister, Eds., American Society for Testing and Materials, 1983, pp. 435-454.
[2] Design and Construction of Frost-Protected Shallow Foundations, American Society of Civil Engineers. SEI/ASCE standard 32-01. 2001.
[3] Esch, D.C., "INSULATION PERFORMANCE beneath roads and airfields in Alaska," Proc. ASCE Cold Regions Engineering Conference, 1986, pp. 713-722.
[4] Tobiasson, Wayne, Young and Greatorex, Alan, "Freeze-thaw durability of common roof insulation" U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, N.H.; Proc. Fourth International Symposium on Roofing Technology, 1997, pp. 352-359.

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