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Product Information Bulletin

EPS Insulation R-value Retention Outperforms XPS Insulation after 15 Year Below-Grade Service

Expanded polystyrene (EPS) insulation has been used successfully as a below-grade insulation product for over 50 years. Plasti-Fab Product Information Bulletin No. 201 provides results from a research project conducted at the National Research Council of Canada/Institute for Research in Construction (NRC/IRC) that demonstrates the durability and thermal performance of EPS as exterior below-grade insulation.

This bulletin provides test results for two products manufactured to ASTM C578, *Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation*[1] installed side-by-side on a below-grade foundation application in St. Paul, MN – Type I EPS insulation and Type X extruded polystyrene (XPS) insulation. Samples of each insulation type were removed from the exterior of a commercial building at a depth of approximately 6 feet below grade after 15 years of service and tests were conducted by an independent, third-party test laboratory.[2]

The thermal resistance (R-value) of the test specimens was determined using ASTM C518, *Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Apparatus,* immediately after removal from the excavation and again after 4 weeks of laboratory conditioning. The moisture content by volume of the test specimens was determined by weighing them immediately after removal from the excavation, after four weeks laboratory conditioning at approximately 20 ºC (72 ºF)/50% RH and again after oven-drying to constant weight.

R-values measured immediately after removal from the excavation would be expected to be representative of the in situ R-value of the two insulation types at the time samples were removed. The R-values and moisture contents determined after four weeks laboratory conditioning highlight the relative change in measured values for the two insulation types when removed from exposure to the in situ soil moisture and temperature conditions for a period of time.

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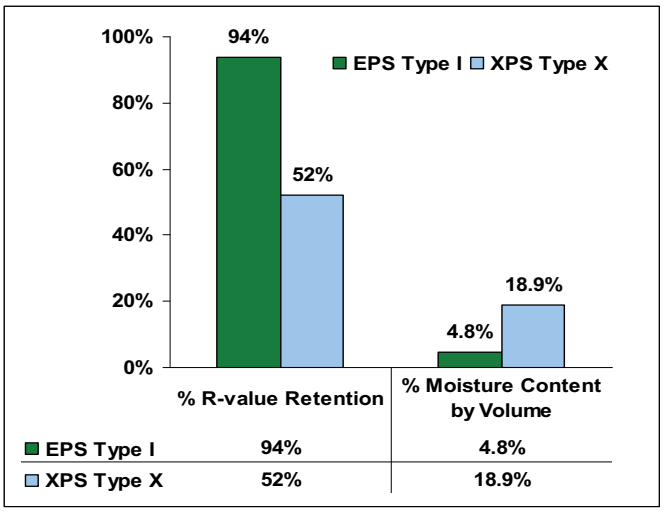
1 This specification is similar to CAN/ULC-S701, "Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering," the National Standard of Canada for EPS and XPS insulation.
2 Stork Twin Cities Testing Corporation, ST. Paul, MN – IAS Accreditation TL-217.



TEST RESULTS

The left side of the graph illustrates R-value retention for each product type based upon test measurements immediately after removal from the excavation of R-3.4 per inch for EPS Type I and R-2.6 per inch for XPS Type X versus C578 minimum requirements of R-3.6 for EPS Type 1 and R-5.0 for XPS Type X.

The right side of the graph illustrates moisture content by volume when removed from the excavation. This comparison illustrates that the EPS Type I moisture content at 4.8% was significantly less than the XPS Type X at 18.9% when installed in this side-by-side application.

After four weeks laboratory conditioning, measured R-values were R-3.7 per inch for the EPS Type I and R-2.8 per inch for the XPS Type X. Moisture content by volume after the laboratory conditioning was 0.7% for the EPS Type I and 15.7% for the XPS Type X.

CONCLUSIONS

The EPS Type I R-values immediately after removal from the excavation and after four weeks laboratory conditioning confirm EPS thermal performance demonstrated previously in the Canadian NRC/IRC research project. The R-value for the XPS Type X specimens in comparison to C578 minimum requirements can be attributed to the moisture content of specimens when removed from the excavation and the retained moisture content after four weeks laboratory conditioning.

The test results also confirm that C578 maximum water absorption by volume values of 4.0% for EPS Type I and 0.3% for XPS Type X do not correlate with in situ performance. This is because C578 values are based upon a laboratory test method that submerges specimens under a head of water. Water absorption measured using these test conditions may be applicable for applications that require extended exposure to water such as installation on a below-grade foundation below the water table.

In the absence of hydrostatic pressure on a foundation, moisture absorption in closed cell foam plastic insulations such as EPS and XPS can only occur by vapour diffusion as a result of prevailing thermal/vapour pressure gradients. Research from the University of Minnesota[3] indicates exterior below grade insulation should seldom experience vapour pressure differentials that exceed 1015 Pa (0.30" Hg) outwards and 1690 Pa (0.50" Hg) inwards. Changes in moisture content at these levels of vapour differential occur very slowly.

Water vapour permeability is the material property which determines the ability of a material to resist vapour movement through its thickness as a result of a vapour pressure difference between two surfaces, under specified temperature and humidity conditions. Water vapour permeance (WVP) is the performance property in C578 used to compare this characteristic for different product types. A lower WVP value indicates greater resistance to vapour movement.

C578 maximum WVP values for 1-inch (25.4 mm) thick product are 287 ng/Pa·s·m^2 (5.0 perms) for EPS Type I and 86 ng/Pa·s·m^2 (1.5 perms) for XPS Type X. The results from this test program indicate that a product with a lower WVP may accumulate more moisture within its cellular structure on the long term since it resists moisture loss when inward and outward vapour pressure differentials occur. As well, the results confirm the drying process is much slower for lower WVP product.

3 University of Minnesota Underground Space Centre, Moisture Absorption and its Effect on the Thermal Properties of EPS Insulation for Foundation Applications, A Review Analysis of Published Laboratory and Field Tests, October 1986.