Specification Check – Molded Polystyrene

Truths and Insights on Under-Slab Insulations with Structural Implications

By Sean O'Keefe

Lightweight and versatile, molded polystyrene foam is a common commercial building material that remains misunderstood. Frequently misidentified as Styrofoam, molded polystyrene products range from lightweight structural materials and insulations for commercial construction to packaging for electronics, medicines, and fragile payloads to Original Equipment Manufacturer (OEM) applications like garage doors, jet skis, RVs, and much more.

"Molded polystyrene foam is a very versatile material that efficiently solves a lot of common construction challenges," says Dale Mullikin, a National Account Director for Atlas Molded Products.

Structurally, molded polystyrene is well suited to difficult circumstances where a lightweight structural fill is needed. At Snowbird Ski & Summer Resort in Utah, molded polystyrene was used to help stabilize a 45-year-old mountainside cable tram when a new 23,000-square-foot guest center was built on top of Hidden Peak at 14,000 feet. Designers did not want any additional loading in the form of soil settlement to be added to the tram's foundation wall as a result of the new building.

As insulation, molded polystyrene rigid foam is well-suited to many different construction applications where a high-performance building envelope is desired. At Badger State Fruit Processing, a family-owned business serving Wisconsin's Cranberry industry, molded polystyrene was chosen. Badger State's insulation needs were not just in the walls and roof, but included foundation perimeter and under-slab applications as well, making it a six-sided challenge. The underslab insulation had a compressive strength able to support the weight of their massive freezers without risk of structural collapse.

Though structural loading is never an issue, occasionally proving molded polystyrene's structural capacity can be. When Mullikin recently approached a company building a large food processing facility about using molded polystyrene rigid foam insulation beneath the cold storage slabs, he got a little more than he expected back from the owner's engineer.

The engineer's reply by email read, in part: "I was forwarded some of your technical brochures. I wanted to verify if you had technical information regarding the insulation foundation modulus (equivalent modulus of subgrade reaction) for your product. We are expecting very high point loads on the slab for this project, so I would like to have that information available for verification and future reference."

"This was a first for me," says Mullikin. "The term modulus of subgrade reaction was not something I was familiar with." Fortunately, Mullikin had a reliable resource in Todd Bergstrom, Ph.D., of AFM Corporation. Bergstrom has a Doctorate in material science and engineering from Northwestern University and spent the last 22 years researching, developing, and testing molded polystyrene materials against variables of every sort. From proving R-values to conducting water absorption testing, and quantifying structural performance, Bergstrom has spent his career on the front lines of molded polystyrene material science.

"Modulus of subgrade reaction refers to the relative stiffness of the layers of support beneath a concrete slab," says Bergstrom. Quantified, the modulus of subgrade reaction assists engineers in selecting the appropriate molded polystyrene foam to support the pressure of the loaded slab. "In this case, the engineering proved that Foam-Control PLUS+ molded polystyrene insulation would support the same loads as a subgrade composed using XPS (Extruded Polystrene)."

As Bergstrom points out, some of the reason for the confusion surrounding rigid cellular polystyrene materials is that rigid cellular polystyrene can be used as both an insulation and a structural fill called geofoam. Though the materials are identical, within ASTM International standards there are two separate designations: ASTM C578 for insulation and ASTM D6817 for geofoam.

Rigid cellular polystyrene was first used in commercial construction more than 50 years ago as insulation. It was first tested by the ASTM and published in their standards under ASTM C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation. Rigid cellular polystyrene products include both extruded polystyrene and molded polystyrene materials whose practical purposes in commercial construction have grown well beyond the original thermal insulation objectives to now prominently include structural support.

"All rigid cellular polystyrene fell under C578 until 2002 when ASTM D6817 was introduced specifically to account for structural applications using geofoam," says Bergstrom. "Many architects still think of these products exclusively as insulations and, problematically, the original structural capacities listed in the insulation standard for XPS materials are inadequate without adjustment factors. Structural loading should always be specified using the structural capacities in ASTM D6817."

ASTM D6817, Standard Specification for Rigid Cellular Polystyrene Geofoam, determines the structural capacity of rigid cellular polystyrene by compressing the material until it is deformed by only one percent. Conversely, the insulation specification, ASTM C578, compresses the same material until it is deformed by ten percent.

"C578 is meant to compare two types of materials against one another," summarizes Bergstrom. "D6817, however, defines the loading capacity the material can support indefinitely when used structurally."

"Twenty-plus years of working with clients on insulations and structural solutions, and they never run out of questions," says Mullikin. "For the project at Snowbird Ski & Summer Resort in Utah, by filling the void between the new foundation and the tram wall with Foam-Control Geofoam, designers developed a structural barrier that will never erode. And, in the case of Badger State Fruit Processing, Foam-Control PLUS+ and PLUS+ 400 were selected based on a combination of performance, environmental impact, cost, and strength."▪

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