

## Durafill™ Geofoam reduces weight on underground U-505 exhibit at Chicago Museum of Science and Industry, saving additional structural expense.



### Project:

The construction of a new indoor, climate controlled exhibit room for the 252 ft. long U-505 submarine at the Museum of Science and Industry in Chicago. The new space is a 75 ft. x 300 ft. room, 42 ft. below the front lawn of the building's East Pavilion. The U-505 had been located outside since it arrived at the museum in 1954. This is the largest exhibit conservation project in the museum's history.

### Product:

The feature product is varying sizes, shapes and tapers of Durafill ultra lightweight expanded polystyrene (EPS) geofoam blocks. Durafill's unmatched weight-to-strength load bearing characteristics are uniquely effective in reducing the weight burden on underlying materials or structures without sacrificing compressive strength.

### Application:

Durafill blocks were used around the sides and up to the crest of the large span, radius roof over the underground room in which the submarine is housed, and over the roof of the underpass between the basement of the existing building and the new sub room.

Durafill provided a lightweight alternate to packing soil or pea gravel, bringing the final grade level with the peak of the roof and providing lightweight fill above the underpass, significantly minimizing the weight burden on both structures. A polyethylene membrane and a 12 to 18 inch layer of top soil were placed over the Durafill.

### Project Participants:

#### Structural Engineer

Halvorson & Kaye/  
Structural Engineers, P.C.  
Greg Lakota –  
Vice President, SE, PE  
Chicago, IL

#### Durafill Geofoam Manufacturer

Plymouth Foam Inc.  
Doug Wehrwein –  
Senior Account Manager  
Plymouth, WI

#### Distributor

RKD Construction  
Supplies & Equipment  
Bob Senase – Account Manager  
Northlake, IL

#### Contractor

W.E. O'Neil Construction  
Dennis Murzyn – Project Manager  
Dean Psaros – Project Superintendent  
Chicago, IL

### Timeframe:

Construction began in February of 2003; the U-505 was moved and placed in its new location in April 2004; the roof was enclosed in the summer of 2004; the Durafill geofoam was placed in November and December of 2004; landscaping was completed in the spring of 2005 and the new exhibit opened June 5, 2005.



## **The Challenge:**

The main roof of the underground room for the U-505 is framed with tapered steel box girder arches that brace the below grade walls and are able to support a portion of the soil load required to cover the enclosure.

As the roof and underpass designs were being finalized a key decision had to be made: either incur a significant additional expense to increase their weight bearing capacity, or find a way to minimize the weight of the soil required over the structures.

Greg Lakota of Halvorson & Kaye, the project's structural engineers, had some prior construction experience with geofoam, and after some research, determined that it was a viable option. The Chicago Department of Construction and Permits approved its use and the problem was uniquely solved.

A ring of approximately 3 to 4 feet of Durafill was placed around the exhibit roof, and approximately 6 feet of Durafill was placed over the pedestrian underpass. Depending on the need to fit the contour of the roof, up to five layers of custom shaped Durafill covers the roof.

## **Performance**

### **Easy Installation**

Plymouth Foam reviewed the engineering drawings and designed a detailed configuration that clearly outlined the optimal size, shape, placement and installation sequence of each Durafill block. The blocks were manufactured to spec, labeled with a code corresponding to the installation diagram, and delivered to the site in the order in which they were to be placed.

### **Weight Reduction**

Approximately 54,500 cubic feet of Durafill was used on the project, displacing a like volume of packed down soil. Knowing that a cubic foot of Durafill weighs 1 lb. and a cubic foot of packed soil weighs between 110 and 125 lbs., it is estimated that Durafill lightened the weight burden on the large span roof by approximately 3,200 tons.

## **Cost Savings**

Durafill made economical sense also. "When you take into account the time saved and the elimination of the need to pack down the soil, it's probably cheaper than using soil," said Lakota. "It's fair to say that we also saved a significant expense by avoiding the need to build in the extra roof support.

## **Above Grade Space**

There were no compromises above ground as the front lawn of the East Pavilion that covers the submerged U-505 exhibit has the same appearance and load bearing integrity as if standard packing soil was used. The 12 to 18 inches of top soil that covers the Durafill has supported the growth of a lush lawn and other plantings, and the compressive strength is able to support trucks, crowds and temporary structures if the area is ever used for an outdoor exhibition or performance.

## **Product Specs**

- Durafill 15; 1 lb. density per cubic foot
- The total volume can be viewed in several ways:
  - 1,400 total blocks, 4 ft. wide x 8 ft. high, ranging in thickness from 6" to 48"; 250 of the blocks were tapered from 0" to 6".
  - 54,533 cubic feet of Durafill delivered in approximately 15 truckloads from November 3-16, 2004.

## **Common Applications for Durafill Geofoam:**

Durafill has very low density, good insulation, low hydraulic conductivity, and strength and deformation properties that complement soil behavior. It is suited for a wide range of geotechnical engineering applications including:

- Minimizing surface load burdens while maintaining compressive strength in a variety of building and renovation construction projects
- Lightweight fill for building and road construction on soft ground
- Roadway and runway sub-grade and foundation insulation
- Slope stabilization
- Retaining wall and abutment backfill: lateral pressure reduction
- Landscape design



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