North America's first vertically integrated foamed glass aggregate manufacturing facility
FOAMED GLASS AGGREGATE
Lightweight, Insulating, and Sustainable

Made from 100% post consumer recycled glass

Herb Northrop
Chief Operating Officer

March 21, 2019

NERC Conference

AERÖ AGGREGATES
Outline

- History
- Manufacturing
- Material Properties
- Installation
- Applications
- Brief Case Studies
History

- Developed in Germany – early 1980s
- Technology taken to Norway – early 1990s
- Thermal barrier for roadways
- Led to Lightweight applications
- Growth through Scandinavia
  - Geotechnical Applications *(Norway, Sweden, Finland)*
- Germany & Switzerland
  - Thermal Insulation
  - Lightweight Concrete

OVER 25 YEARS UNDER NATIONAL ROADWAYS AND RAILWAYS IN EUROPE!
Glass Recovery in the U.S.A.

Total Glass: 11.6 Mton/yr
Containers: 9.4 Mton/yr

... Only ~31%
Made from 100% Post-Consumer Recycled Glass

140 million glass bottles recycled /year starting in 2018
Manufacturing

- 10 acre site/ 97,000 sq.ft. building
- Former Baldwin Steam Locomotive facility
The Process

- Recycled Glass ...
  Any Color, Any Size, CSP tolerant
- Cleaning of Glass Cullet
- Mill into Fine Powder
- Mix w/ Foaming Agent
- Process through Kiln
- Stockpile
The Process
The Process

- State of the art proven technology
- Fully automated, continuous 24/7 operation
Closed vs. Open Cell

**Closed Cell**
- Wet Process
- Dry Process

**Open Cell**

![Closed Cell Image]

![Open Cell Image]
LIGHTWEIGHT FILL ALTERNATIVES

- Geofoam (1-2 pcf)
- Foamed Glass Aggregate (8-25 pcf)
- Foamed Concrete (20-45 pcf)
- Expanded Shale or Clay (45-65 pcf)
Reduced Carbon Footprint

• 50% Less CO2 than Other Lightweight Materials
• 50% Less Energy Consumed than Other Lightweight Options

http://www.epd-norge.no/?lang=en_GB

An EPD® (Environmental Product Declaration) is an independently verified and registered document that communicates transparent and comparable information about the life-cycle environmental impact of products. Both the underlying LCA (Life-Cycle Assessment) and the EPD are always based upon international standards.

Regional Greenhouse Gas Initiative
an Initiative of the Northeast and Mid-Atlantic States of the U.S.

PARIS CLIMATE CHANGE ACCORD
## Material Properties: G15 UL-FGA (Closed Cell)

<table>
<thead>
<tr>
<th>Property</th>
<th>Units</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle Size</td>
<td>in</td>
<td>0.4 – 2.4</td>
</tr>
<tr>
<td>Loose Bulk Density (dry), max</td>
<td>pcf</td>
<td>15</td>
</tr>
<tr>
<td>Compacted Density (moist)</td>
<td>pcf</td>
<td>15-23</td>
</tr>
<tr>
<td>Thermal Conductivity</td>
<td>W/mK</td>
<td>0.11 dry/0.15 wet</td>
</tr>
<tr>
<td>Peak Friction Angle</td>
<td>degrees</td>
<td>55</td>
</tr>
</tbody>
</table>

### Compacted Unit Weight Comparison

<table>
<thead>
<tr>
<th>Material</th>
<th>Unit Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>120 pcf</td>
</tr>
<tr>
<td>Washed Stone</td>
<td>100 pcf</td>
</tr>
<tr>
<td>Expanded Shale</td>
<td>60 pcf</td>
</tr>
<tr>
<td>G15 UL-FGA</td>
<td>20 pcf</td>
</tr>
</tbody>
</table>
Daily Quality Control

**Determine Dry Bulk Density**

- `< 15 pcf (avg ~13.5)`

**Determine Compressive Strength**

- `@ 20%`
- `> 15,000 psf`

Modified version of the European Standard EN 1097-11, “Tests for mechanical and physical properties of aggregates, Part 11: Determination of compressibility and confined compressive strength of lightweight aggregates”.

Installation

- Maximum lift thicknesses of 24 inches (0.6 m)
- Compaction is performed with a tracked excavator or dozer 600 - 1,000 psf (30 - 50 kPa)
- 2 to 4 passes over the UL-FGA layer
Installation

Easily graded

Side Slopes @45°

Geotextile Separator
• 100 CY Walking Trailer
  • (1) Load UL-FGA
  • (3) Loads other ‘LW’ Agg
  • (7.5) Loads Washed Stone
• Simplify Logistics in the Field
• Improve Efficiency in the Field
• AND Reduce Carbon Emissions

• Also, Delivers in Super Sacks
  • (3 CY) UL FGA = 1,200 Lbs
  • (3 CY) Stone = 8,500 Lbs
Applications …

- Embankment over Soft Soils
- Bridge Approaches
- Cover over Tunnels, Culverts, Aging Utilities
- Retaining Walls, Building Foundations, MSE Walls

Green Roofs, Under Foundation Slabs, Pipe Insulation, …
Completed Projects

• Maine
• Massachusetts
• New York
• New Jersey
• Pennsylvania
• Delaware
• Maryland
• Virginia
• Colorado

• Pending projects in – NH, TX, CT, DC, WV, MI, FL, VT, RI
Case Studies

• Pennsylvania
  • Langley Avenue Navy Yard Access, Philadelphia
  • I-95 South, Philadelphia
  • JFK Blvd, Philadelphia

• New Jersey
  • RCA Pier, Camden
  • Wittpenn Bridge (Route 7), Kearny

• New York
  • USTA Broadcast Building, Queens
  • Nassau Expressway, Queens
Langley Avenue, Philadelphia
I-95 South, Philadelphia
I-95 South, Philadelphia
JFK Blvd, Philadelphia
JFK Blvd, Philadelphia
Wittpenn Bridge, Kearny
US Tennis Assn. Broadcast Building, Queens, NY
Nassau Expressway, Queens, NY
Foamed Glass Aggregate

- Ultra Lightweight and Insulating Engineered Material
- Chemically, UV, Volume Stable
- Efficient Installation, Not Weather Sensitive
- Technically proven, decades of history
- Economically attractive, we are saving our customers significant capital on their project costs
- Made from 100% recycled glass
- A true “closed loop” solution
- Sustainable and Environmentally Responsible
Thank You