What is a Foundry?

- A place where molten metal is poured into an engineered shape.
- “Castings” are used in all manufactured products.
- You are never more than six feet away from a casting.
- Demonstration
Significant Importance

Casting Industry Historically Important

Why Elaborate on History?

- Survival of this industry is important to all of us, both from an economic standpoint and national security standpoint
- Recycling provides an opportunity to conserve natural resources, reduce all of our costs, preserve our environment, and make us all more cost competitive
- We should be the leaders in the world when it comes to innovation
- Our success as a country long-term depends upon finding sustainable solutions in manufacturing, rebuilding and expanding our infrastructure, and providing good paying jobs to build our economy

Foundry Sand

- What is it?
  - “Foundry Sand” is a specialty silica sand used to make a mold that comes in contact with the molten metal during the casting process.
Foundry Sand: Geotechnical Projects, Characteristics and Examples

Typical Foundry Sands
- Uniform specific gradations and chemistries are desired in the casting process
- A number of different types of sands
  - Round Grain Silica and Lake Sands most common
- Mined in many parts of the United States
- Some regions of the US are more actively producing these sands

Before Using Sand in Casting Process
- Right Gradations and Chemistries Located
- Sand is Screened
- Impurities are Removed
- Fines are Removed
- Sand is Dried
Once Sand Arrives at Foundry

- Sand is prepared for casting process
  - Stabilized relative to temperature
  - Coated or mixed with other materials depending on casting process
  - Distributed to various machines to create molds or cores in preparation for introduction to molten metal

How Sands Are Used

Automated Molding Line

General Appearance
Can This Material Be Recycled?

- Casting Process
- Asphalt
- Concrete
- Cement
- Horticultural Soils
- Potting Mixes
- Polymer Composites
- Remediation Product
- Embankment Material
- Sub-Base
- Leachate Collection
- ADC

What About Volumes?

- Casting Industry Generates Roughly 6 to 8 Million Tons of Sand in the US Annually
- Much of Material Generated Regionally
  - Upper Midwest
  - Alabama
  - Texas

What About Environmental?

- Many Factors
- Some General Observations
- Some Specific Considerations

Environmental Data Sets

- The Following Slides Show Comparative Analysis of Sands and Soils
  - Total Metals – Units MG/KG
  - Based on 17 No-Bake Samples, 11 Mold Sand Samples, 3 Mixed Sand Samples
Environmental Comparison
Soils versus Sand (MG/KG)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Store-Bought Soil</th>
<th>No-Bake Sand (Core)</th>
<th>Green Sand (Mold Sand)</th>
<th>Mixed Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>15.3</td>
<td>&lt;0.05</td>
<td>&lt;1.9</td>
<td>&lt;0.2</td>
</tr>
<tr>
<td>Barium</td>
<td>137</td>
<td>&lt;0.04</td>
<td>11</td>
<td>1.93</td>
</tr>
<tr>
<td>Cadmium</td>
<td>1</td>
<td>&lt;0.1</td>
<td>&lt;0.42</td>
<td>&lt;0.34</td>
</tr>
<tr>
<td>Chromium</td>
<td>33.3</td>
<td>&lt;0.004</td>
<td>&lt;19.6</td>
<td>&lt;2.0</td>
</tr>
<tr>
<td>Lead</td>
<td>16.3</td>
<td>0.28</td>
<td>&lt;2.6</td>
<td>&lt;3.41</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.16</td>
<td>&lt;0.02</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Selenium</td>
<td>3.3</td>
<td>&lt;0.05</td>
<td>&lt;0.3</td>
<td>&lt;0.35</td>
</tr>
<tr>
<td>Iron</td>
<td>22,400</td>
<td>0.4</td>
<td>1,467</td>
<td></td>
</tr>
</tbody>
</table>

Midwest Farm Soils vs. Foundry Sand

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Soils Bkgrd.</th>
<th>No Bake</th>
<th>Green Sand</th>
<th>Mixed Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>0.2</td>
<td>&lt;0.1</td>
<td>&lt;0.42</td>
<td>&lt;0.34</td>
</tr>
<tr>
<td>Chromium</td>
<td>12</td>
<td>&lt;0.004</td>
<td>&lt;14.6</td>
<td>&lt;2.0</td>
</tr>
<tr>
<td>Copper</td>
<td>119</td>
<td>1</td>
<td>16.9</td>
<td>-----</td>
</tr>
<tr>
<td>Lead</td>
<td>19</td>
<td>0.28</td>
<td>&lt;2.6</td>
<td>&lt;3.1</td>
</tr>
<tr>
<td>Mercury</td>
<td>-----</td>
<td>&lt;0.02</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Zinc</td>
<td>75</td>
<td>1.6</td>
<td>&lt;12.7</td>
<td>-----</td>
</tr>
</tbody>
</table>

Environmental Considerations

- Almost all foundry sands are suitable for recycling in wide variety of applications
  - Exceptions – Sands from brass and bronze foundries pouring leaded alloys
- State Laws Dictate Allowable Applications
  - Wide Variety of What States Allow
  - Good Source of Information [www.afsinc.org](http://www.afsinc.org)
  - Look at AFS FIRST Section

Engineering Information

- Granular Material
- Avg. Sieve Size Roughly 55 Mesh
- Dark Brown/Dark Gray in Color
- 85% Silica, Balance Primarily Clays
- Virgin Sands have less than 0.5% passing 200 Mesh – see a little more in recycled sands (1 to 4%)
Typical Physical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Results</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>2.39 – 2.55</td>
<td>ASTM D854</td>
</tr>
<tr>
<td>Bulk Relative Density kg/m³</td>
<td>2590 (160)</td>
<td>ASTM C48/AASHTO T84</td>
</tr>
<tr>
<td>Absorption, %</td>
<td>0.45</td>
<td>ASTM C128</td>
</tr>
<tr>
<td>Moisture Content, %</td>
<td>0.1-10.1</td>
<td>ASTM D2216</td>
</tr>
<tr>
<td>Clay Lumps/Friable Particles</td>
<td>1-44</td>
<td>AASHTO C142/AASHTO T112</td>
</tr>
<tr>
<td>Coefficient of Permeability (cm/sec)</td>
<td>10 minus 3 – 10 minus 5</td>
<td>AASHTO T215/ASTM D2434</td>
</tr>
<tr>
<td>Plastic Limit/Plastic Index</td>
<td>Nonplastic</td>
<td>AASHTO T90/ASTM D4318</td>
</tr>
</tbody>
</table>

Typical Mechanical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Result</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro-Deval Abrasion Loss. %</td>
<td>&lt; 2</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Magnesium Sulfate Soundness Loss</td>
<td>5-15, 6-47</td>
<td>ASTM C88</td>
</tr>
<tr>
<td>Friction Angle (deg)</td>
<td>33-40</td>
<td>-----------------------</td>
</tr>
<tr>
<td>California Bearing Ratio, %</td>
<td>4-20</td>
<td>ASTM D 1883</td>
</tr>
</tbody>
</table>

Physical Properties

- Tell Us:
  - Size and Distribution of sand is uniform
  - Particle Shape Sub angular to rounded
  - Low absorption and nonplastic (variations in absorption can be attributed to different binder systems)

Mechanical Properties

- Tell us:
  - FS has good durability characteristics as measured by the MD abrasion and magnesium sulfate soundness loss
  - If you have a higher soundness loss, usually attributed to samples of bound sand not a breakdown of individual sand grains
  - Friction angle in the range of conventional sands
Geotechnical Expertise

- Tomorrow’s Presentation – John Dingeldein, PE
- Very Good Source of Information
- Long History of Project Work – Variety of Applications
- Highly Advise Discussing His Experience Working with Foundry Sands

Geotechnical Characteristics

- Sand Classification AASHTO = A3, USCS = SP
- Typical Proctor B/W 109 and 122 pcf at optimum moisture content of 15%
- Friction Angle = 35 Degrees
- Resistivity > 5,600 ohm-cm

Geotechnical Characteristics

- pH for molding sands usually around 9.0 with others closer to neutral and a few can be slightly acidic (depending on binder)
- Typical Sulfates Molding Sand < 100 ppm
- Typical Chloride Levels Molding sand < 40 ppm

Some Project Examples

- Road Projects
- Sub-Base Projects
Ohio Turnpike - KBI

CLSM Project

CLSM Project

Bottom Line

• Foundry Sands Can Be Utilized in Myriad of Applications
• Really Talking About Sand
• Uniform Material
• Cost Advantages
• Environmental Advantages
• Help is Available