AN INTRODUCTION TO LOW DENSITY CELLULAR CONCRETE AND ADVANCED FOAM TECHNOLOGIES

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Aerix Industries™

Foaming Agents and Technical Support Provided By Aerix Industries™ Engineering Solutions for Project Savings

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LOW-DENSITY CELLULAR CONCRETE IS DEFINED BY ACI 523 AS…

Concrete made with hydraulic cement, water and preformed foam to produce a hardened material with an oven dry density of 50 pounds (22.7 kg) per cubic foot or less.

Preformed foam is created by diluting a liquid foam concentrate with water in predetermined proportions and passing this mixture through a foam generator.
CONFORMS TO ACI INDUSTRY STANDARDS

Types of Foam

Preformed
Produced by Foam Generator

ACI 523
Cellular Concrete

Agitated
Produced by the mixing action of a concrete mixer

ACI 229
CLSM

Cellular concrete can be flowable fill (ACI 229 – Chapter 8) but flowable fill (CSLM) cannot be cellular concrete because of the density being higher than 50pcf.
CELLULAR CONCRETE REPLACES COARSE AGGREGATE WITH AIR

The air cells must be resilient in order to withstand the rigors of mixing and pumping in various applications.

Foam has the stability to be calculated as a solid but the properties to be placed as a low density fluid material.
CELLULAR CONCRETE BATCHING PROCESS

- Transit Mixer with 114 PCF Base Grout
- Concrete Pump
- Auto Foam Generator
- Inline Foam Injector
- Foam Concentrate
- Additional Requirements: Water Supply - Electrical Supply
- Air Compressor

Diagram illustrates the process of cellular concrete batching with various components and connections.
TYPES OF ON-SITE INSTALLATION EQUIPMENT INCLUDE

- High production self-contained unit for larger volume projects
- Mobile Mixing units
- Self-contained trailer wet batch system
Production of cellular concrete is more environmentally friendly than alternative methods

- 55% Less trucking
  - Truckloads / 1000 cubic yards (765 cubic meters)
    - Typical Fill - 100 trucks
    - Cellular Concrete – 45 trucks
    - Elimination in coarse aggregate haul

- 55% Less Fuel

- 55% Less Carbon Emissions

- Requires fewer pieces of equipment
  - Cleaner, less congested jobsites
**TYPICAL GUIDELINES CELLULAR CONCRETE MIXES**

<table>
<thead>
<tr>
<th>Cast Density</th>
<th>Typical Compressive Strength at 28 days</th>
<th>Portland Cement</th>
<th>Water</th>
<th>Foam Volume</th>
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</thead>
<tbody>
<tr>
<td>lb/ft³</td>
<td>psi</td>
<td>MPa</td>
<td>lb/yd³</td>
<td>kg/m³</td>
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<tr>
<td>20</td>
<td>320</td>
<td>50</td>
<td>0.34</td>
<td>328</td>
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<tr>
<td>25</td>
<td>400</td>
<td>80</td>
<td>0.55</td>
<td>420</td>
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<tr>
<td>30</td>
<td>481</td>
<td>140</td>
<td>0.97</td>
<td>512</td>
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<tr>
<td>35</td>
<td>561</td>
<td>210</td>
<td>1.45</td>
<td>603</td>
</tr>
<tr>
<td>40</td>
<td>641</td>
<td>280</td>
<td>2.28</td>
<td>695</td>
</tr>
<tr>
<td>45</td>
<td>721</td>
<td>330</td>
<td>3.10</td>
<td>787</td>
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<tr>
<td>50</td>
<td>801</td>
<td>450</td>
<td>4.11</td>
<td>878</td>
</tr>
<tr>
<td>55</td>
<td>881</td>
<td>640</td>
<td>4.41</td>
<td>970</td>
</tr>
<tr>
<td>60</td>
<td>961</td>
<td>830</td>
<td>4.41</td>
<td>1062</td>
</tr>
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75% of the volume is foam.
Typical Strength Curve of Cellular Concrete
ASTM TEST METHODS THAT APPLY TO CELLULAR CONCRETE

ASTM C 869

“Standard Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete”

ASTM C 796

“Standard Test Method for Foaming Agents for use in Producing Cellular Concrete using Preformed Foam”

ASTM C 495

“Standard Test Method for Compressive Strength of Lightweight Insulating Concrete”
QUALITY CONTROL IS ALWAYS MEASURED IN THE FIELD
FOAM TECHNOLOGY HAS MADE HUGE ADVANCEMENTS WITH STABLE BUBBLE TECHNOLOGY

- **Typical Foams**
  - 3 foot lift thickness
  - Pumping distance limited to 5,000 feet maximum
  - Only non-permeable
  - Viscosity was almost 1
  - Fly ash usage limited

- **Advanced Foam Technology**
  - 4-20 foot lift thickness
  - Pumping distance increased to more than 14,000 feet
  - Permeability is also an option
  - Thicker material
  - Higher fly ash usage and slag cement usage
<table>
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<td>▪ Tunnel &amp; Mine Abandonment</td>
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CELLULAR CONCRETE IS AN IDEAL SOLUTION FOR ANNULAR AND TUNNEL BACKFILL

- Highly flowable material able to completely fill annular space
- Lightweight and easily pumped long distances at low pressures
- Will not float pipe or damage liner for sliplining
- Strength and density can be customized to project requirements
- Shrinkage of less than 0.3%
- Quick and Easy Installation
- Environmentally Safe

Cellular Concrete has been pumped over 700 feet vertically and over 15,000 feet.

Can accommodate any diameter pipe.
CULVERT OR ANNULAR APPLICATION

- 150 yd³ (114 m³) of 500psi (3.4 MPa) pumped 100ft (30.5m) under SR 1 for MaineDOT.

Photo Courtesy of SnapTite
Gravity Sewer Annular Fill  
Kaneohe Kailua Tunnel, Honolulu, HI

The purpose of the Kaneohe-Kailua gravity sewer tunnel is to transport wastewater between Kaneohe and Kailua. Approximately three miles long, the 10-foot inner diameter design of the tunnel will use gravity to carry the sewage, rather than a force main. This alternative will minimize sewage spills near homes and preserve Kaneohe Bay. The tunnel will also eliminate above ground wastewater storage and eliminate its operational maintenance.
GRAVITY SEWER ANNULAR FILL
KANEHOE KAILUA TUNNEL, HONOLULU, HI

- 28,000yd³ 50pcf
- 4” injection line
- Material pumped for 3 miles
- Water chilled from 70° to 50°
- Maintained 18” to 24” controlled lifts due to distance and heat

“Aerix Industries provided a quality bubble and the physical bubble was not compromised at all over the entire distance pumped”

Don Painter, Project Manager of Southland/Mole JV
TYPICAL APPLICATIONS

- Tunnel & Mine Abandonment
- Annular Fills for Tunnels, Water & Sewer Lines
- Void Fills
- Soft Soil Remediation
- Tremie Applications
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- Slope Stabilization
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UTILITY/TUNNEL ABANDONMENT

*Information provided by Mainmark, Australia*
Gas Pipe Line Abandonment
Atlanta Gas Light (AGL)

- 12 ½ mile abandonment
- 1,000-1,500 ft placement points
- 6,500 yd³ of 40pcf
- Non-pervious

- 20km abandonment
- 300 – 450 meter placement points
- 8450 m³ of 640kg/m³
- Non-pervious

*Information provided by Gibson Grouting Services, Smyrna, GA*
PERMEABLE LOW DENSITY CELLULAR CONCRETE
PERMEABLE VS. NON-PERMEABLE

- Bubble Chemistry is different
  - In non-permeable we need to maintain the bubble structure
  - With Permeable we need to coalesce the bubble structure
PLDCC Permeability / Infiltration**

** University of Missouri, J.T. Kevern
Observation of Permeability 24 hours after placement

*Information provided by CellFill, Grove, OK*
VOID FACTORS OF PLDCC

** University of Missouri, J.T. Kevern
PLDCC Compressive Strength - UMKC

**University of Missouri, J.T. Kevern**
ABANDONMENT OF ROOSEVELT AVE DRAWBRIDGE COUNTERWEIGHT WELL PITS

- Rapid installation without disturbing traffic pattern
- Minimize bearing pressure

*Information provided by Geo-Cell Solutions Inc., Fresno, CA*
INDOOR POOL ABANDONMENT

*Information provided by CJ Geo, VA*
SLAB SUPPORT
SOUTH STREET LANDING, PROVIDENCE, RI
THE CHAPEL, GALVEZ ST., NEW ORLEANS, LA
Typical Applications

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USE CELLULAR CONCRETE FOR SUBGRADE MODIFICATION WHEN EXISTING SOILS ARE UNDESIRABLE

Cellular Concrete Advantages

- Reduce Vertical Dead Loads
- Increase Strength/Stability with Minimal Weight
- Improve Seismic Stability
- Reduce Settlement Potential
- Increase Bearing Capacity
- Insulating
CELLULAR CONCRETE USED TO REPLACE UNSTABLE SOILS AT THE UNIVERSITY OF CONNECTICUT

- Football stadium constructed on unstable soils
- Lightweight Cellular Concrete sub-base equally distributed the loads
- 40,000 yds (30,600 m³) of 35pcf (480kg/ m³) material placed at 150 cy per hour (115 m³/hr)

*Information provided by Pacific International Grout., Bellingham, WA*
LIGHTWEIGHT CORE IN LEVEE APPLICATION
LOUIS ARMSTRONG AIRPORT
NEW ORLEANS, LA
LOUIS ARMSTRONG AIRPORT
NEW ORLEANS, LA

[Images of construction site at Louis Armstrong Airport]
Using Cellular Concrete with Driven Piles
Increasing the Elevation Needs

- Drive piles as per the grade beam plans
- Cap off the piles to the desired height
- Place a Cellular Concrete slab over the piles to the desired elevation
- Excavate out over the driven piles to create the forms for the grade beams
- Place the appropriate rebar for the grade beams
- Pour the grade beams
- Voila – With the final pour in place the elevation is achieved! Reducing the down drag on the driven piles.
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THE FLUIDITY OF CELLULAR CONCRETE MAKES IT FAVORABLE FOR TREMIE APPLICATIONS

- Coastal piers compromised
- Placed sheet pile around existing piers, to isolate wood from water
- 70 pcf Cellular Concrete used as fill between the sheet pile and the pier

Hudson River in New Jersey

Seawall Tremie Application in Florida
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CELLULAR CONCRETE IS IDEAL RETAINING WALL BACKFILL

Cellular Concrete Advantages

- Reduce Lateral Load
- Ease of Placement
- Increased lift heights
- Reduces schedule impact
- Allows for design flexibility
- Engineered Permeability
SEGMENTAL WALL CONFIGURATION
SEGMENTAL WALL CONFIGURATION
Strapping & Internal Angle of Friction

35° - 45° (Conservative)
60° - 70° (Liberal)

? = are you designing the project as
A "soil wall" or "concrete wall"
SR 542, Bellingham, WA

- Vertical Facia walls >50’
- Shotcrete over the facia walls
**TYPICAL APPLICATIONS**

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SLOPE STABILIZATION WITH CELLULAR CONCRETE

*Information provided by CellCrete, Monrovia, CA*
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TRENCH BACKFILL OPPORTUNITIES

- Allows for narrower trench and less disturbance to the native material.
- Widths may be reduced to within 6-in of utility
- enough space to properly place the cellular in the pipe haunch areas
- Eliminates backfill compaction.
- Fills all voids
FLOWABLE & SELF COMPACTING
**Illustration provided by Cematrix**
IDENTIFY BURIED UTILITIES WITH A DYE

- clear indicator for future operators
- Different colors can be used
  - Red - fiber optics or high voltage lines
  - Blue – water lines
  - Yellow – sewer lines

Photo Courtesy of Throop Cellular Concrete
FULLY EXCAVATABLE & VERSATILE
FULLY EXCAVATABLE & VERSATILE

*Information provided by Cell-Crete, Monrovia, CA
INfiltration/Exfiltration Systems

Growing Medium and Vegetation

Pervious pavers or Pervious pavement

Silt Fabric

Permeable Cellular Concrete

Retention/Detention Chambers

Retention/Detention Pipes

If Needed - Layer of Permeable Cellular Concrete to Lighten the overall loading

Sub-Grade
APPLICATIONS FOR OTHER INDUSTRIES AND UNIQUE APPLICATIONS
What conclusions can we draw about cellular concrete?

- Broad Range of Densities
- Economical
- Versatile
- Easily Placed
- Rapid Installation
- Durable
- Permanent and Stable
- Environmentally Friendly

No One Foam Does it All

We can customize our products to meet your project needs