An Introduction to Cellular Concrete and Advanced Engineered Foam Technology

Not just products…Solutions

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Aerix Industries™

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- Aerix Industries has met the standards and requirements of the Registered Continuing Education Program.
- Credit earned on completion of this program will be reported to RCEP at RCEP.net
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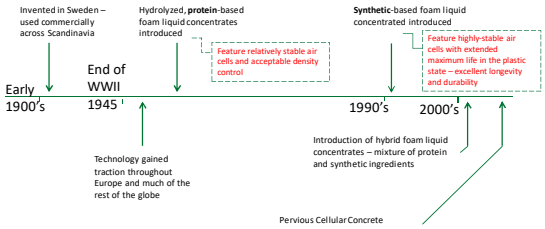
Low-density cellular concrete is defined by ACI 523 as…

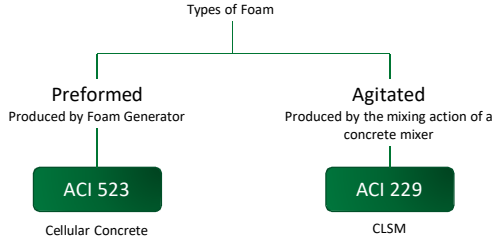
Concrete made with hydraulic cement, water and preformed foam to produce a hardened material with an oven dry density of 50 pounds (22.7 kg) per cubic foot or less.

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

A brief history of cellular concrete



Conforms to ACI industry standards



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.

Conforms to ACI industry standards

Preformed
Produced by Foam Generator

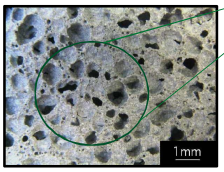
ACI 523

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 PORE STRUCTURE WHEN CURED

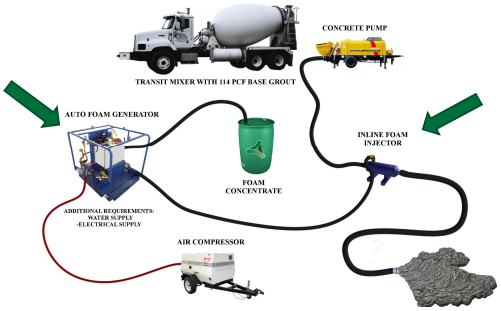


Cementitious materials encapsulate the air bubbles, then dissipate leaving a void structure as a replacement to traditional aggregate

Lightweight Cellular Concrete differs from conventional aggregate concrete in the methods of production, the density of the material and the extensive range of end uses.

PERVIOUS & NON-PERVIOUS

CELLULAR CONCRETE BATCHING PROCESS



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

ADVANTAGE OF A MORE ENVIRONMENTALLY FRIENDLY THAN ALTERNATIVE METHODS

- Less pieces of equipment
- Less fuel
- Less Carbon emissions
- Less congested jobsites

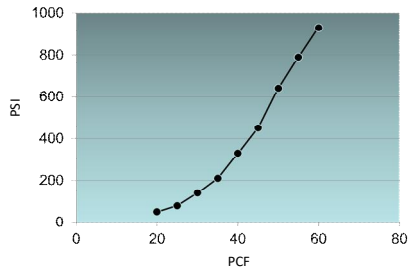
Typical Guidelines Cellular Concrete Mixes

TYPICAL VALUES

Cast Density		Typical Compressive Strength at 28 days		Portland Cement		Water		Foam Volume	
lb/ft³	kg/m³	psi	MPa	lb/yd³	kg/m³	gal	L	ft³/yd³	m³/m³
20	320	50	0.34	328	195	19.7	97.3	22.7	0.84
25	400	80	0.55	420	249	25.2	124.6	21.5	0.80
30	481	140	0.97	512	304	30.7	151.9	20.3	0.75
35	561	210	1.45	603	358	36.2	178.8	19.1	0.71
40	641	330	2.28	695	412	41.7	206.1	17.9	[illegible]
45	721	450	3.10	787	467	47.2	233.4	16.7	[illegible]
50	801	640	4.41	878	521	52.6	260.4	15.5	0.57
55	881	790	5.45	970	575	58.2	287.7	14.3	0.53
60	961	930	6.41	1062	630	63.7	315.0	13.1	0.49

75% of the volume is foam

Typical Strength Curve of Cellular Concrete



ASTM Test Methods That Apply to Cellular Concrete

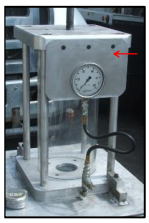
ASTM C 869 — "Standard Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete"

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

Compressibility Testing on Cellular Concrete Validates Ability to Resist Bubble Collapse from Pressure



Compressibility device to evaluate stability of Cellular Concrete

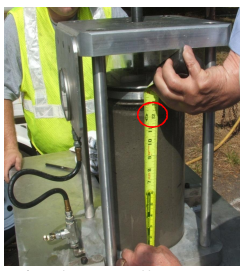
Note: The clear cylinder limits the pressure that can be applied, as does the loading by turning a screw through a threaded top plate. However, the grout is tracked through the pump during calibration, so the test acts as confirmation of the cellular concrete performance that is observed during pumping.

The cellular concrete level was 12 inches at zero pressure

*Information provided by Ardaman & Assodates, Inc. Tampa, FL

The Cellular Concrete Fully Rebounded to the Original Fill Height

At 30 psi pressure, the cellular concrete was reduced in height to 9 inches



*Note there was no visible collapse of the cellular concrete after the test.

*Information provided by Ardaman & Assodates, Inc. Tampa, FL

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
  - Permeable is also an option
  - Thicker material
  - Higher fly ash usage and slag cement usage

Geotechnical Applications

- Tunnel Backfill and Annular Fills
- Subgrade Modification
- Tremie Applications
- Bridge Approach
- Retaining Wall Backfills
- Fill Underground Tanks & Pipelines
- Fill for Abandoned Mines
- Fill Around Conduits and Pipes

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 horizontally

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

Gravity Sewer Annular Fill
Kaneohe 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

**Information provided by Southland/Mole JV, Kaneohe, HI*

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

Utility/Tunnel Abandonment

*Information provided by Mainmark, Australia

NC 72, Fayetteville, NC

- Hurricane Matthew Oct '16
- washed out backfill
- void of 900 cubic feet
- CC placed in three hours
- Using ready-mix trucks

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

Backfilling of Pools

South Street Landing, Providence, RI



Backfill from Rough Grade to Top of Footing

- Ease of placement
- Fast
- No compaction
- Reduced traffic impact.

*Information provided by Cell-Crete, Monrovia, CA

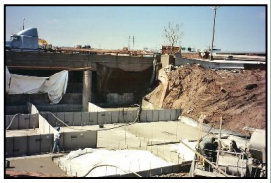
Geotechnical Applications

- Tunnel Backfill and Annular Fills
- Subgrade Modification
- Tremie Applications
- Bridge Approach
- Retaining Wall Backfills
- Fill Underground Tanks & Pipelines
- Fill for Abandoned Mines

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

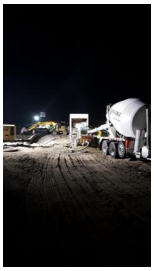


Cellular concrete used to replace unstable soils at the University of Connecticut

- Football stadium constructed on unstable soils
- Lightweight Cellular Concrete sub-base equally distributed the loads
- 40,000 yds (30,600 m^3) of 35pcf (480kg/ m^3) material placed at 150 cy per hour (115 m^3/hr)

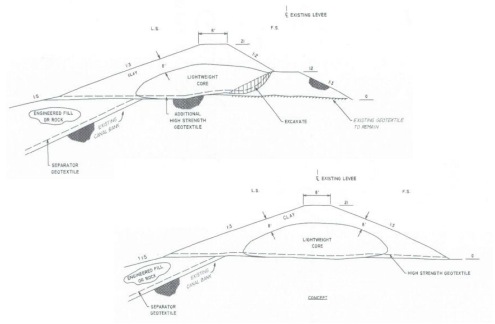
*Information provided by Pacific International Grout., Bellingham, WA

SR 50, Ocoee, FL



*Information provided by CDM Smith, Orlando, Fl & Aerix Industries

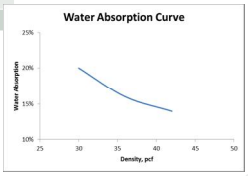
Lightweight Core in Levee Application



120 Day Water Absorption Study*

Non-Pervious Cellular Concrete

Sample ID	Net Cast PCF	Net @ 120 days pcf	Avg. Absorption %
30 pcf	30.3	34.6	**16.6**
36 pcf	34.9	38.7	**12.5**
42 pcf	41.5	45.4	**12.4**



*Haller Laboratory Report (No. L4538-2-R)

Geotechnical Applications

- Tunnel Backfill and Annular Fills
- Subgrade Modification
- Tremie Applications
- Bridge Approach
- Retaining Wall Backfills
- Fill Underground Tanks & Pipelines
- Fill for Abandoned Mines

The fluidity of cellular concrete makes it favorable for tremie applications

Hudson River in New Jersey

- 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

Seawall Tremie Application in Florida

Geotechnical Applications

- Tunnel Backfill and Annular Fills
- Subgrade Modification
- Tremie Applications
- Bridge Approach
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- Fill Underground Tanks & Pipelines
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Cellular concrete is ideal retaining wall backfill

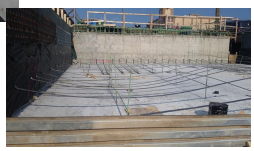
Cellular Concrete Advantages

- Reduce Lateral Load
- Ease of Placement
- Increased lift heights
- Reduces schedule impact
- Allows for design flexibility
- Engineered Permeability

Segmental Wall Configuration

Segmental Wall Configuration
IDOT Lake Shore Drive & I-55 Interchange

- Elimination of lateral loads as well reduction in vertical loads
- Three new ramps for lane change requirements

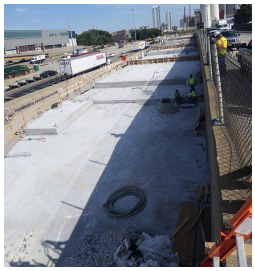


- 22,000 yd^3
- 6 phases over 2 years
- 1000yd^3 per day of production
- 24-30pcf @ 40psi

*Information provided by MixOnSite USA Inc., Buffalo Grove, IL

Strapping Configuration
IDOT Circle Interchange

- 18,000 cubic yards of cellular concrete
- 24-30pcf / 40psi
- 4 phases over a 2 year duration
- Daily production rates > 1000 cubic yards



*Information provided by MixOnSite USA Inc., Buffalo Grove, IL

Lane Expansion in Philadelphia for Rapid Installation

Pumped 6,800 cubic yards (5,200 cubic meters)

Existing soils were soft for traditional compacted fill and accelerated production schedule was needed

*Information provided by A-Deck Inc., Norristown, PA

Geotechnical Applications

- Tunnel Backfill and Annular Fills
- Subgrade Modification
- Tremie Applications
- Bridge Approach
- Retaining Wall Backfills
- Underground Utility Protection
- Fill Underground Tanks & Pipelines
- Fill for Abandoned Mines
- Fill Around Conduits and Pipes

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

GeoThermal Model – Utility Protection

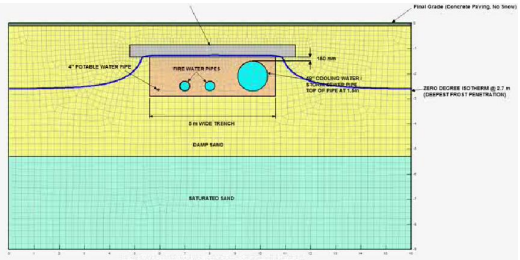


**Illustration provided by Cematrix

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

Water Main Abandonment
IL Tollways Project (Alternative to CLSM)

- 13,400 LF ; 60" and 90" water main abandonments for three Tollway projects
- 13,000 cubic yards of 24-30pcf / 40psi

- Staging area for dry mix equipment (photo above) was over 1,000 feet to injection points.

*Information provided by MixOnSite USA Inc., Buffalo Grove, IL

Fully Excavatable & Versatile

Emerging Technologies and Engineered Foam Solutions

Pervious Cellular Concrete (PCLWC)

- Open Cell Technology
- Permeability Drainage of 162" -1600"/hr
- Density of 25pcf – 35pcf

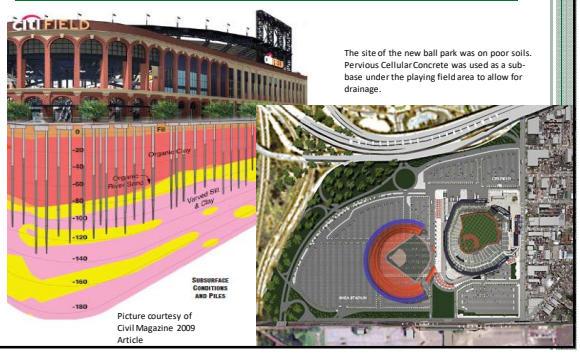
Pervious vs. Non-Pervious

- Bubble Chemistry is different
  - In non-pervious we need to maintain the bubble structure
  - With Pervious we need to coalesce the bubble structure

Typical Uses and Applications for Pervious Cellular Concrete

- Sports Field Sub-base Fills
- Bridge Approach Fills
- Retaining Wall Backfills
- Foundation Fills
- Pervious Pavement Sub-base Fills
- Pipeline Bedding Fills
- Culvert Relining Fills
- Pool Deck Sub-base Fills
- Pervious Paver Sub-base Fills

Pervious Cellular Concrete used as a sub-base at the New York Mets Ballpark saving the owner over $500,000 dollars



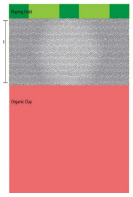
The site of the new ball park was on poor soils. Pervious Cellular Concrete was used as a sub-base under the playing field area to allow for drainage.

Picture courtesy of Civil Magazine 2009 Article

Pervious cellular concrete used as a sub-base at CitiField

The site of the new ball park is on organic clay

The original design called for 4' of lightweight aggregate. Cellular Concrete was proposed as a value engineering alternative.



*Information provided by Mixonsite USA Inc., Buffalo Grove, IL

Rose Coulee Bridge Fargo, ND

Pervious cellular concrete used on bridge approach to allow flood waters to drain

Using pervious cellular concrete on the bridge approach allowed the flood waters to drain alleviating pooling and potential deterioration

Standing water from flooding of Red River in Fargo, ND had deteriorated the bridge approach.

*Information provided by Cellular Concrete Inc., Zimmerman, MN

2,600 Cubic Yards of 25pcf Pervious Cellular Concrete

Pervious Cellular Concrete Advantages

- Reduced Settlement
- Increase Bearing Capacity
- Improve Seismic Stability
- Permeability of $1x10^{-2}$ cm/sec

Louis Armstrong Airport
New Orleans, LA

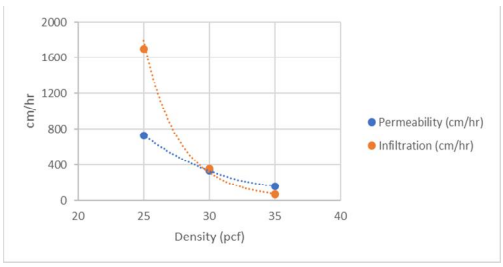
Louis Armstrong Airport
New Orleans, LA

Permeability of Cellular Concrete

Observation of Permeability 24 hours after placement

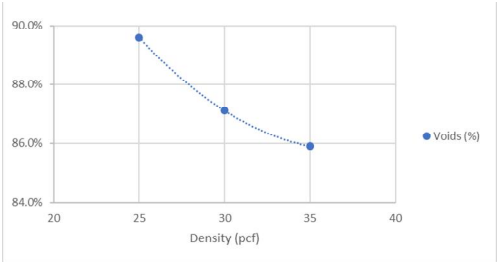
*Information provided by CellFill, Grove, OK

PCLWC Permeability / Infiltration**



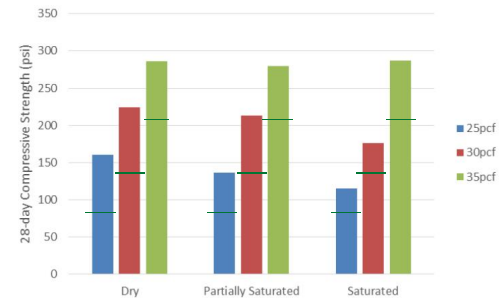
** University of Missouri, J.T. Kevern

Void Factors of PCLWC



** University of Missouri, J.T. Kevern

PCLWC Compressive Strength - UMKC



PennDOT Rt. 30 Sinkhole

Sinkhole remediation in the median

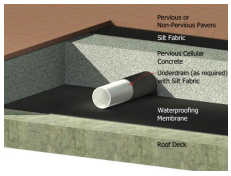
- Fast production
- Self-compacted and self-leveled
- Permeable solution

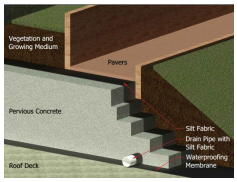
*Information provided by A-Deck Inc., Norristown, PA

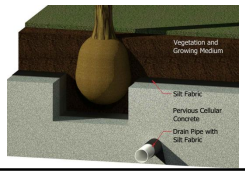
Green Roof Environmental and Economic Benefits

- Reduces storm water runoff and filters pollutants; neutralizes acidity of acid rain
- Improves air quality and help offset carbon footprint
- Acts as a sound proofing barrier (up to 40 decibels in some cases)
- Expands the lifespan of roof by protecting roof surface from contraction and expansion
- Insulates and cools building, reducing utility costs
- Qualifies for up to 10-20 LEED certification points
- Create habit for birds and insects
- Reduces "urban heat island effect" by cooling urban environment through evaporative transpiration

Pervious Green Roof Applications

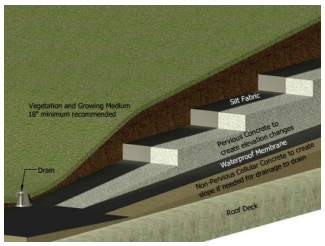






Green Roof Elevation Changes

- Easily incorporates desired elevation changes in any green roof application
- Reduced labor costs
- Speed up construction schedule
- Economical



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

Questions?