An Introduction to Low Density Cellular Concrete and Advanced Foam Technologies

Foaming Agents and Technical Support Provided By

Aerix Industries™
Engineering Solutions for Project Savings

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Aerix Industries™

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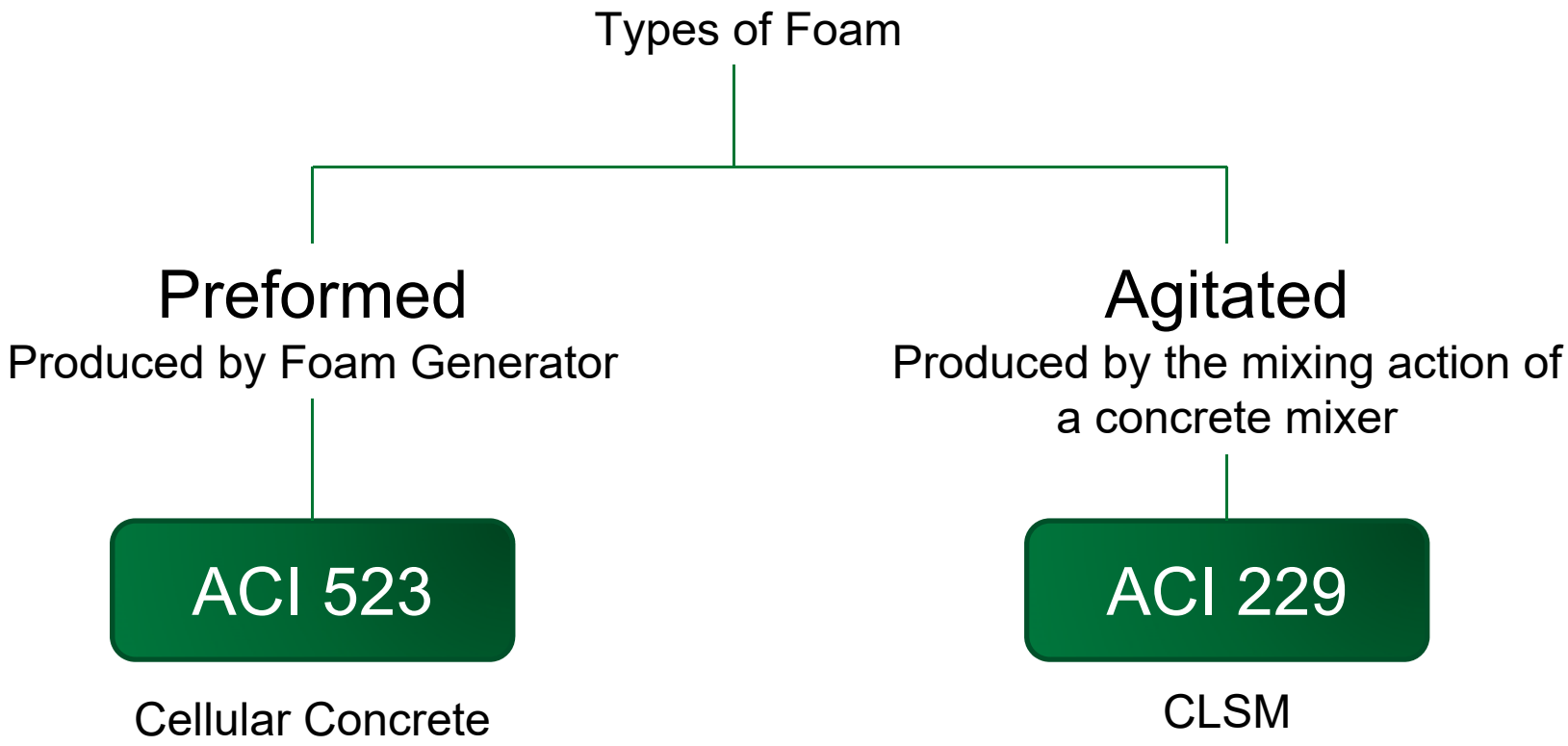
LOW-DENSITY CELLULAR CONCRETE IS DEFINED BY ACI 523 AS…

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



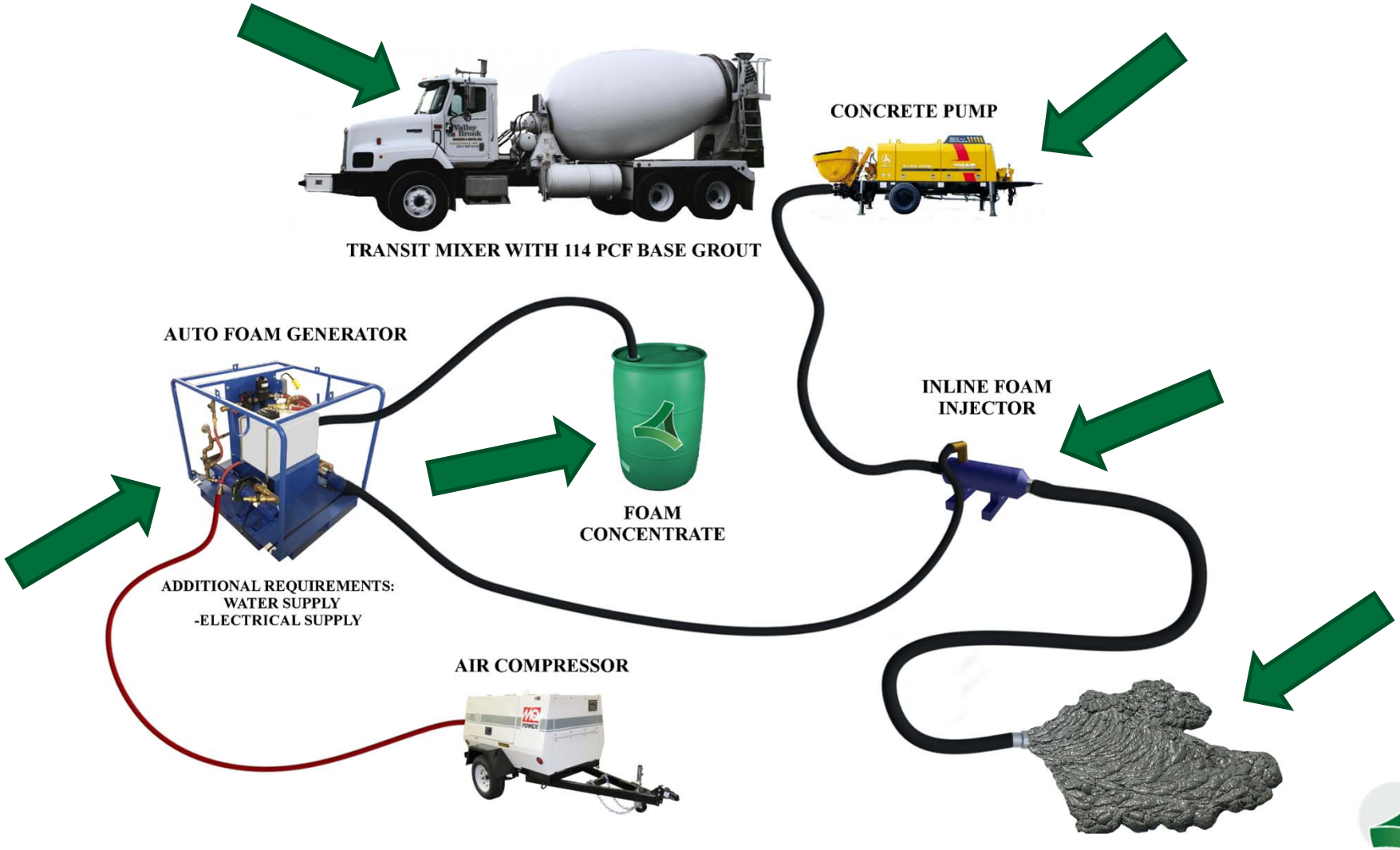
Cellular concrete can be flowable fill (ACI 229 – Chapter 8) but flowable fill (CSLM) cannot be cellular concrete because of the density being higher than 50pcf.

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



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

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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 equipmer
  - Cleaner, less congested jobsites

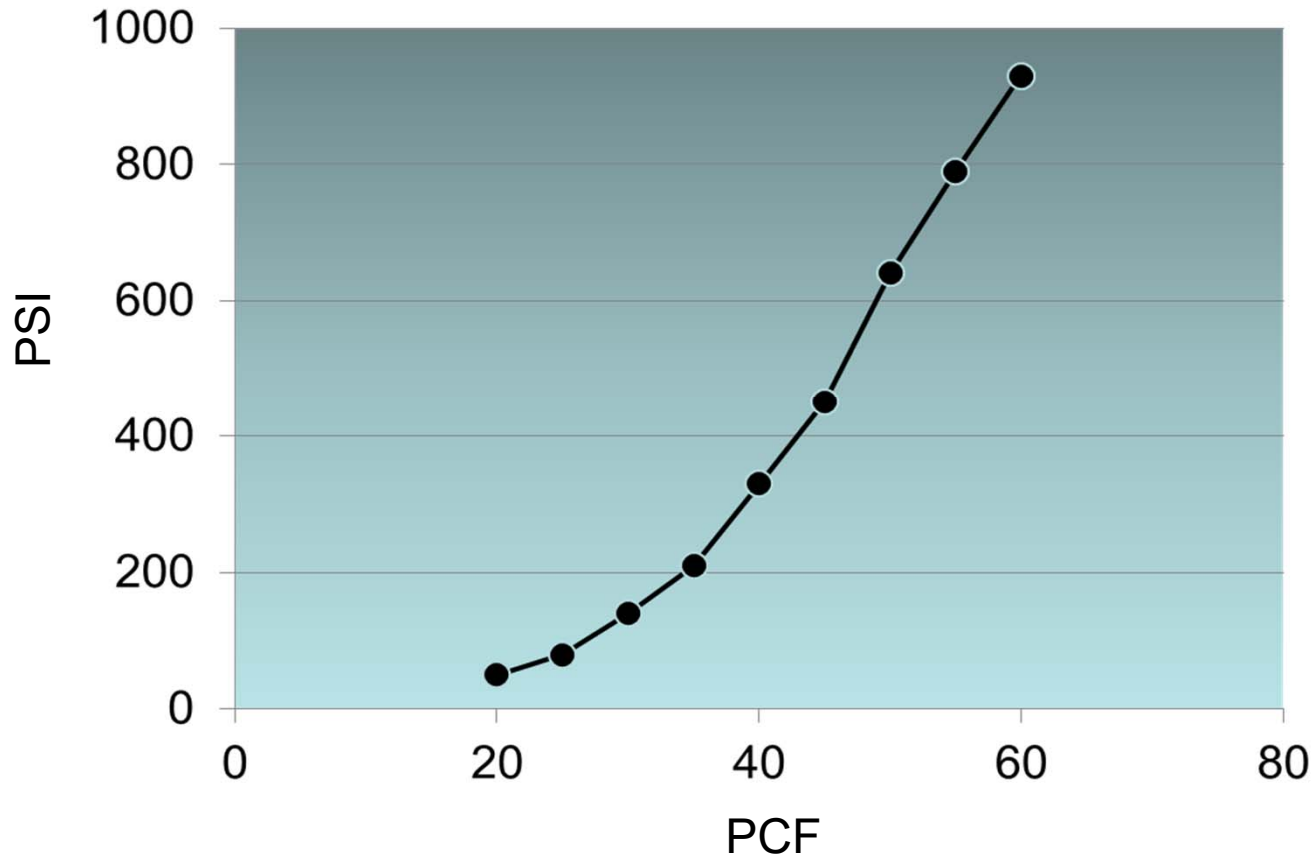
TYPICAL GUIDELINES CELLULAR CONCRETE MIXES

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	0
45	721	450	3.10	787	467	47.2	233.4	16.7	0
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

FOAM TECHNOLOGY HAS MADE HUGE ADVANCEMENTS WITH STABLE BUBBLE TECHNOLOGY

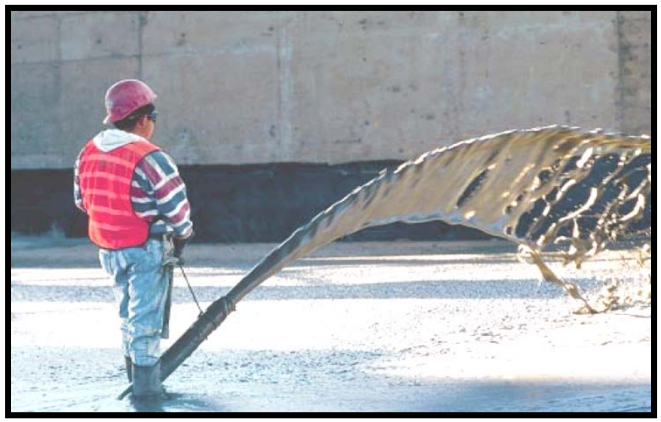
- Typical Foams
  - 3 foot lift thickness
  - Pumping distance limited to 5,000 feet maximum
  - Only non-permeable
  - Viscosity was almost 1
  - Fly ash usage limited
- Advanced Foam Technology
  - 4-20 foot lift thickness
  - Pumping distance increased to more than 14,000 feet
  - Permeability is also an option
  - Thicker material
  - Higher fly ash usage and slag cement usage

TYPICAL APPLICATIONS

- Tunnel & Mine Abandonment
- Annular Fills for Tunnels, Water & Sewer Lines
- Void Fills
- Soft Soil Remediation
- Tremie Applications
- Retaining Structure Backfills
- Slope Stabilization
- Fill for Underground Utility, Conduit & Pipes
- Tanks & Pipeline Abandonment
- Fill Around Conduits and Pipes
- Green Roof Applications

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 yd^3 (114 m^3)of 500psi (3.4 MPa) pumped 100ft (30.5m) under SR 1 for MaineD

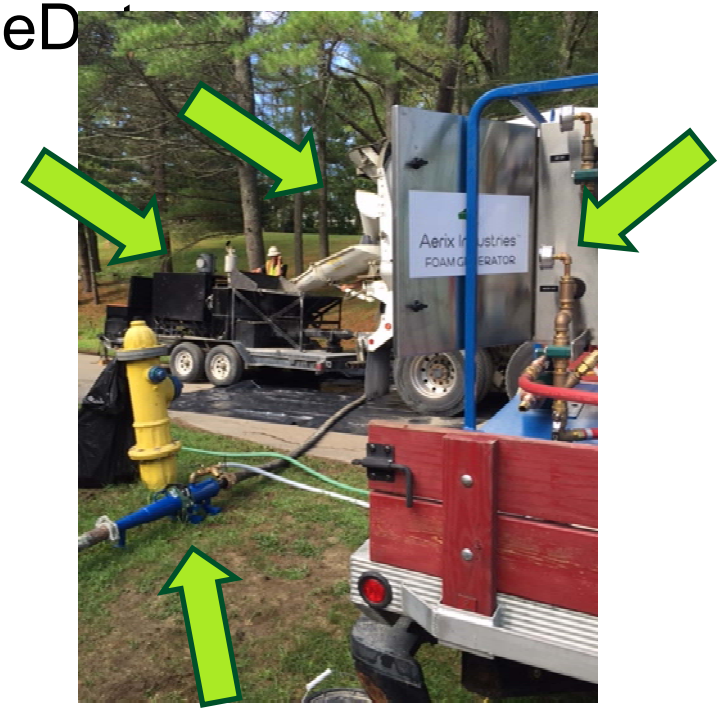


Photo Courtesy of SnapTite

GRAVITY SEWER ANNULAR FILL
KANEOHE KAILUA TUNNEL, HONOLULU, HI

Kaneohe-Kailua Wastewater Conveyance & Treatment Facilities Project

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
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*

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UTILITY/TUNNEL ABANDONMENT

**Information provided by Mainmark, Australia*

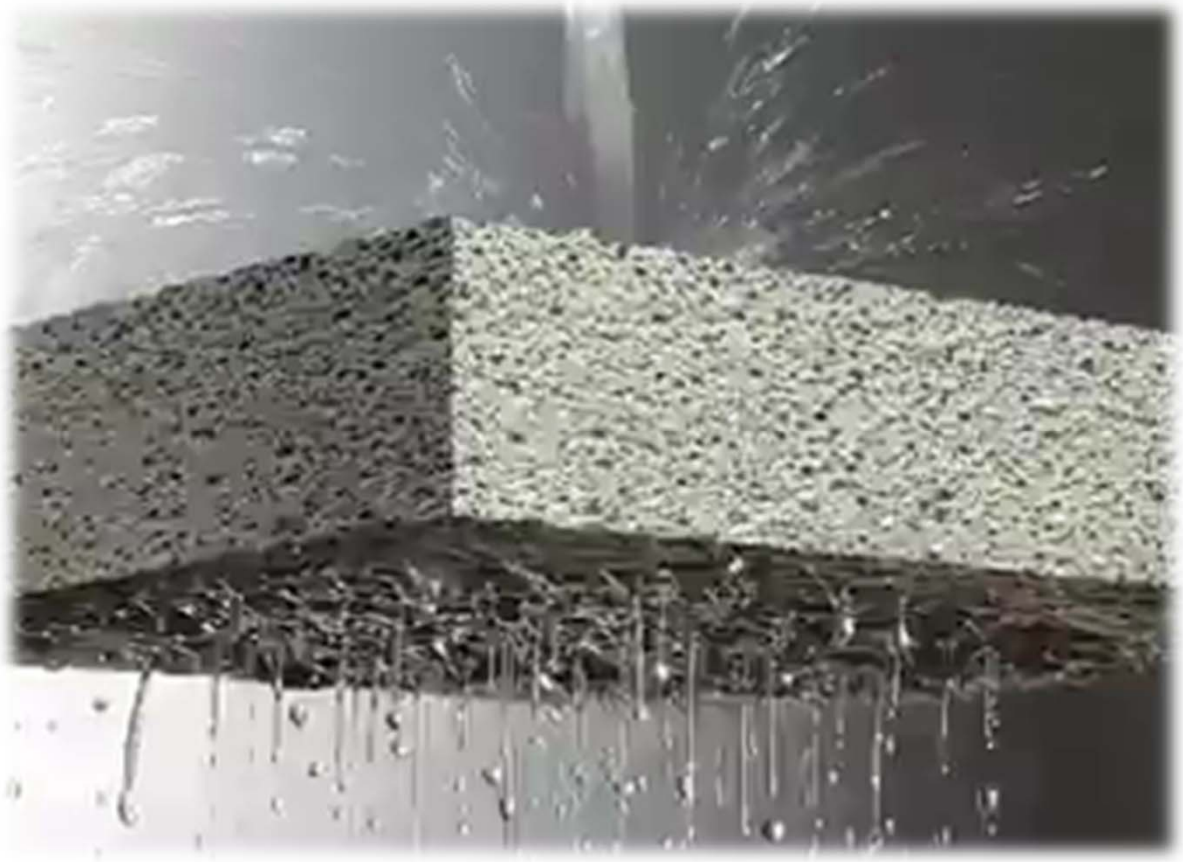
Gas Pipe Line Abandonment
Atlanta Gas Light (AGL)

- 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/m^3
- Non-pervious

**Information provided by*
Gibson Grouting Services, Smyrna, GA

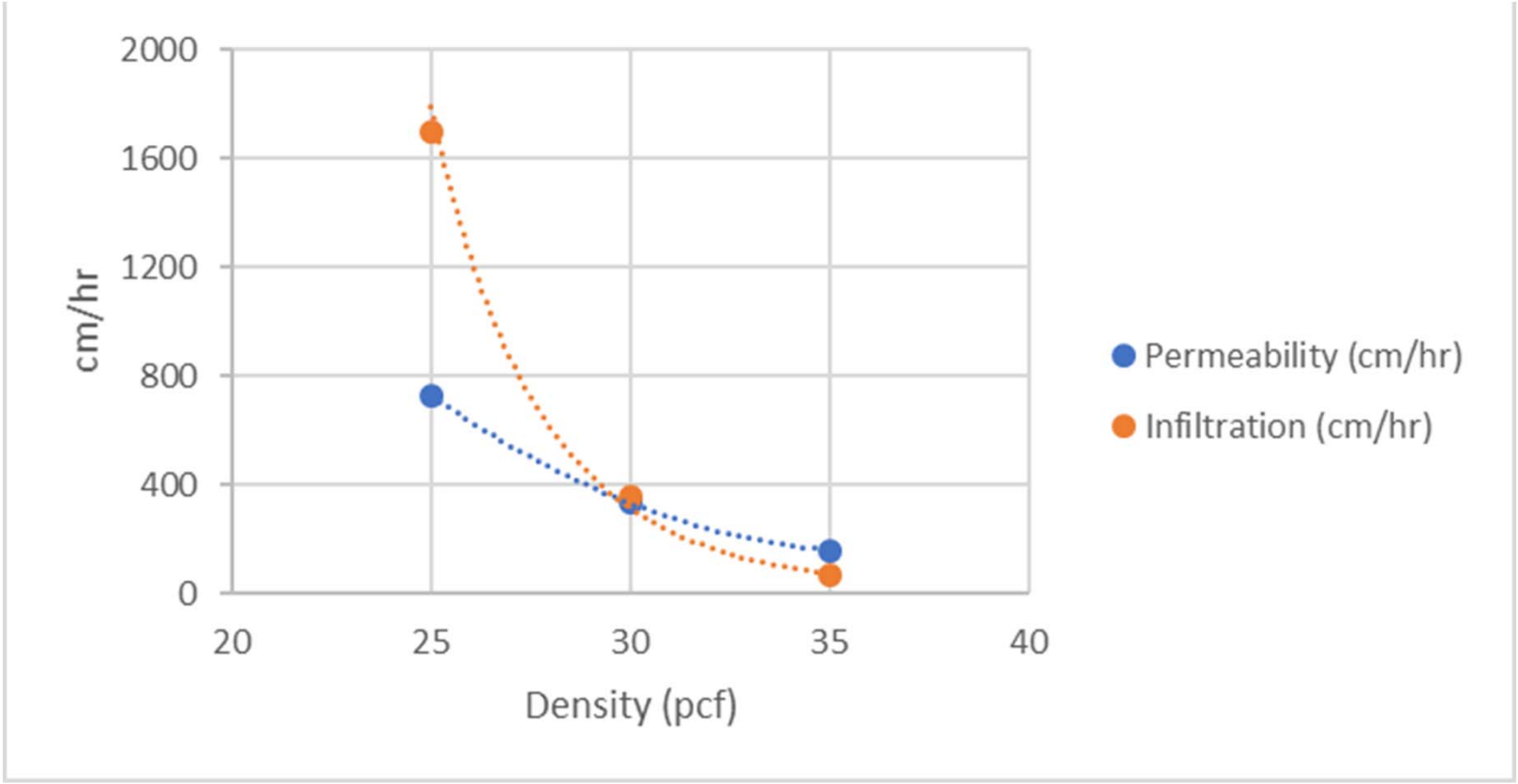
Permeable Low Density Cellular Concrete



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

PERMEABILITY OF CELLULAR CONCRETE

Observation of Permeability 24 hours after placement

**Information provided by CellFill, Grove, OK*

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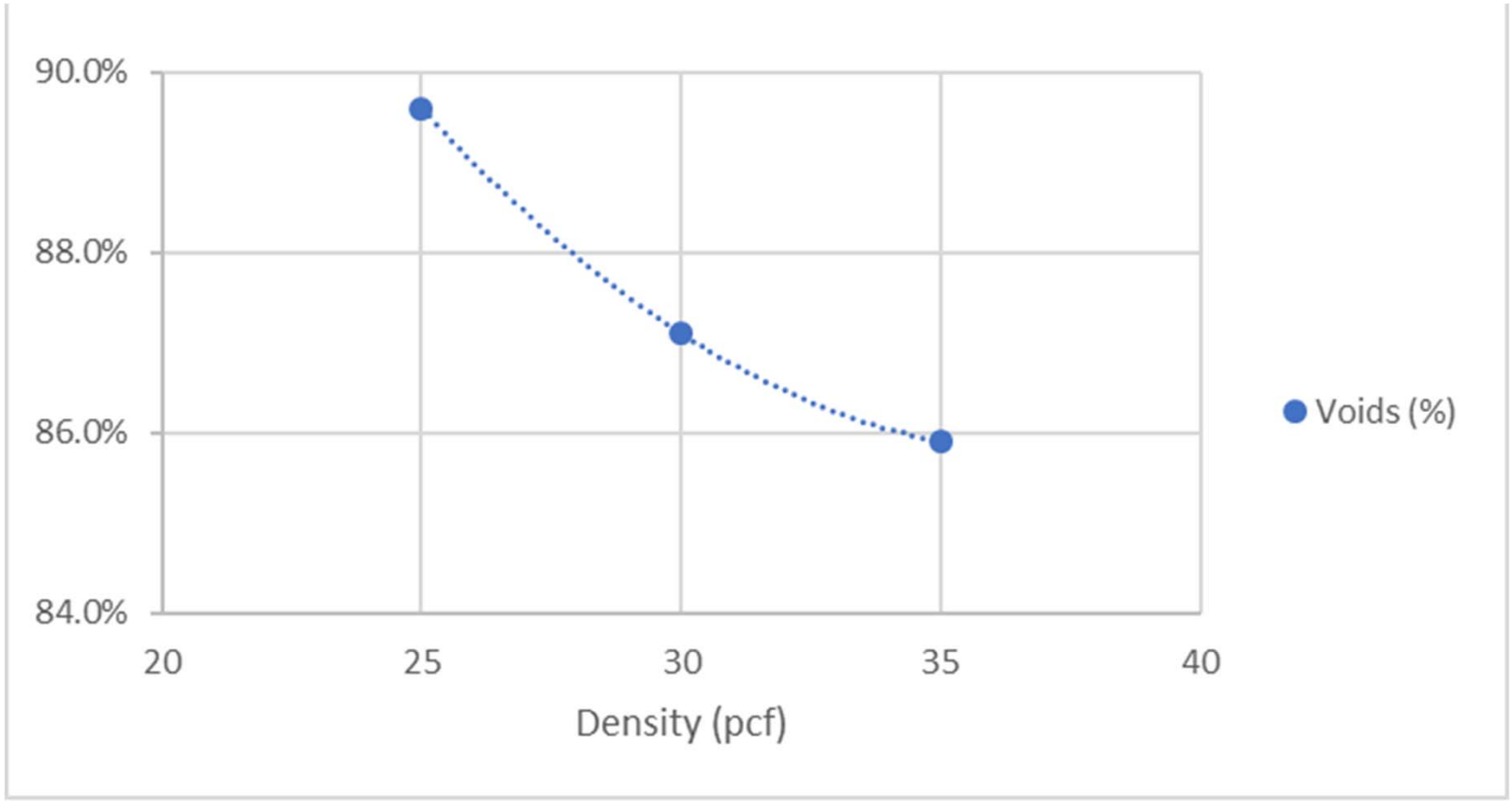
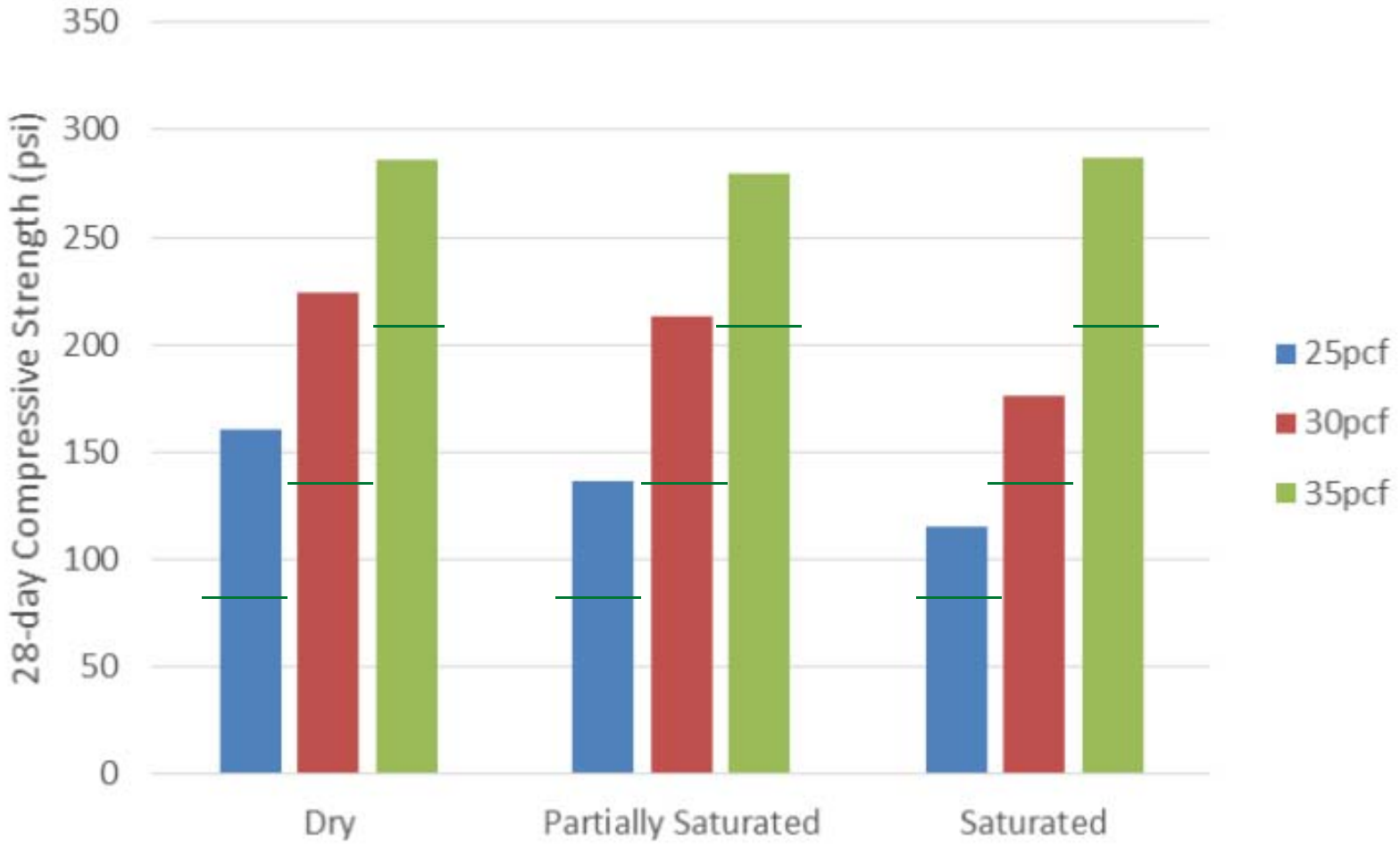
VOID FACTORS OF PLDCC



** University of Missouri, J.T. Kevern

PLDCC Compressive Strength - UMKC



** University of Missouri, J.T. Kevern

Abandonment of Roosevelt Ave Drawbridge Counterweight Well Pits

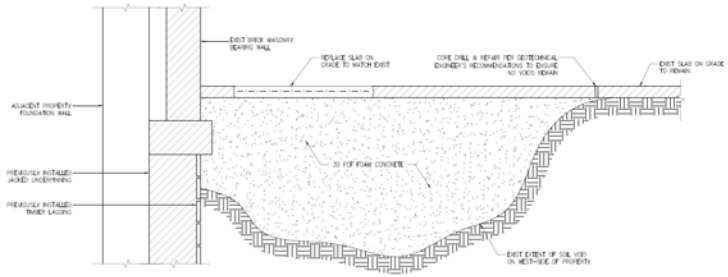
- Rapid installation without disturbing traffic pattern
- Minimize bearing pressure

**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



1 SLAB RESUPPORT DETAIL

THE CHAPEL, GALVEZ ST., NEW ORLEANS, LA

*Information provided by CellFill, Grove, OK

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USE CELLULAR CONCRETE FOR SUBGRADE MODIFICATION WHEN EXISTING SOILS ARE UNDESIRABLE

Cellular Concrete Advantages

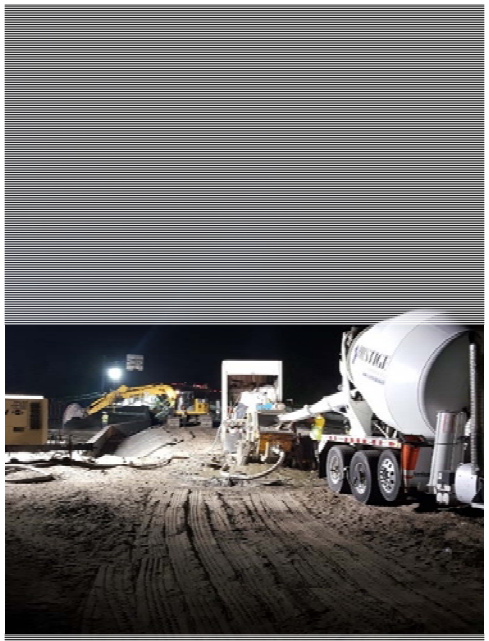
- Reduce Vertical Dead Loads
- Increase Strength/Stability with Minimal Weight
- Improve Seismic Stability
- Reduce Settlement Potential
- Increase Bearing Capacity
- Insulating

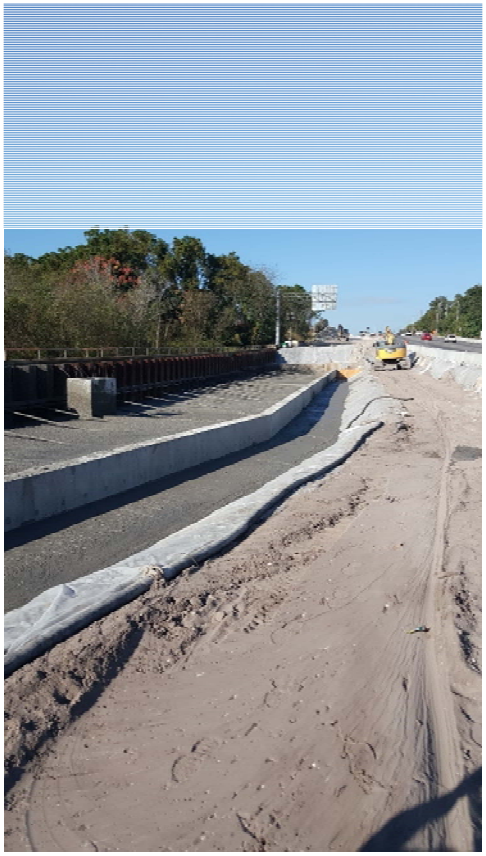
CELLULAR CONCRETE USED TO REPLACE UNSTABLE SOILS AT THE UNIVERSITY OF CONNECTICUT

- Football stadium constructed on unstable soils
- Lightweight Cellular Concrete sub-base equally distributed the loads
- 40,000 yds (30,600 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*

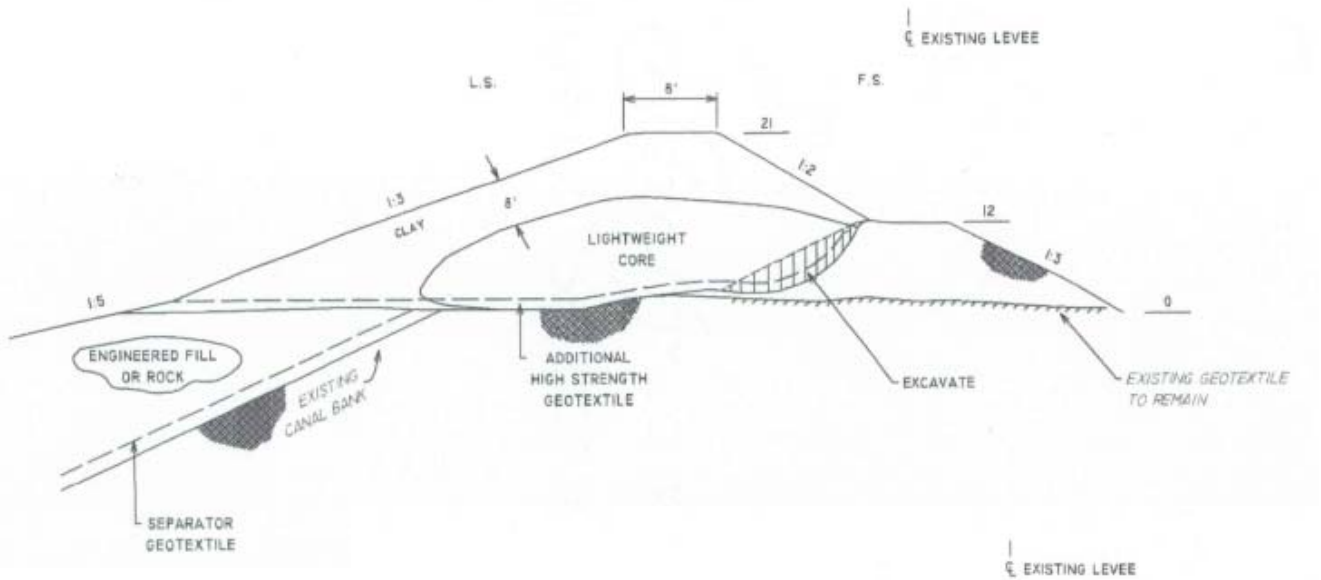
SR 50, Ocoee, FL

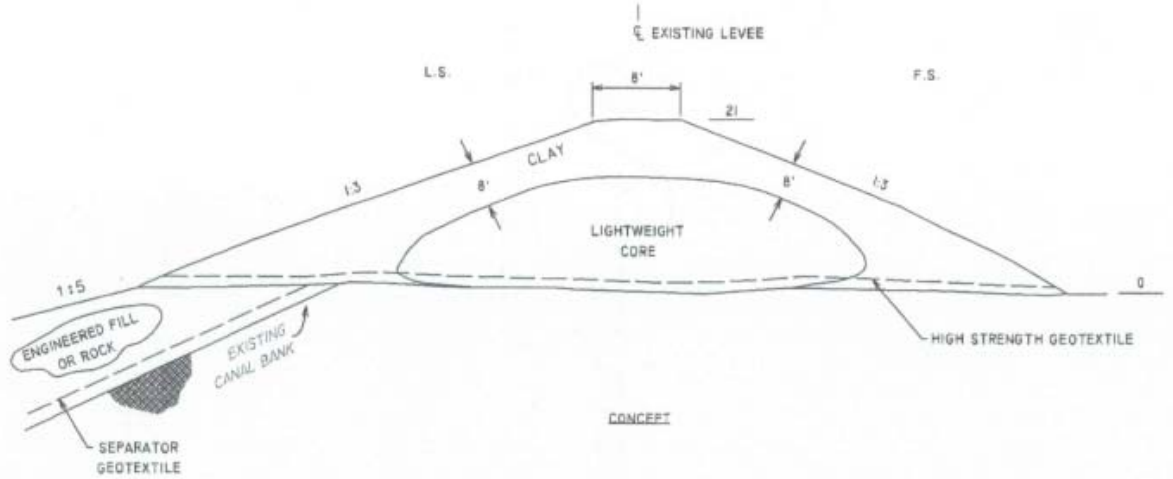




**Information provided by CDM Smith & MixOnSite*

LIGHTWEIGHT CORE IN LEVEE APPLICATION





Louis Armstrong Airport
New Orleans, LA

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Louis Armstrong Airport
New Orleans, LA

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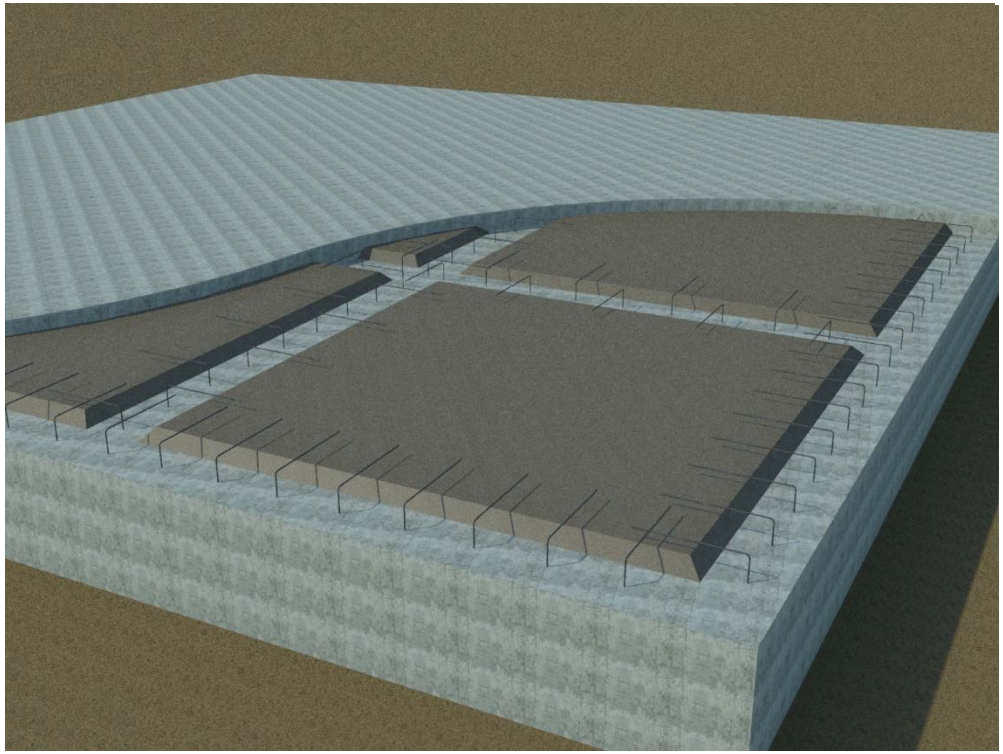
Using Cellular Concrete with Driven Piles Increasing the Elevation Needs



- 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

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

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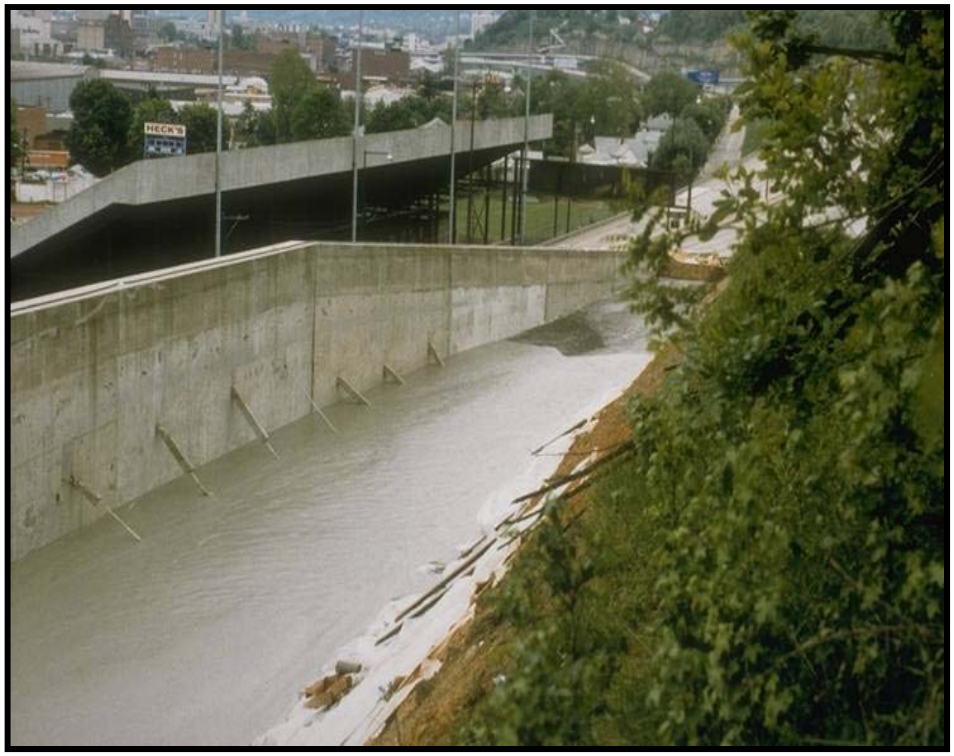
CELLULAR CONCRETE IS IDEAL RETAINING WALL BACKFILL

Cellular Concrete Advantages

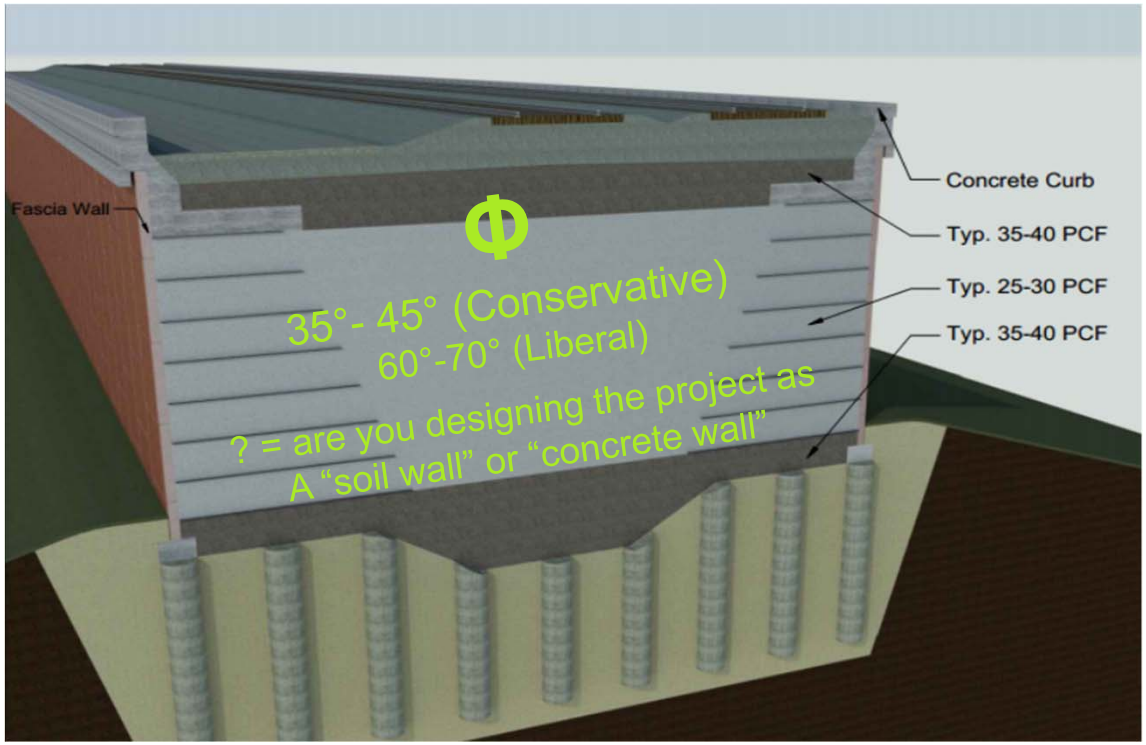
- Reduce Lateral Load
- Ease of Placement
- Increased lift heights
- Reduces schedule impact
- Allows for design flexibility
- Engineered Permeability



SEGMENTAL WALL CONFIGURATION

Segmental Wall Configuration

STRAPPING & INTERNAL ANGLE OF FRICTION



SR 542, BELLINGHAM, WA

- Vertical Facia walls >50’
- Shotcrete over the facia walls

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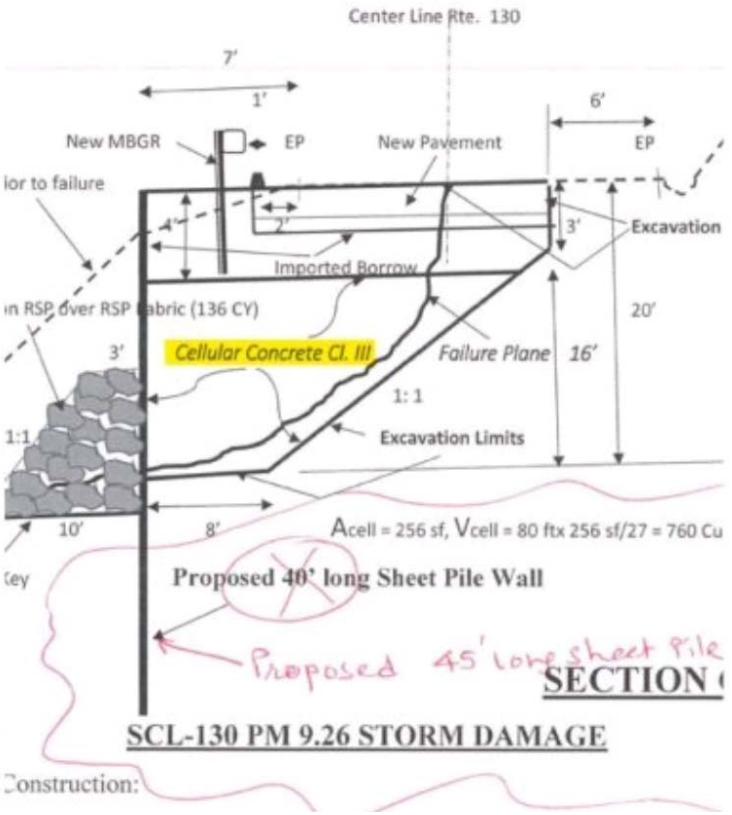
Slope Stabilization with Cellular Concrete



**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

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Flowable & Self Compacting

GeoThermal Model – Utility Protection

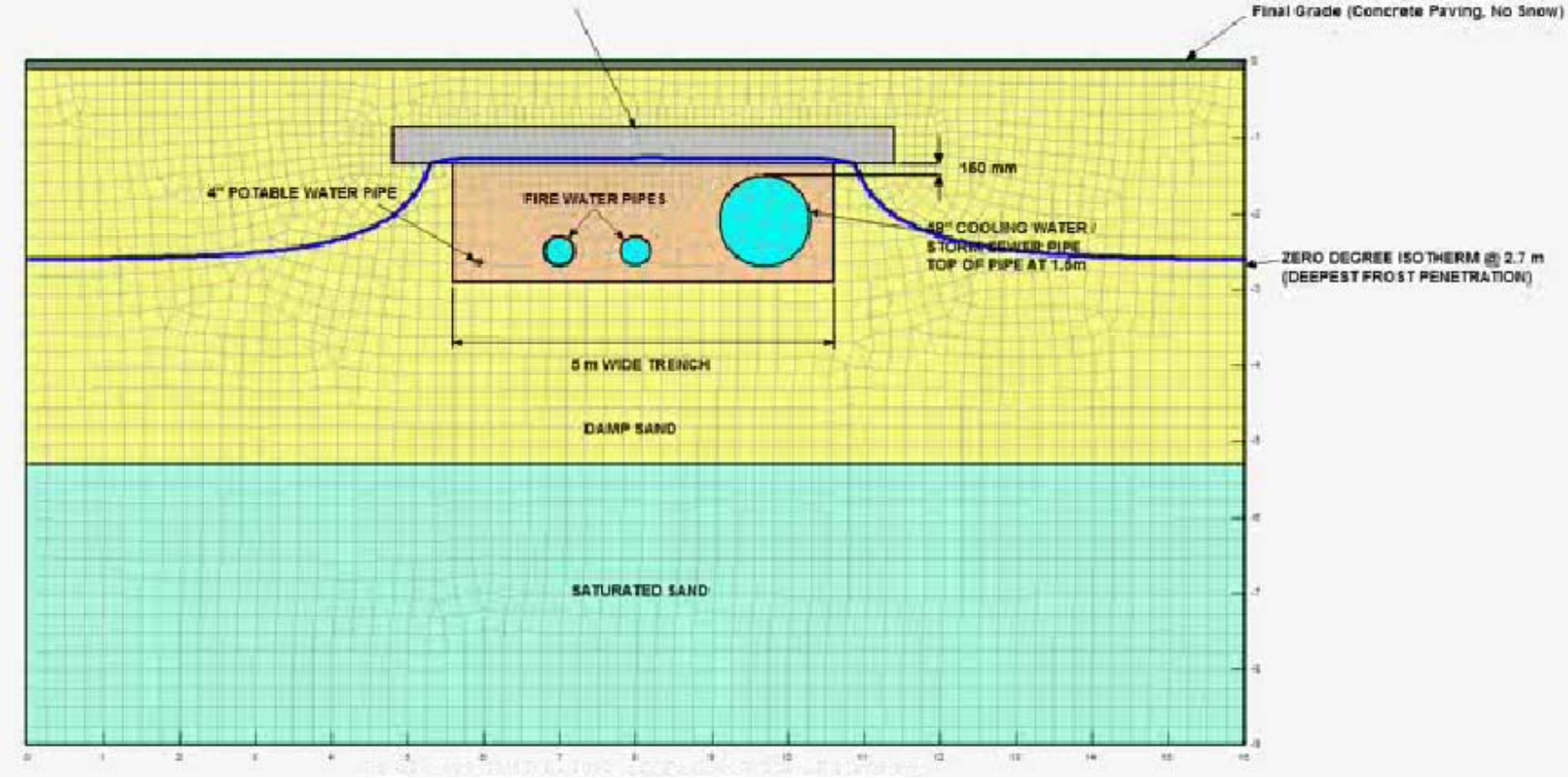


**Illustration provided by Cematrix

IDENTIFY BURIED UTILITIES WITH A DYE

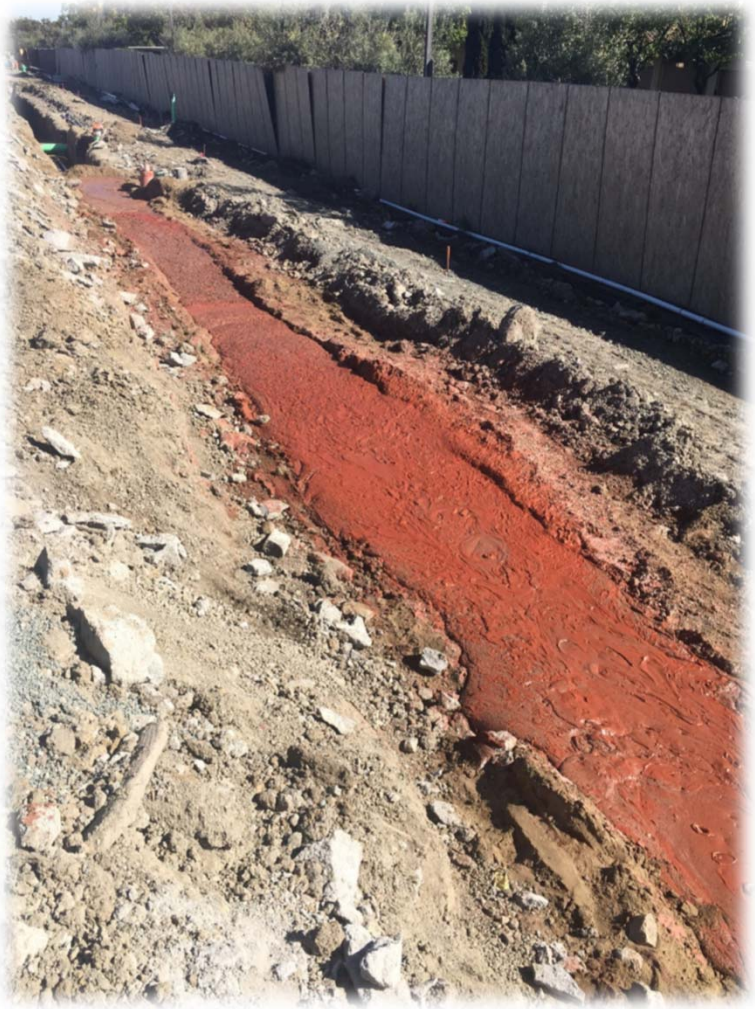


Photo Courtesy of Throop Cellular Concrete

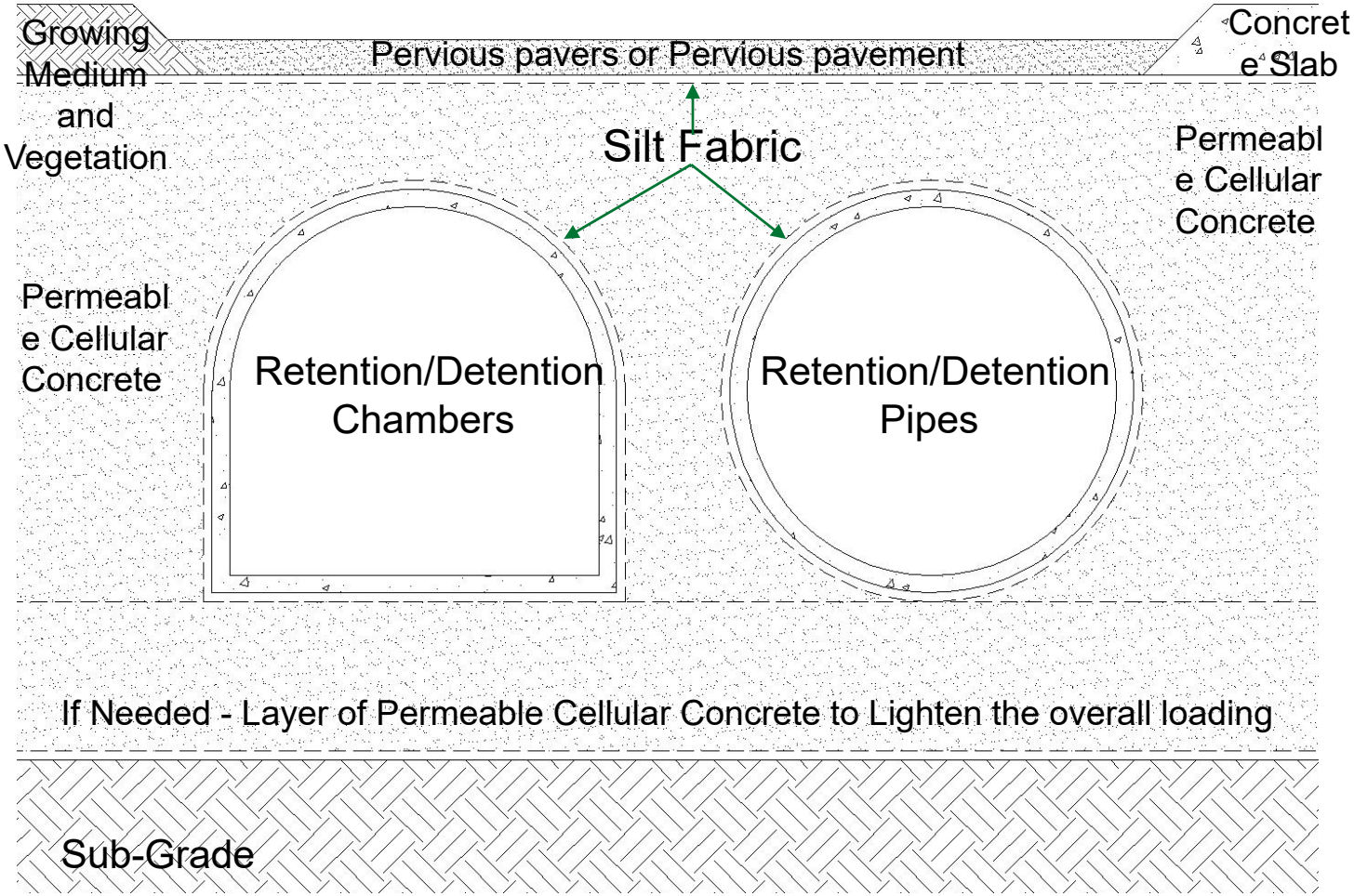
- clear indicator for future operators
- Different colors can be used
  - Red - fiber optics or high voltage lines
  - Blue – water lines
  - Yellow – sewer lines

Fully Excavatable & Versatile

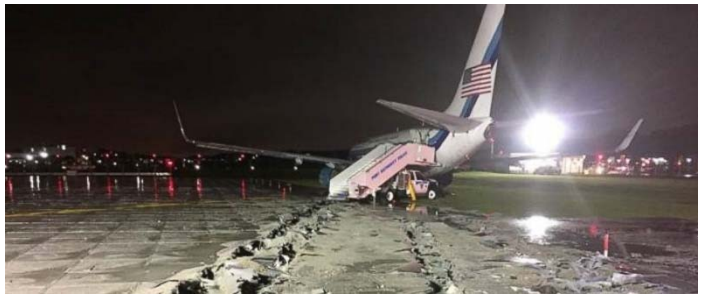
FULLY EXCAVATABLE & VERSATILE

**Information provided by Cell-Crete, Monrovia, CA*

INFILTRATION/EXFILTRATION SYSTEMS



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

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<u>No One Foam Does it All</u>

We can customize our products to meet your project needs