Low-Density Cellular Concrete (LDCC)

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Prepared 1/2019

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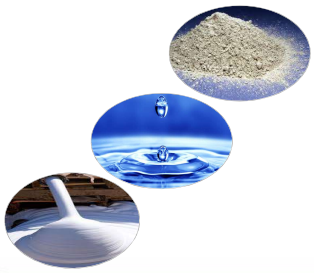
Low-Density Cellular Concrete (LDCC) is defined by ACI 523 as...

- 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.



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LDCC 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

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Conforms to ACI industry standards

Types of Foam

Preformed	Agitated
Produced by Foam Generator	Produced by the mixing action of a concrete mixer
ACI 523	ACI 229
Cellular Concrete	CLSM

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

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Keep in Mind.....

- Lightweight Cellular Concrete (LDCC)
  - Is designed to replace traditionally compacted backfill
  - It is not designed to be the driving or wearing surface
- Flowable & Self-Compacting
- Rapidly Placed

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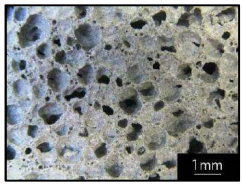
LDCC pore structure when cured



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.

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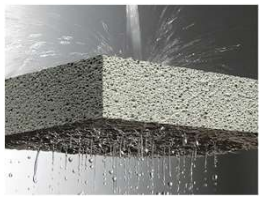
Permeable & Non-Permeable LDCC



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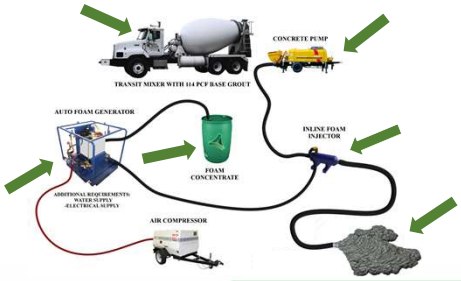
cellular concrete batching process



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Production of LDCC 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

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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	0.66
45	721	450	3.10	787	467	47.2	233.4	16.7	0.62
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

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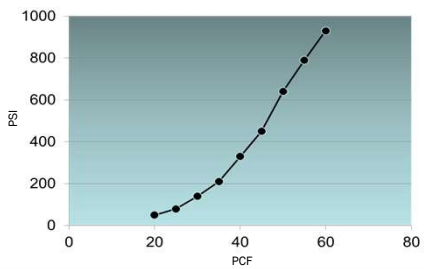
Typical Strength curve of cellular concrete



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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"

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Quality Control is Always Measured in the field



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Compressibility testing on LDCC validates ability to resist bubble collapse from pressure

Compressibility device to evaluate stability of LDCC

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 LDCC level was 12 inches at zero pressure

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

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The LDCC fully rebounded to the original fill height

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


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

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

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Advancements

Foam technology has made huge advancements with a very stable bubble

- 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
  - Lift of 35' has been achieved
  - Pumping distance increased to more than 16,000 feet
  - Permeability is also an option
  - Thicker material
  - Compatibility with fly ash / slag cement

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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

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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 horizontally


Can accommodate any diameter pipe

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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

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Gravity Sewer Annular Fill
Kaneohe Kailua Tunnel, Honolulu, HI

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Gravity Sewer Annular Fill
Kaneohe Kailua Tunnel, Honolulu, HI

"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

- 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

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

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US61 & Greenwell Springs Rd
Baton Rouge, LA

*Information provided by CARVE, Grove, OK

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Utility/Tunnel Abandonment

*Information provided by Mainmark, Australia

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San Pedro Fuel Depot (UST Tank Farm)

- UST Abandonment project – largest volume LDCC project known.
- Was used to receive, store and distribute diesel and jet fuels for military use in California, Arizona and Nevada.

*Information provided by CellCrete, Monrovia, CA

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Permeable Low-Density Cellular Concrete (PLDCC)

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Coefficient of Permeability k (cm/sec) (log scale)

	10^{2}	10^{1}	1.0	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}
Drainage	Good					Poor				Practically Impermeable		
Backfill types	Clean gravel		Clean sands, clean sand and gravel mixture, **PLDCC**			Very fine, sand, organic and inorganic silts, mixtures of sand silt and clay, glacial till, stratified clay, **LDCC**				"Impermeable" soils, e.g., homogenous clays below zone of weathering		

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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

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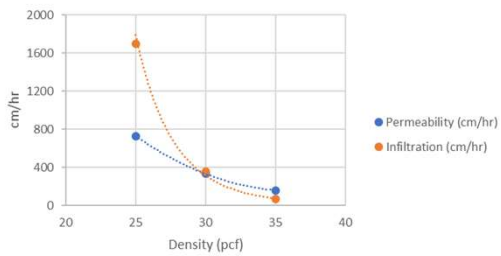
PLDCC Permeability / Infiltration



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Permeability of Cellular Concrete

Observation of Permeability 24 hours after placement

*Information provided by CellFill, Grove, OK

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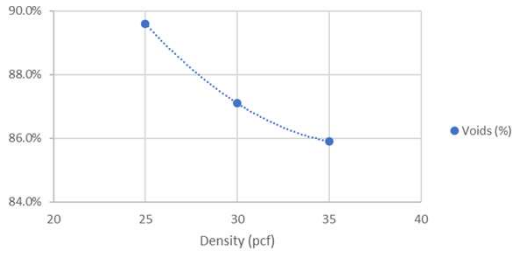
Void Factors of PLDCC



** University of Missouri - Kansas City, J.T. Kevern

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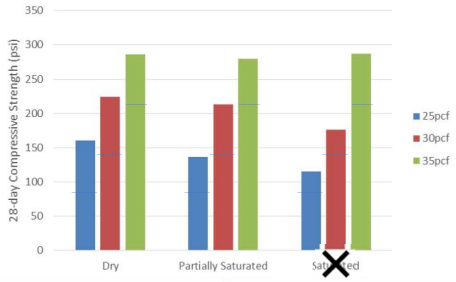
PLDCC Compressive Strength



** University of Missouri - Kansas City, J.T. Kevern

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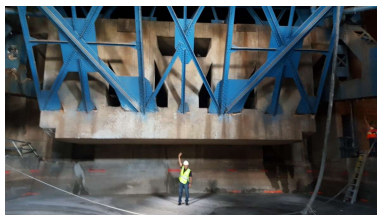
Abandonment of Roosevelt Ave Drawbridge Counterweight Well Pits



- Rapid installation without disturbing traffic pattern
- Minimize bearing pressure

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

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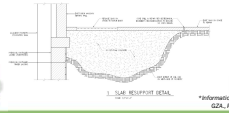
Slab Support South Street Landing, Providence, RI



*Information provided by EZA., Providence, RI

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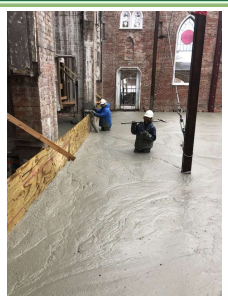
The Chapel, Galvez St. New Orleans, LA



*Information provided by Cellfill, Grove, OK

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- 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

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Use cellular concrete for subgrade modification when existing soils are undesirable

LDCC/PLDCC Advantages

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

SR 50, Ocoee, FL

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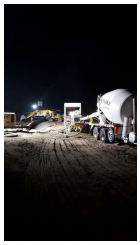
SR 50, Ocoee, FL



*Information provided by CDM Smith & MixOnSite

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

Using permeable 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

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River scouring embankment on I-29 threatened safety of motorists

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I-29/I-80, Council Bluffs, IA

- 113,900 yd³ 32pcf LDCC
- ± 1,500 yd³ /day

*Information provided by MixOnSite, Buffalo Grove, IL

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Louis Armstrong Airport New Orleans, LA

*Project by MixOnSite USA Inc., Buffalo Grove, IL

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Louis Armstrong Airport
New Orleans, LA



*Project by MixOnSite USA Inc., Buffalo Grove, IL

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What about sedimentation…clogging?

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Louis Armstrong Airport
New Orleans, LA


*Project by MixOnSite USA Inc., Buffalo Grove, IL

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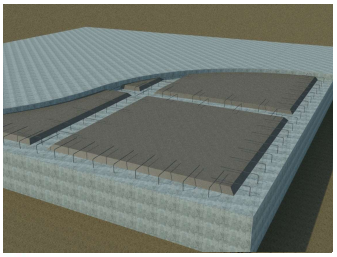
Using Cellular Concrete with Driven Piles Increasing the Elevation Needs



- 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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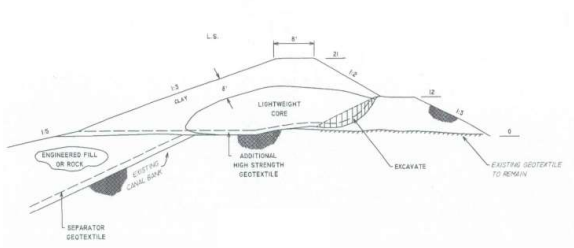
Lightweight Core in Levee Application



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- Green Roof Applications

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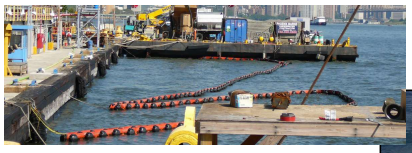
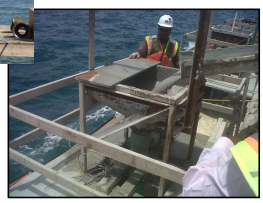
The fluidity of LDCC makes it favorable for tremie applications



- 65+ pcf density
- material moved 35' underwater



*Photos provided by Others

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LDCC/PLDCC is ideal retaining wall backfill

LDCC/PLDCC Advantages

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

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Segmental Wall Configuration

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Segmental Wall Configuration

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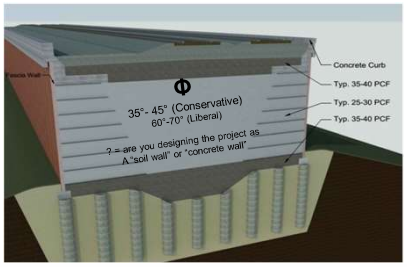
Strapping & Internal Angle of Friction



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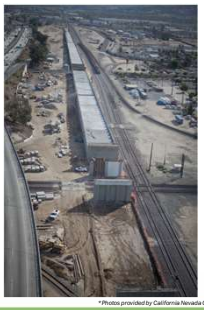
Grade Separation for UP RR Mainline



*Photos provided by California Nevada Cement Association

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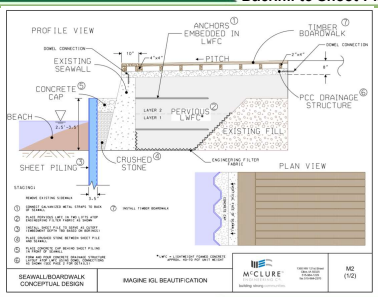
Backfill to Sheet Pill Wall with PLDCC



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Caltrans, Route 128, Napa County

*Information provided by CalCrete, 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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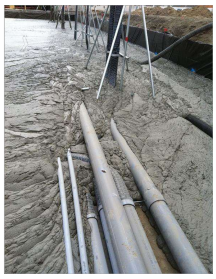
Duct Bank and Utility Trench Backfill



- Flows into every nook and cranny
- No vibration or compaction required
- Easily excavatable for maintenance

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GeoThermal Model – Utility Protection

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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

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Fully Excavatable & Versatile

Photo Courtesy of Throop Cellular

Photo Courtesy of A-Deck

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Fully Excavatable & Versatile

*Information provided by Cell-Crete, Monrovia, CA

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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

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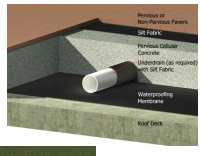
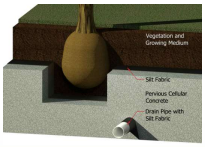
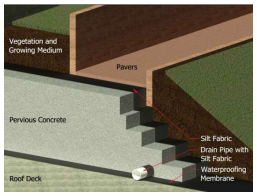
PLDCC Green Roof Applications







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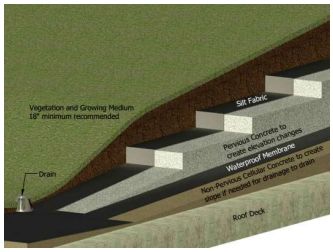
Green Roof Elevation Changes



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

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- Other Applications

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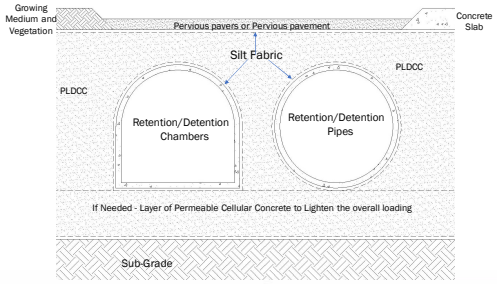
Infiltration/Exfiltration Systems



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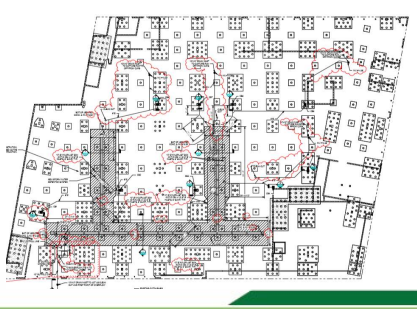
2424 Tulane Stormwater Detention System New Orleans, LA



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2424 Tulane Stormwater Detention System New Orleans, LA

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What conclusions can we draw about LDCC/PLDCC?

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

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Contact Information

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