Greg Halsted is the Manager of Pavements and Geotechnical Markets for the Portland Cement Association (PCA).
- He is responsible for expanding the market share for use of portland cement in all paving and engineered cement applications.
- Greg has over 35 years of engineering experience, including 17 with the Georgia DOT and 18+ with cement and concrete associations.
- He has a B.S. degree in Civil Engineering Technology from Southern Polytechnic State University and is a registered professional engineer.
- Greg has a strong background in pavement materials, design, construction, and testing, as well as cement and concrete promotion, education, and advocacy.

INTRODUCTION

• Introduction
• Applications
• LCC - Yesterday
• LCC - Today
• LCC - Tomorrow
• Questions
Cement-Based Paving/Geotech Materials

- Roller Compacted Concrete
- Precast Concrete
- Full-Depth Reclamation
- Soil-Cement
- Cement-Treated Base
- Pervious Concrete
- Cement-Based Subgrade
- Cement-Stabilized Subgrade
- Cement-Modified Soil
- Full-Depth Reclamation

Lightweight Cellular Concrete

- Lightweight cellular concrete, or LCC, is a mixture of portland cement, water, and air that can act as a lightweight, strong, durable, and inexpensive soil or fill replacement for geotechnical applications.
- LCC saves time, money, and natural resources by replacing aggregates with air bubbles in numerous project applications.

Pore Structure when Cured

- Cementitious materials encapsulate the air bubbles, then dissipate leaving a void structure as a replacement to traditional aggregate.
- Cellular concrete differs from conventional concrete in the methods of production, the density of the material, and the extensive range of uses.

American Concrete Institute Standards

- Methods of Foam Incorporation
  - Preformed (produced by a foam generator)
  - Agitated (produced by the mixing action of a concrete mixer)

  - ACI 523
  - ACI 229

  - Low-Density Cellular Concrete (LDCC)
  - Controlled Low-Strength Material (CLSM)
LCC as Defined by ACI 523

“Concrete made with hydraulic cement, water, and preformed foam to produce a hardened material with an oven dry density of 50 lb/ft³ (800 kg/m³) or less.”

Density and Strength Ranges per ACI

<table>
<thead>
<tr>
<th>oven-dry density</th>
<th>usual range of compressive strength at 28 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>lb/ft³</td>
<td>kg/m³</td>
</tr>
<tr>
<td>20 to 25</td>
<td>320 to 400</td>
</tr>
<tr>
<td>25 to 30</td>
<td>400 to 480</td>
</tr>
<tr>
<td>30 to 35</td>
<td>480 to 560</td>
</tr>
<tr>
<td>35 to 40</td>
<td>560 to 640</td>
</tr>
<tr>
<td>40 to 50</td>
<td>640 to 800</td>
</tr>
</tbody>
</table>

Typical Guidelines for LCC Mixes

- Designed to replace traditionally compacted backfill
- Not designed to be the driving or wearing surface, nor to be used in place of a structural concrete design

Important to Remember about LCC
APPLICATIONS

Typical Applications

- Wall configuration backfill
- Annular fills for tunnels and culverts
- Tunnel abandonment
- Fill for underground utilities
- Void fills
- Soft soil remediation
- Slope stabilization
- Tanks and pipeline abandonment
- Fill around conduits and pipes

Vertical Fascia Walls

Grade Separations

50-foot vertical fascia walls
Retaining Wall Backfill

Culvert Applications

Backfill around Utilities

Slope Stabilization
Utility Trench Backfill and Void Fill

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

A Brief History of LCC

- 1900s: Originally invented in Europe
- 1950s: ACI Guidelines and USACE tested
- 1990s: Widely approved by DOTs and other agencies

LCC - YESTERDAY

A Brief History of LCC

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STRUCTURE® Magazine (December 2014)

- Cellular Concrete
- Scott Taylor, P.E., President, Throop Cellular Concrete
- “…the civil/structural engineering world is starting to realize the vast benefits of cellular concrete.”
- “We are seeing the variety of uses expanding daily by enthusiastic and creative engineers everywhere.”
- “Many agencies and engineers are learning about the benefits, and the cellular concrete industry hopes the product will soon be a standard product in all 50 states.”
Cellular Concrete Market (2015 - 2020)

- "The infrastructure sector is estimated to account for the largest market share in the cellular concrete market and this trend is projected to continue..."
- "Cellular concrete is replacing the traditional materials in the construction industry and it is easily available in the market, owing to their lightweight and better-quality properties."

ASTM Test Methods for Quality Assurance

- **ASTM C869**
  "Standard Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete"

- **ASTM C796**
  "Standard Test Method for Foaming Agents for use in Producing Cellular Concrete using Preformed Foam"

- **ASTM C495**
  "Standard Test Method for Compressive Strength of Lightweight Insulating Concrete"

Types of On-Site Installation Equipment

- high production self-contained unit for larger volume projects
- mobile mixing units
- self-contained trailer
- wet batch system
**States with Specifications for LCC**

- California Special Provision – 19-10 “Cellular Concrete Lightweight Embankment Material”
- Colorado Section 206.02(a)(2) “Structure Backfill (Flow-Fill)”
- Florida Section 121 “Flowable Fill”
- Illinois Section 1029 “Cellular Concrete”
- Indiana Section 216 “Cellular Concrete Fill, CCF”
- Iowa Special Provision – 150271 “Lightweight Foamed Concrete Fill”
- Minnesota Section 2519 “Cellular Concrete Grout - Controlled Low Strength Material (CLSM)”
- Missouri Section 621 “Flowable Backfill”
- Nevada Section 207.02.02 “Slurry Cement Backfill”
- New York Section 204-1.02 “Lightweight Concrete Fill”
- Oregon Special Provision – 00444 “Low Density Cellular Concrete”
- Rhode Island Section 603 “Controlled Low Strength Material (CLSM)”
- South Carolina Section 210 “Flowable Fill”
- Texas Special Provision – 00310 “Low Density Cellular Concrete for Microtunnel Backfill”
- Washington Section 2-09.311E “Backfilling”
- Wyoming Supplementary Specification – 600D “High Density Polyethylene (HDPE) Liner Pipe”

**Alternative Terminology**

**LCC - TOMORROW**
Transit Mixers and LCC

Currently in Development

- Guide to Lightweight Cellular Concrete for Geotechnical Applications
- Technical Advisory Committee (TAC) effort
- Information on common uses and conceptual guidance, as well as design guidelines, for construction professionals / design engineers
  - Chapter 1 – Introduction
  - Chapter 2 – Physical Properties
  - Chapter 3 – Geotechnical Design Considerations
  - Chapter 4 – Mixture Design
  - Chapter 5 – Construction
  - Chapter 6 – Inspection, Testing, and Maintenance
- Specifications for construction of LCC fill

Acknowledgements

- Aerix Industries
- California Nevada Cement Association
- California State University – Fullerton
- Cell-Crete Corporation
- Cellular Concrete Inc.
- CEMATRIX
- Elastizell Corporation of America
- National Concrete Pavement Technology Center
- The Reinforced Earth Company
- Richway Industries, Ltd.
- RW Henn LLC
- Scott Taylor
- University of Illinois at Urbana-Champaign
- University of Utah

Concluding Comments

- Broad range of densities
- Economical
- Versatile
- Easily placed
- Rapid installation
- Durable
- Excavatable
- Permanent and stable
- Environmentally friendly