# NIST Low Carbon Cements and Concretes Consortium

## Objectives

1. Discuss the contributions that cements and concretes have on carbon emissions.
2. Identify potential methods of reducing the carbon footprint of concretes and cements, as well as associated challenges.
3. Define the role of NIST’s Low Carbon Cements and Concretes Consortium and how to get involved.
Concrete is a Massive Contributor to Carbon Emissions

90% of Carbon Emissions from Concrete can be attributed to Cement


Most Consumed Materials in the World

Extensive use of concrete causes it to be one of the largest sources of greenhouse gas emissions.

Transportation 29%  
Electricity 28%  
Industry 14%  
Commercial & Residential 12%  
Agriculture 9%  
Concrete 8%
How does cement production emit CO2?

Traditional Portland Cement Production

50%
Chemical reaction that occurs during the production of clinker.

40%
Burning of fossil fuels to heat the kilns that make clinker.

10%
Material sourcing and transport.


A Change is Needed

Carbon Neutral by 2050
### Methods to Reduce Concrete’s Carbon Footprint

<table>
<thead>
<tr>
<th>Optimized Manufacturing</th>
<th>Alternative Methods of Clinker Production</th>
<th>Reduced Use of Clinker in Cement Production</th>
<th>Reduced Portland Cement Content in Concrete</th>
<th>Efficient Design Structural Design</th>
<th>Carbon Capture, Utilization, and Storage</th>
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<tr>
<td>• Alternative Energy Sources</td>
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<td>• Increased Kiln Efficiency</td>
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<td>• Limestone Alternatives (calcium silicates, magnesium silicates)</td>
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<td>• Portland Limestone Cement (Type 1L)</td>
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<td>• Supplementary Cementitious Materials (SCMs)</td>
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<td>• Optimized Aggregate Grading</td>
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<td>• Optimize Performance</td>
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<td>• Avoid Overdesign</td>
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<td>• UHPC</td>
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<td>• Capture CO₂ from production</td>
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<td>• CO₂ Concrete Curing</td>
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<td>• Mineral Carbonation</td>
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<tr>
<td>• Recarbonation</td>
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### Safety and Carbon Neutrality Must Go Hand-in-Hand

Safety and protection of human life is non-negotiable.

- Environmental Risk
- Financial Risk
## Where Does NIST Come In?

### NIST’s Mission

To promote U.S. innovation and industrial competitiveness by advancing **measurement science, standards, and technology** in ways that enhance economic security and improve our quality of life.

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### Measurement Challenges

<table>
<thead>
<tr>
<th>Carbonate Content</th>
<th>Rate of Recarbonation</th>
<th>Durability &amp; Performance</th>
<th>Effectiveness of Carbon Capture</th>
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<tr>
<th>Environmental Product Declarations (EPDs)</th>
<th>Life Cycle Cost Analysis (LCA)</th>
<th>Scalability</th>
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</table>
Building Measurement Confidence

- Mutual Recognition Agreements
- Accreditation Bodies
- Inspection | Testing | Certification
- Products | Personnel | Management Systems
- Documentary Standards
- Measurement Standards | Standard Reference Materials | Standard Reference Data
- International System of Units (SI)

The Role of Standards

- Support Emergence and Growth of New Technologies
- Enhance Confidence in the Quality and Reliability of Low Carbon Cements and Concretes
- Accelerate market adoption
NIST Consortiums Convene Diverse Stakeholders for a Common Goal

Stakeholders
- Industry
- Government
- Academia
- Product Developers
- Consumers

Outputs
- Reference Standards
- Documentary Standards
- Frameworks
- Guidelines
- Best Practices
- Roadmaps
- Data

Impacts
- Economic Security
- National Security
- Future Innovation
- Enhanced Quality of Life

First Consortium In-Person / Hybrid Meeting

- July 20-21, 2023 in Boulder, CO
- 30 In-Person Attendees
- 10 Virtual Attendees
Low Carbon Cements and Concretes Consortium

Membership by The Numbers:

- **46** Member Organizations
- **~4** Organizations in Process
- **10+** Have Expressed Interest

Current Consortium Members

- ASCC
- Argos
- Ash Grove
- Biomason
- Blue Planet Systems
- Boise State U.
- Brimstone
- Building Transparency
- Buchi
- Bureau of Reclamation
- Carbon Limit
- CarbonBuilt
- CarbonCure
- Continental Cement Company
- CMHA
- DOE
- DOT-FHWA
- EPA
- Fortera
- Georgia Tech
- Georgetown U.
- Heidelberg Materials
- Iowa State U.
- Kiewit
- Kline Consulting, LLC
- MIT-Concrete Sustainability Hub
- NRMCA
- NIBS
- NEU
- NSF
- Outside the Box Mtls
- PCA
- Purdue U.
- Solidia Technologies
- Spherical Block, LLC
- Sublime Systems
- Sutter Engineering
- St Mary’s Cement
- UCLA
- Ultra High Materials, Inc
- U. of Miami
- U of Texas- Arlington
- USACE
- WAP Sustainability
- WRI
- WR Meadows

Low Carbon Cements and Concretes Consortium

Steering Group

- Quantifying Carbonates Working Group
  (Elisabeth Mansfield)
- Performance Specifications Working Group
  (Maria Knake)
- Implementation of Innovative Materials
  (Maria Knake)
- Carbon Accounting Working Group
  (Josh Kneifel)
Quantifying Carbonates

Accomplishments

- Draft Test Method for Determination of CO2 in Cements - currently undergoing informal review by ASTM Subcommittee C01.23
- Measurement Context Paper - Written by NIST Staff and Consortium Members, characterizes the background, environment, and requirements for specific quantitative techniques to measure the carbon content of cementitious materials
- Development of six NIST Benchmark Materials

Current Projects

- Measuring CO2 Sequestration in Hardened Concrete (Craig Walloch, CMHA)
  Challenges:
  - Background attributed to aggregate content is almost as large as the signal
  - Measurement of systems that cure by carbonation
  - Material variability
  - Exposure conditions

Prescriptive Vs. Performance Specifications

Prescriptive

- Exact Requirements
- End Result Not Defined
- Composition Defined

Performance

- Desired End Result Described
- Composition Not Defined

Most cement specifications include elements of both.
Performance Specifications Wish List

What should be included in an ideal performance-based low carbon cement specification?

- Green House Gas Emissions Performance
- Functional Performance

Defining Low Carbon Cement and Concrete

A common language to facilitate communication and standardization

- Low Carbon Cement
- Low Carbon Concrete
- Carbonation (of Concrete)
- Recarbonation (of Concrete)
PROBLEM STATEMENT
The implementation and adoption of innovative materials, technologies, design, and practices to achieve low carbon concrete has lagged behind their availability.

CAUSAL FACTORS
- Education
- Materials
- Processes
- Price
- Measurement
- Safety
- Policy
- Methods
- Carbon Accounting
- Terminology
- Identifying current “real world” issues with using carbon accounting
- Identify areas where greater clarity is needed in carbon accounting / LCA

Ongoing Presentations and Information Sharing
Meeting Schedule

Steering Group
Twice per year and as needed (online)

Working Groups
Once every two months (online)

Full Consortium
ACI Spring Convention
ACI Fall Convention
Standalone Event (1-2 days) in July

Many Hands Make Light Work

No fees.
No proprietary information shared.
CRADA signed by all members.

Reach out to Maria Knake, maria.p.knake@nist.gov
Thank You!

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