Sustainability and How the Industry is Reducing it’s Environmental Impact
By Lori Tiefenthaler and Jay Whitt
Products and Technology: Developing Sustainable Solutions in Our Markets

It is difficult to have the same offering in each market; however, we strive to serve all of our areas with at least one sustainable cement. User of recycled materials (Circular Economy):

- Slag
- Fly Ash

Blended Cements – EcoCem

Low-carbon cement types:

- Portland Limestone Cement (IL) - EcoCem PLUS
- Composite Cements (IT) - EcoCemPLUS
- Slag and Portland (IS)
- Fly Ash and Portland (IP)

Lehigh Cement: Cement and Slag facilities - including JVs

HeidelbergCement 2030 Commitments

“We are committed to fulfilling our share of the global responsibility to keep temperature rise below 2°C, and we will continue to reduce our impacts on air, land and water.”

Ensuring Compliance and Creating Transparency

“We adhere to international human rights, anti-corruption and labour standards and cooperate proactively in a transparent and transparent manner with all our stakeholders.”

Being a Good Neighbour

“We are committed to supporting the social and economic development of our neighboring communities and ensure transparent communication to all our stakeholders.”

Achieving Excellence in Occupational Health and Safety

“We are committed to continuously enhancing the occupational health and safety conditions of our employees, contractors, and third parties.”

Driving Economic Strength and Innovation

“We will ensure sustainable profitability through the effective management of all economic resources and the continuing innovation of products and services.”

Leading the Way to Carbon Neutrality

Our goal is to realize the vision of carbon-neutral concrete at the latest by 2050.
Why PLC? 2030 Sustainability Commitments

Lehigh wants to be a leader in Sustainability.

We have aligned our Sustainability Commitments with the UN Sustainable Development Goals (SDG) enacted in 2015 by the UN General Assembly, which have been adopted by all 193 member states. Their aim is to end extreme poverty, fight injustice and to protect our planet with 17 goals set out for 2030.

For Lehigh: 30% Reduction in Carbon Emissions by 2030

PLC is an immediate strategy that can be implemented to tackle carbon emissions; it’s something that we can do NOW.

Increasing CO2 efficiencies at cement plants (Mitchell’s K4, etc.)

Production and use of PLC is a proactive step that can be taken to promote GREEN BUILDING.

Lower “Global Warming Potential” value for use in EPD’s (Environmental Product Declaration) with PLC

Cement/Concrete Products and Technology: Sustainable Solutions

At least 80% of HeidelbergCement’s Research and Development Investments are Sustainability Driven

- Reduction of clinker content in cement and concrete
- Alternative cementitious systems
- Levers for Lower Carbon Concrete
  - Use of fly ash other recycled fines in cement production
  - Use of fly ash other recycled fines in massive construction pours
  - Use of fly ash other recycled fines in cement production
  - Use of fly ash other recycled fines in massive construction pours

ALTERNATIVE RAW MATERIALS
- Biomass (zero emissions)
- Other fuels
- Waste oil, tires
- RDF
- Sewage sludge
- Wood, paper, carton
- Animal meal, animal fat
- Animal bone meal

Heatcrete® is a special concrete with high thermal conductivity for energy storage.

Powercrete® increases the efficiency of underground power cables with its high thermal conductivity.

Sustainability Evolution – Developing Expertise

Environmental Product Declaration (EPD)

“a transparent, verified report used to communicate the environmental impact (e.g., resource use, energy, emissions) associated with the manufacture or production of construction materials...”

What are the Benefits of EPD’s

- Provide verifiable and transparent information on life-cycle environmental impact data for materials or products
- Allow meaningful comparisons of the environmental performance of materials
- Identify areas for environmental performance improvement, encouraging industry efficiency

Source: FHWA
Environmental Product Declarations (EPD) – What’s Included to Make Them Transparent Reporting of Environmental Impacts - EPD

Updated Cement Industry average in Q1 2021 will have a PLC

Products and Technology: Using Portland Limestone Cement (PLC or Type IL)

EcoCem® PLC is a blended portland cement with up to 15% limestone and as much as 10% less embodied carbon.

Benefits of Using Type IL

<table>
<thead>
<tr>
<th>Concrete Producers</th>
<th>Contractors/Customers</th>
<th>Public</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced Energy impact from cement</td>
<td>Improved Consistency and workability</td>
<td>Fewer CO2 Emissions</td>
</tr>
<tr>
<td>Lower Global Warming Potential (GWP)</td>
<td>&gt; Durability</td>
<td>More Durable Concrete with SCMs</td>
</tr>
<tr>
<td>Better Chemical Control</td>
<td>Particle packing optimized</td>
<td>Cleaner Air</td>
</tr>
<tr>
<td>Synergies with SCMs</td>
<td>Lower Carbon Concrete</td>
<td>Concrete has Lifetime CO2 Uptake</td>
</tr>
</tbody>
</table>

What does PLC do for me?

- The primary advantage is that it allows for a reduction in CO2, typically up to 10%
- PLC is a simple, straight forward switch in your operation; essentially “plug n play”
- Pull OPC powder out of your mix, and replace it with PLC
- PLC provides you an opportunity to “Go Green” and increase your sustainability without spending money on capital investments for specialized systems at your ready mixed concrete plants

Link: [www.concretejustgotgreener.com](http://www.concretejustgotgreener.com)

PORTLAND LIMESTONE CEMENT RESOURCES

Advantages of PLC

https://www.greenercement.com/
PLC or Type IL: Current Status

- Lehigh Cement - Seattle market reaching 100% conversion to PLC
- Department of Transportation in 32+ States have now approved the use of PLC or Type IL cement.
  - IDOT 2013-14
  - FAA
  - US Army Corps of Engineers
- Many Cities and Counties are adopting PLC into their local specifications
- Engineers and Architects have begun adding ASTM C 595 to their specifications
- PLC is being used on many high profile projects, where reducing carbon footprint is part of their goal
- Performance concrete rather than specified concrete is bringing additional value to the owner and contractor
- Combining PLC with recycled products is leading the way in sustainable design.

PLC or Type IL: Current Status

Portland Cement Association: https://www.greenercement.com/

Links to PLC fact sheets, Research Reports and for the Architects, Engineers and Specifiers, there is a link to “How to Specify PLC”.

What is a PLC?
- Type IL blended cement in ASTM C595/AASHTO M240
  - Allowed 5% to 15% limestone by mass
  - Typically made from the same clinker as C150 cement; PLC just has ~6% more limestone.
  - Designed for equivalent performance.
- ~ 5-10% additional limestone added to the Finish Mill, replacing clinker at 1:1.
- Ground Finer for equivalent performance
- Optimized Sulfate for Set Control

Keys to PLC Performance

- Improved Particle Packing
  - Enhanced particle size distribution
  - Reduced porosity through formulation of control/mice
  - Nucleation creates more surface area for increased precipitation of cement

The LS occupies the finest part of the cement Particle Size Distribution (PSD) spectrum
Products and Technology:

**Re-Carbonation Ready** - Embodied Carbon Emission Reduction Accounting Soon

RE-Carbonation benefits quantifiable through EPDs:
- HeidelbergCement: significant carbonation R & D
- HeidelbergCement Research Labs:

**EPD Calculations a concrete product (EN 16757, Annex BB)**

The CO₂ uptake in kg for each application during 1 year can be calculated as:

\[
\text{CO}_2 \text{ uptake} = (10) \times \text{DO}_{2} \times \text{C}_{2} \times (\text{M} / 10000) \times \text{M} \times \text{C}
\]

- CO₂ uptake = f(concrete properties, pavement type, time, cement parameters)

**Global Cement and Concrete Association** good source on this topic

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**SUSTAINABILITY**

**Sustainable Concrete Pavements – Whole Life Carbon Accounting**

**Life Cycle Assessment (LCA)** – Use-phase impacts are often dominant (energy, CO₂ etc.)

- **Pavement Vehicle Interaction (PVI)** – roughness, texture and deflection (stiffness)
  - Useful tool for agencies to reduce GHG emission. Increasing the stiffness using 10% resurfacing in the network per year → 18% reduction of GHG emissions from the pavement network, or 440 Mt CO₂eq, over a 50-years. (AzariJafari et al.)

- **Albedo** – Mitigating Urban Heat Island and Climate Change
  - Reflective pavements could lower air temperatures by more than 2.5°F, and offset CO₂ equivalent of 4 million cars per year

- **Carbon Uptake** – can offset 5.4% of GHG emissions associated with clinker production!
  - 5.8 Million metric tons CO₂ can be sequestered by US pavement network (AzariJafari et al.)

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**PORTLAND LIMESTONE CEMENT PROJECTS**

**Lehigh Project and Case Studies using EcoCemPLCTM**

**PLC PROJECTS**

**First Iowa DOT PLC Pavement Project - 2013**

Concrete was a Ternary Mixture:
- **Iowa DOT QMC Mix Design**
  - Type IL(10) Cement and 20% Class C Fly Ash
  - 19,270 yd³ Concrete
  - 4,274 Tons Type IL(10) Cement

Pavement:
- 10 ½ inch Doweled Pavement
- 4 Miles, 2 East Bound Lanes w/ Turn Lanes
- Placed in 12 days: May 24-June 19, 2013

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**Lehigh Hanson**

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**HeidelbergCement**
Central Iowa Expo Center: Boone IA

Concrete Mix Information:
- Iowa DOT QMC Mix Design
- Type II(10) and 20% Class C Fly Ash
- 2,536 yd³ Concrete
- 553 Tons Type II(10) Cement

Pavement:
- 6 Inch Plain Pavement
- 19 Mile Haul from Concrete Plant!
- Placed: June 21-28, 2013

Lehigh Plant – Leeds, Alabama

- 2009-10 Creek Relocation
  - 26,800 CY
    - Soil Stabilization, Creek Lining, Tunnel Under Plant

- 2010 New Cement Silo
  - 5,100 CY
  - Slip Formed – 5100 CY (40% Slag)
  - Intricate Structural Design

City of Leeds, AL Streets

- 2013 & 15 Streets – 500 CY (20% F-ash)
- City of Leeds Paving – 400 CY
Indiana First PLC Pavement Project - Patching

Project: completed Sept. 2020  
Project location: I-65 Columbus, IN

Comments from the project:
Plastic properties of the concrete were very consistent and stable

Expected project duration was 5-6 Saturdays; due to the performance of the PLC concrete, the project was completed in 3 Saturdays.

Flowable fill: 68 yards  
First time DOT was using a higher performance flowable mixture  
Flowable Fill: 8 hour DCP blow count (typically a 3 day spec – 30 blows). New mix met in ~2.5 hrs

PLC PROJECTS

Indiana First PLC Pavement Project - Patching

PLC PROJECTS

Indiana First PLC Pavement Project - Patching

Resources for You
Portland Cement Association: [https://www.greenercement.com/](https://www.greenercement.com/)

The Site Contains a CO2 Calculator – How much CO2 can you save by using PLC on a project?

<table>
<thead>
<tr>
<th>BY VOLUME</th>
<th>There is an Option for Lane Miles as Well.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total volume of concrete (cu. yd.)</td>
<td>1000</td>
</tr>
</tbody>
</table>
| CO2 Savings with PLC | 23 Tons  
45,910 lbs  
21 Metric Tons  
20,824 kg |
| Cement factor (lb/cu. yd.) | 564 |

Basic calculator assumptions:
- Design of concrete is supported by 4,000 psi, 72°F, of building floor systems.
- For advanced calculation, input your total concrete volume and cement factor.

PORTLAND LIMESTONE CEMENT RESOURCES

A Green Cement | PLC | Portland Limestone Cement - YouTube
WHAT CEMENT SPECIFICATIONS COVER PLC?
PLC containing from 5% to 15% limestone is now included in the current blended cement Type I. specifications of ASTM C95 and AASHO M240. ASTM C595 and the use of Type I. is accepted in the following Specifications and State DOT's:

<table>
<thead>
<tr>
<th>SPECIFICATIONS</th>
<th>STATE DOT'S</th>
<th>OTHER SPECIFICATIONS</th>
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</thead>
<tbody>
<tr>
<td>ACI 318 Building code for structural concrete</td>
<td>Illinois All concrete</td>
<td>FAA P901 Concrete Paving Specification</td>
</tr>
<tr>
<td>ACI 501 Specification for structural concrete</td>
<td>Indiana DOT All concrete, Stabilization pending final issue</td>
<td>Included in AIA MasterSpec</td>
</tr>
<tr>
<td>ASTM C84 Specification for ready mix concrete</td>
<td>Iowa DOT All concrete</td>
<td></td>
</tr>
<tr>
<td>ASTM C270 Specification for mortar for unit masonry</td>
<td>Kentucky Transportation Cabinet All concrete, Stabilization request pre-bid</td>
<td></td>
</tr>
<tr>
<td>ASTM C476 Great for masonry</td>
<td>Minnesota DOT All concrete</td>
<td></td>
</tr>
<tr>
<td>ASTM C1406 Potted, pre-bonded, dry combined materials for use in wet or dry substrate jointed application</td>
<td>Ohio DOT All concrete</td>
<td></td>
</tr>
<tr>
<td>ASTM C1711 Historic Masonry Mortar</td>
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</tbody>
</table>

The only restriction on the use of Type I. cement may be in specifications of private design firms that have not updated their specifications to current industry standards. For assistance on specifications and additional data, reference the Portland Cement Association at www.greenecement.com.

Specifying PLC

Thank You!

Questions?

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Resources for Information and Learning on Concrete Sustainability and Transparency

https://www.fhwa.dot.gov/pavement/sustainability/
Greenencement.com – Portland Limestone Cement
CSHub/MIT – YouTube – MIT Concrete Sustainability Hub Public Videos
Home | Concrete Sustainability Hub [mit.edu] – Website with research Briefs
https://buildwithstrength.com/ – National Ready Mix Concrete Association Educations – On demand videos
Carbonleadershipforum.org – Carbon Leadership Forum
Buildingtransparency.org – CSL’s tool for viewing EPDs
 GCCassociation.org – Global Cement and Concrete Association
NRMCA.org/association-resources/sustainability/epd-program - NRMCA
Home - Build With Strength - A Coalition of the National Ready Mixed Concrete Association
LinkedIn.com/groups/1807540/ - Women in Concrete Alliance
https://www.linkedin.com/company/lehigh-hanson/mycompany/
Environmental Product Declarations (EPDs) - Lehigh Hanson, Inc - Lehigh Hanson and Industry Wide EPDs

CONSTRUCTION SUSTAINABILITY RESOURCES

Increase Your Knowledge

Thank You!
Questions?

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