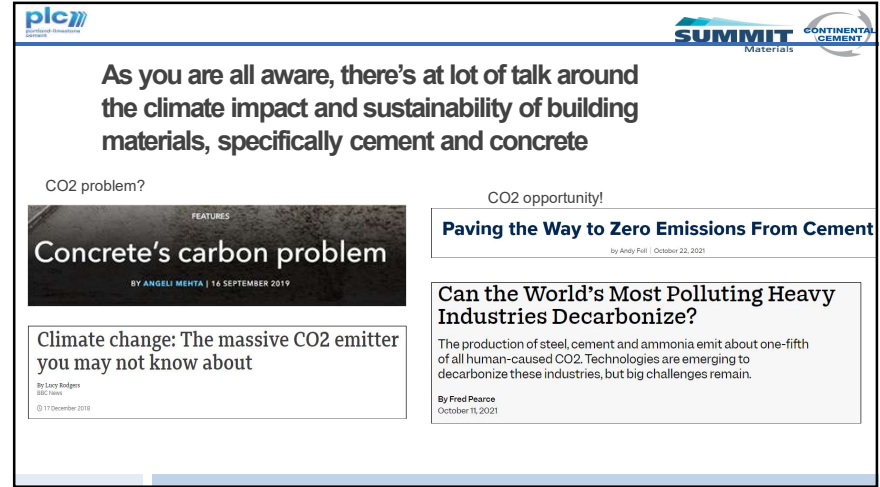


Portland-Limestone Cement (PLC)
Nicolas Marks

CONTINENTAL CEMENT

plc portland-limestone cement



As you are all aware, there's a lot of talk around the climate impact and sustainability of building materials, specifically cement and concrete

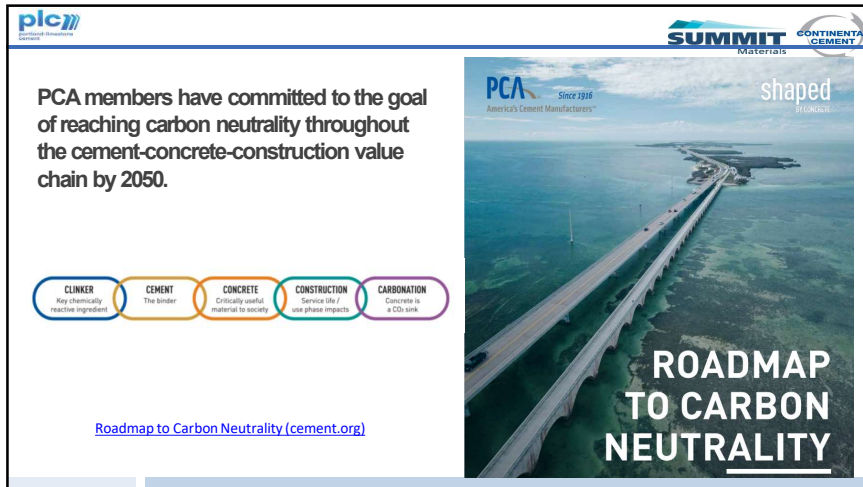
CO2 problem? CO2 opportunity!

Concrete's carbon problem
BY ANGELI MENTA | 16 SEPTEMBER 2019

Paving the Way to Zero Emissions From Cement
by Andy Fall | October 22, 2021

Can the World's Most Polluting Heavy Industries Decarbonize?
The production of steel, cement and ammonia emit about one-fifth of all human-caused CO2. Technologies are emerging to decarbonize these industries, but big challenges remain.
By Fred Pearce
October 11, 2021

Climate change: The massive CO2 emitter you may not know about
By Lucy Rodgers
S&P Global
© 17 December 2019

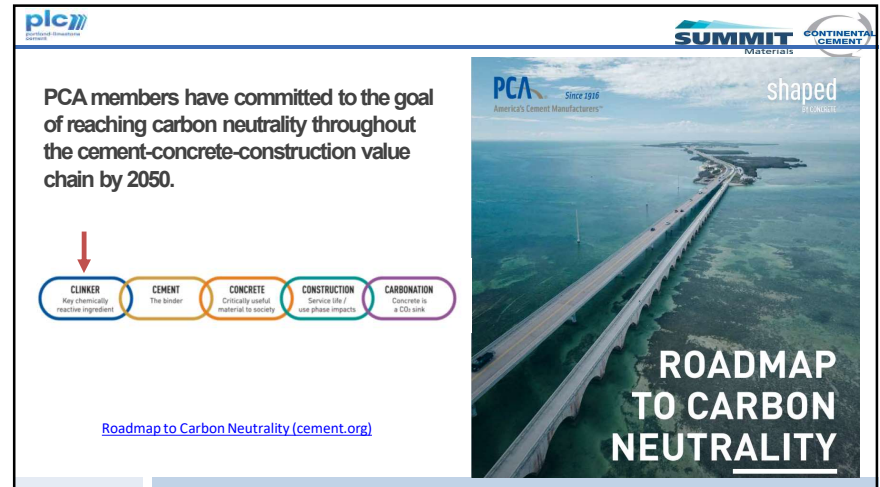


PCA members have committed to the goal of reaching carbon neutrality throughout the cement-concrete-construction value chain by 2050.

ROADMAP TO CARBON NEUTRALITY

[Roadmap to Carbon Neutrality \(cement.org\)](https://www.cement.org/Roadmap-to-Carbon-Neutrality)

CLINKER: Key chemically reactive ingredient
CEMENT: The binder
CONCRETE: Critically useful material to society
CONSTRUCTION: Service life / use phase impacts
CARBONATION: Concrete is a CO2 sink

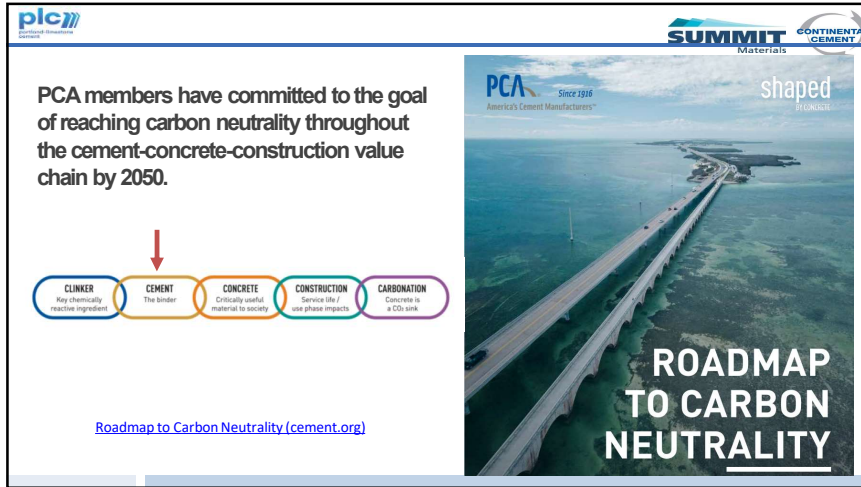


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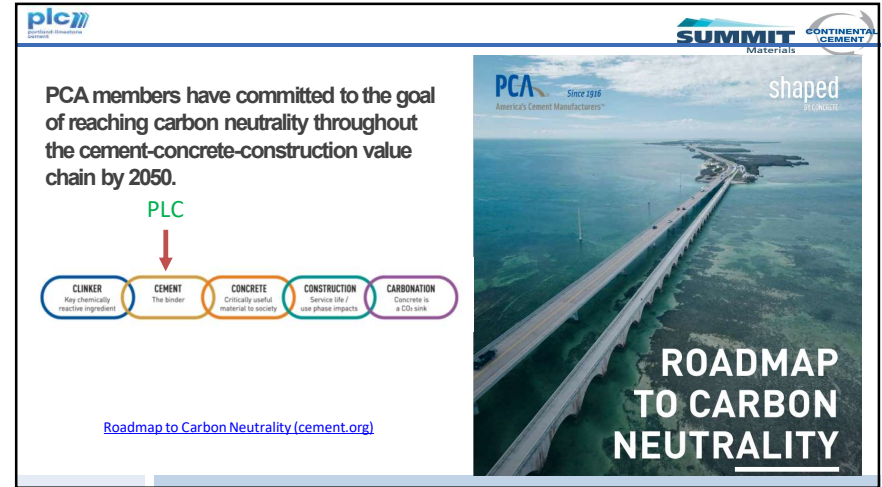


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Diagram showing the value chain: CLINKER (Key chemically reactive ingredient) → CEMENT (The binder) → CONCRETE (Critically useful material to society) → CONSTRUCTION (Service life / use phase impacts) → CARBONATION (Concrete is a CO₂ sink). A red arrow points to the CEMENT stage.



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ROADMAP TO CARBON NEUTRALITY

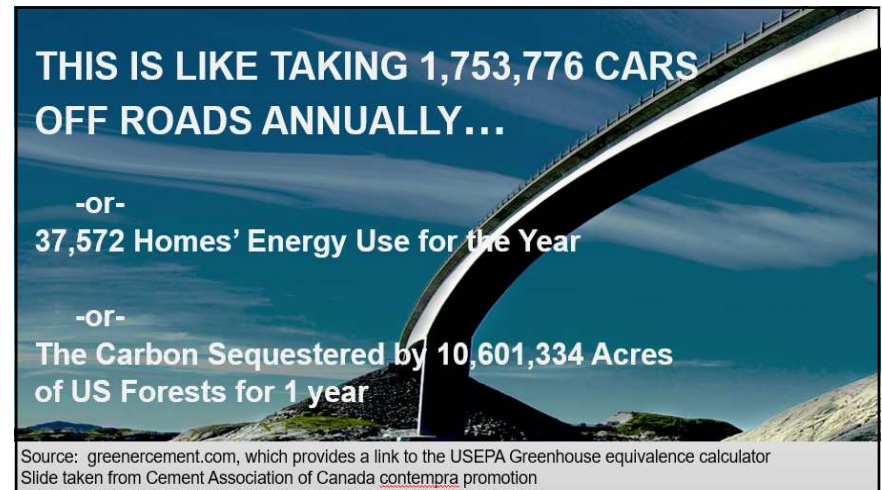
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8.1 Million Metric Tons of CO₂ would have been saved if the US used 100% Portland-Limestone Cement in 2019

Statement taken from greencement.com (PCA); Image from Cement Association of Canada contempora promotion



THIS IS LIKE TAKING 1,753,776 CARS OFF ROADS ANNUALLY...


-or-
37,572 Homes' Energy Use for the Year

-or-
The Carbon Sequestered by 10,601,334 Acres of US Forests for 1 year

Source: greencement.com, which provides a link to the USEPA Greenhouse equivalence calculator
Slide taken from Cement Association of Canada contempora promotion

plc
PORTLAND CEMENT
INNOVATION

U.S. Standards




Cementitious Materials and Concrete Standards

C150 portland cement – up to 5% limestone, Type I or I/II most common

C595 blended cement – 5% to 15% limestone, Types IL and IT. Also pozzolan and slag blended cements, Type IP and IS

C1157 hydraulic cement – can contain limestone in varying amounts. Types GU, HE, MS, HS, MH, LH


C94 ready-mixed concrete – equal recognition of C150, C595, and C1157 and equal handling of SCMs



Courtesy of Jamie Farny, PCA

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PORTLAND CEMENT
INNOVATION

SUMMIT Materials **CONTINENTAL CEMENT**

Long Track Record

Blended limestone cements


History of good performance, even at higher limestone contents than the U.S.

Europeans introduced in the late 1960s

Canada has used them since the late 2000s

U.S. standards in place since 2012 (even earlier as C1157 performance cements)

Market share for blended cements grows as users gain comfort working with them



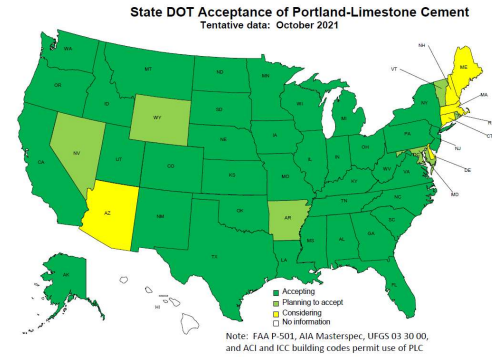
Courtesy of Jamie Farny, PCA

History of Limestone in Cement

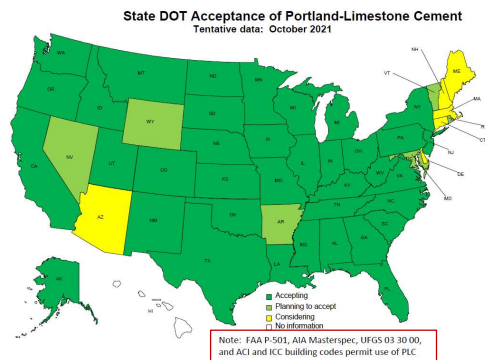


- 1983 CSA A5 allows up to 5% limestone in Portland cement
- 2004 ASTM C 150 allows 5% in Types I-V
- 2006 CSA A3001 allows 5% in other Types than GU
- 2007 AASHTO M85 allows 5% in Types I-V
- 2008 CSA A3001 includes PLC containing 5%-15% limestone
- 2012 ASTM C595/AASHTO M 240 include PLC

DOT Acceptance of Portland-Limestone Cements



DOT Acceptance of Portland-Limestone Cements



How do I specify Portland-Limestone Cements?



Specifying PLC for use in concrete is not complicated, it only requires one change to project specifications:

ASTM C150 Type I/II Portland Cement

How do I specify Portland-Limestone Cements?



Specifying PLC for use in concrete is not complicated, it only requires one change to project specifications:

- ASTM C150 Type I/II Portland Cement
- ASTM C595 Type IL

How do I specify Portland-Limestone Cements?





Specifying PLC for use in concrete is not complicated, it only requires one change to project specifications:

- ASTM C150 Type I/II Portland Cement
- ASTM C595 Type IL

If concrete requires special properties, such as sulfate resistance, a qualifier can be added to the IL designation:

Cement type	OPC C150 (M 85)	PLC C595 (M 240)
General use	I	IL
moderate sulfate resistance*	II, II(MH)	IL(MS)
moderate heat of hydration	II(MH)	IL(MH)
high sulfate resistance*	V	IL(HS)
low heat of hydration	IV	IL(LH)

Home
Why PLC
CO2 Calculator
Case 5

What is PLC?


A greener cement option

A blended cement with additional limestone content, optimized for performance

The easiest way to reduce your carbon footprint by about 10%

Suitable for buildings, bridges, pavements, geotechnical applications

Availability continually increases



Reduce Your Carbon Footprint With PLC

The same durable, resilient concrete you depend on can now reduce your carbon footprint by 10%.

Easy. Proven. Readily available.

Courtesy of Jamie Farny, PCA




Mix Designs with PLC

Proportioning, batching, and mixing

PLC replaces ordinary portland cement at 1:1 ratio

PLC allows for the same dosages of fly ash or other pozzolans, slag cement

As with any new material, some testing is warranted to confirm effect fresh and hardened properties

Air content, slump, bleed potential, setting time, compressive strength


Some producers report no adjustments are needed, others tweak proportions or adjust admixture dosages



Courtesy of Jamie Farny, PCA

plc Continental Cement
SUMMIT Materials Continental Cement

Mix Designs with PLC



Typical effects on fresh and hardened properties

Workability	Increase or decrease No significant effect on admixtures
Bleeding	Decreases with increasing limestone fineness Generally of no concern
Setting time (initial, final)	Can be slight decrease w/increasing limestone fineness Not a concern even up to 15% limestone
Heat of hydration	Slight increase at early ages (up to 48 hours) But less significant at later ages
Compressive strength	Can increase slightly Both early-age and long-term strengths
Scaling and freeze-thaw resistance	Use same techniques as with OPC concrete mixes: Proper air-void systems, curing, higher strengths
Sulfate resistance	Use same techniques as with OPC concrete mixes: Low w/c (or w/cm) and MS or HS designations

Courtesy of Jamie Farry, PCA

plc Continental Cement
SUMMIT Materials Continental Cement

Working with PLC Mixes


Normal operations for:

- Placing
- Finishing
- Curing

As fineness increases, may see:

- Slightly less bleed water
- Slightly shorter setting times
- Slightly higher water demand

Virtually the same handling and performance as OPC

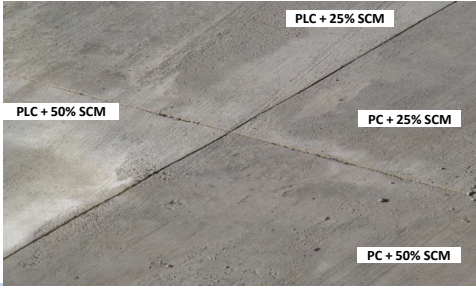


Courtesy of Jamie Farry, PCA

plc Continental Cement
SUMMIT Materials Continental Cement

Performance of PLC Concrete

Field Trials: Pavement slab after one winter

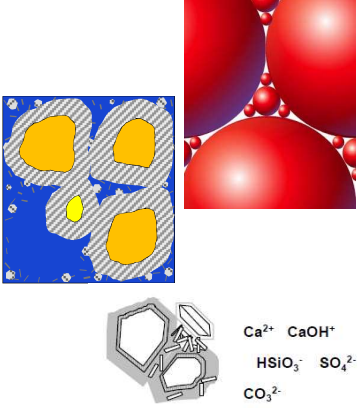


Courtesy of PCA

plc Continental Cement
SUMMIT Materials Continental Cement

How Limestone Works

- Particle packing
 - Improved particle size distribution
- Nucleation
 - Surfaces for precipitation
- Chemical reactions
 - Only a small amount, but...



Ca^{2+} $CaOH^+$
 $HSiO_3^-$ SO_4^{2-}
 CO_3^{2-}

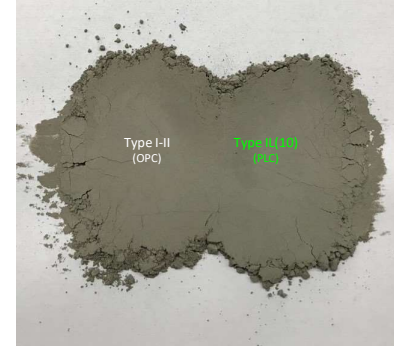
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Cement Color Comparison



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Cement Color Comparison



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Green America Recycling Expansion Project



27

Green America Recycling Expansion Project



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Summary

- A Portland cement with additional limestone content, optimized for performance
- Compared to C150 cements, PLC reduces carbon footprint of concrete by about 10%
- Portland cements are easily replaced by Portland-Limestone Cements (1:1)
- Complimentary to the use of supplementary cementitious materials
- Suitable for buildings, bridges, pavements, geotechnical applications

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greencement.com

CO2 Calculator

See how much CO2 you can save using PLC (Type IL). Enter your building size or pavement length to see how much you can reduce your carbon footprint.

Enter Your Project Size

BUILDING SIZE (Total Square Feet) | PAVEMENT LENGTH (Total Lane Miles)

CHOOSE ONE

CEMENT SILO (Capacity in Metric Tons) | GEOTECHNICAL (For Soil Treatment, Volume in cu ft)

CALCULATE

To view the assumptions made on these calculations, see our advanced calculator.

- More info
- Calculator for CO2 savings
- Benefits of PLC
- Spec language
- Case studies
- FAQs
- Contact an expert

SUMMIT Materials **CONTINENTAL CEMENT**

greencement.com

CO2 Calculator

See how much CO2 you can save using PLC (Type IL). Enter your building size or pavement length to see how much you can reduce your carbon footprint.

Potential CO2 Savings in a 10,000 Sq Ft Building Project

- = 8 Tons
- = 15,390 lbs
- = 7 Metric Tons
- = 6,981 kg

CALCULATE AGAIN

To view the assumptions made on these calculations, see our advanced calculator.

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THANK YOU!!!

Nicolas Marks
Continental Cement - Director of Technical Services
nicolas.marks@continentalcement.com