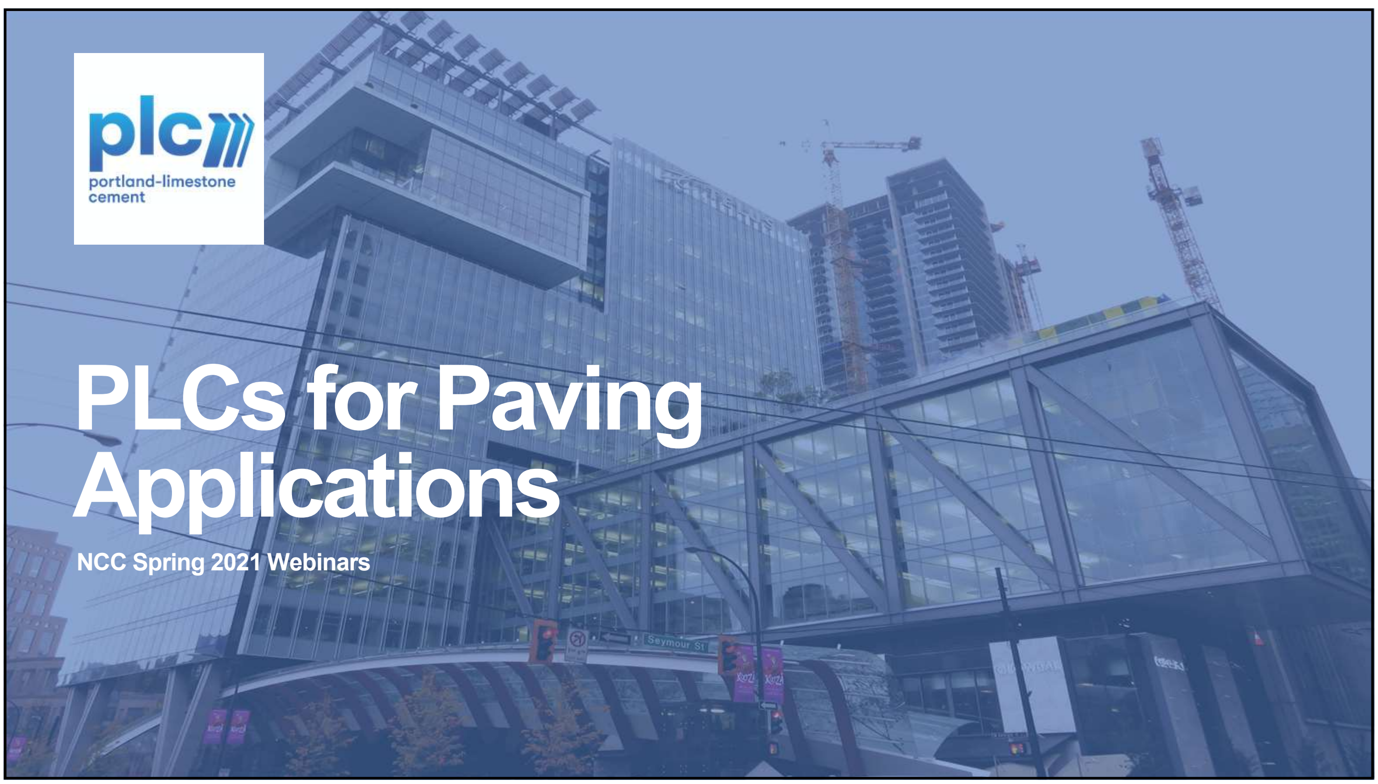
About the Presenter

Jamie Farny is the Director, Building Marketing for Portland Cement Association. He promotes the use of cement-based materials for buildings and other applications by focusing on sustainability, resilience, energy efficiency, durability, and other key benefits.

He assisted with development of PCA's new campaign to raise awareness of portland-limestone cements (PLCs) for improved sustainability of concrete construction.

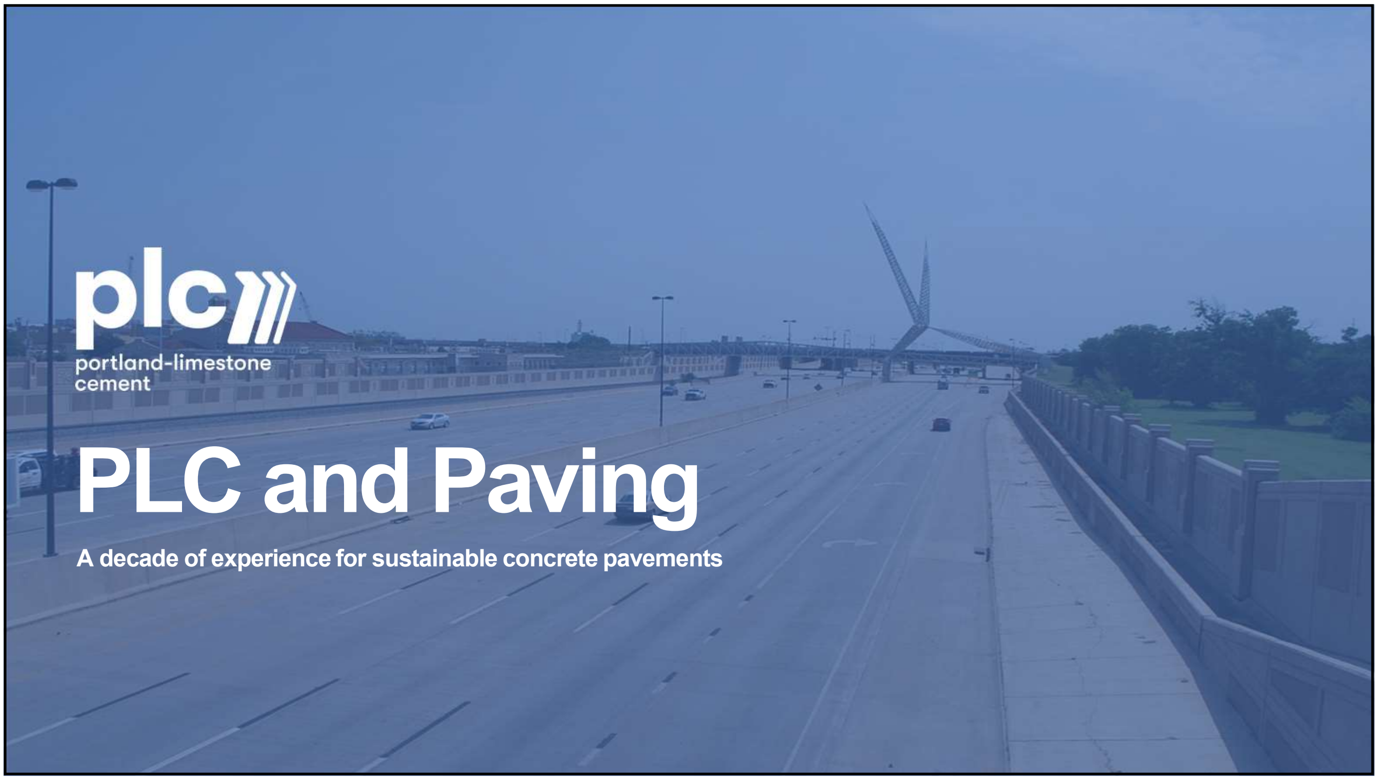
As a voting member of numerous committees of ACI, ASTM, and The Masonry Society, he works to develop technical guides, codes, and standards related to materials, design, and construction using cement, concrete, and masonry.

He holds a B.S. degree in Civil Engineering from the Illinois Institute of Technology.



PLCs for Paving Applications

NCC Spring 2021 Webinars



plc portland-limestone cement

PLC and Paving

A decade of experience for sustainable concrete pavements

plc portland-limestone cement

American Jobs Plan

Modernize highways, roads, and bridges

Transportation needs continue to grow

Jobs Plan prioritizes resilient infrastructure and recognizes sustainable building materials (such as PLC)

Jobs Plan increase for research investments & tax incentives for emerging technologies aligns with industry's efforts to drive down its carbon intensity

Administration has tied infrastructure program to investing in industry & solutions that:

- Help US/economy recover from the pandemic
- Look for ways to build more sustainably

New $$? Sustainable construction: PLC concrete

A focus on cement and concrete

CO2 Footprint of Construction

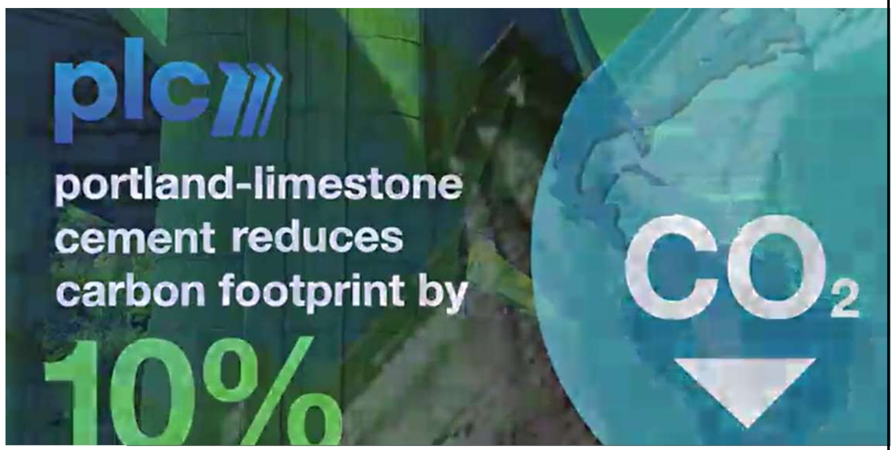
CO2 problem?

CO2 opportunity!

Whether you are hearing about this from your customers or not, you will soon

PLC is proven technology

PLC can help position concrete pavements as more sustainable



What is PLC?

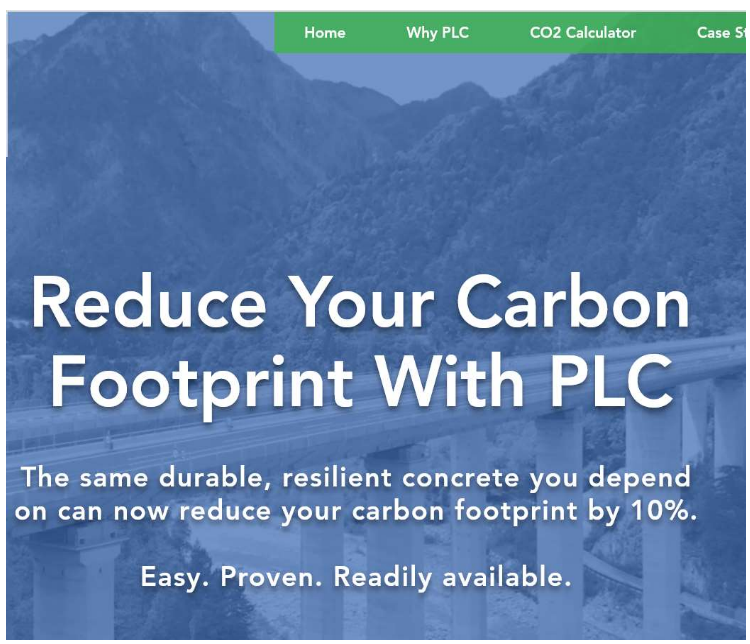
A greener cement option

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

Readily available throughout the U.S. and Canada



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

U.S. Standards

Cementitious Materials and Concrete Standards ASTM/AASHTO

C150/M 85 portland cement – up to 5% limestone, Type I or I/II most common

C595/M 240 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/M 157 ready-mixed concrete – equal recognition of C150, C595, and C1157 and equal handling of SCMs

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

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

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

Performance of PLC Concrete

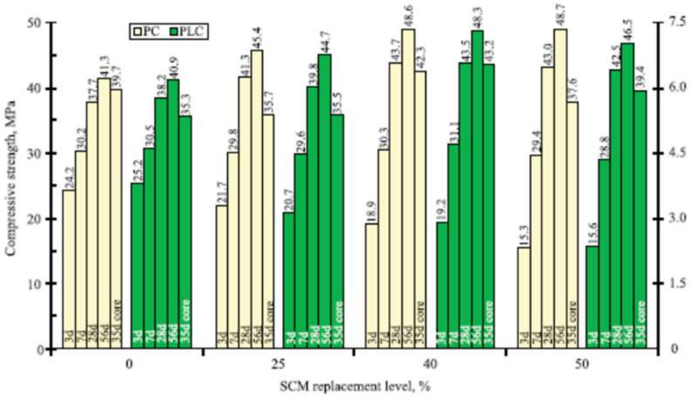
A look at hardened properties

Strength

- OPC to PLC comparisons
- With and without SCMs

Durability

- Scaling
- Freeze-thaw resistance
- Chloride permeability
- ASR resistance
- Sulfate resistance
- Field trial results



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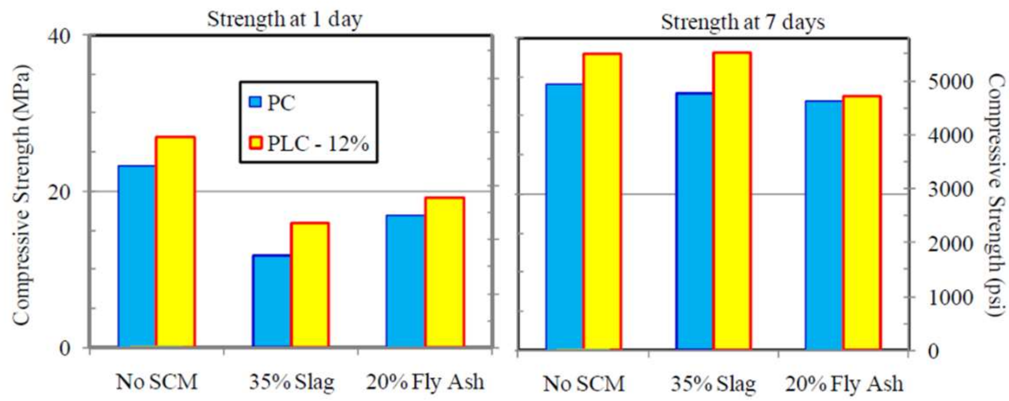
Performance of PLC Concrete

Early age strength development with and without SCMs



Thomas and Hooton 2010

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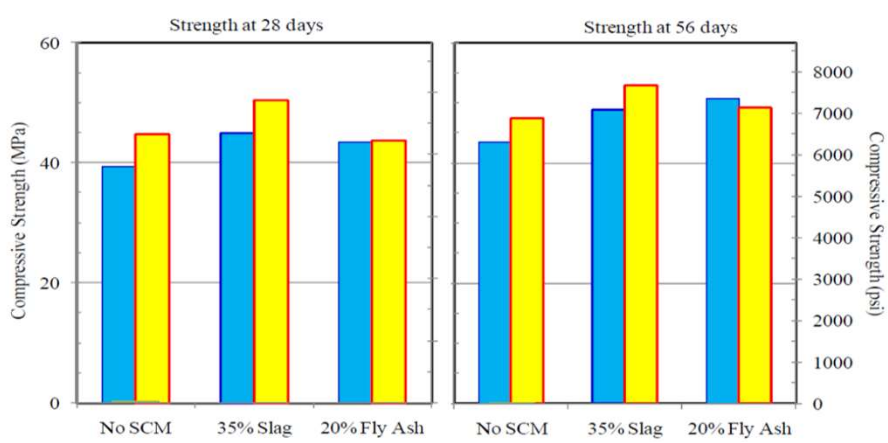
Performance of PLC Concrete

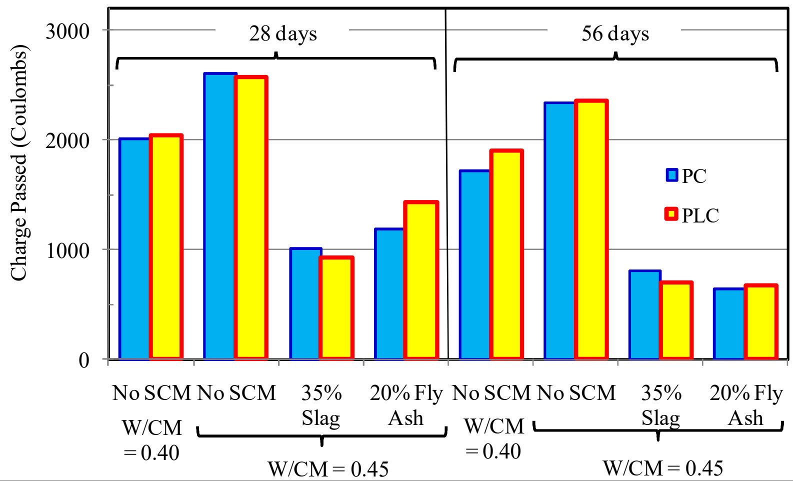
Later age strength development with and without SCMs



Thomas and Hooton 2010

Performance of PLC Concrete

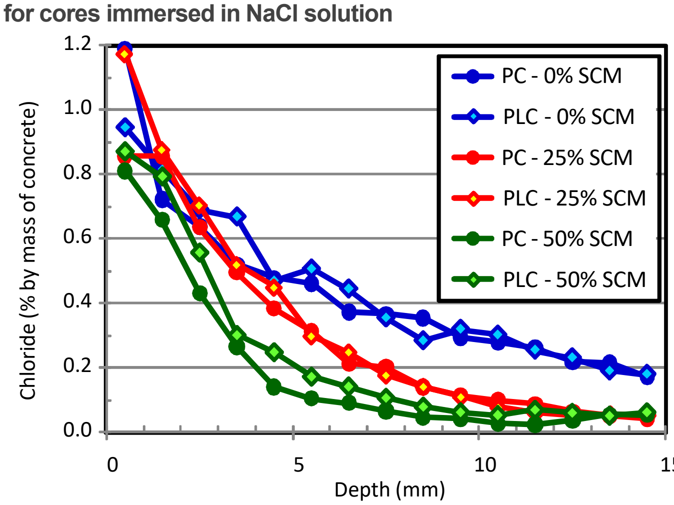
"Permeability" T277/C1202



Thomas and Hooton 2010

Performance of PLC Concrete

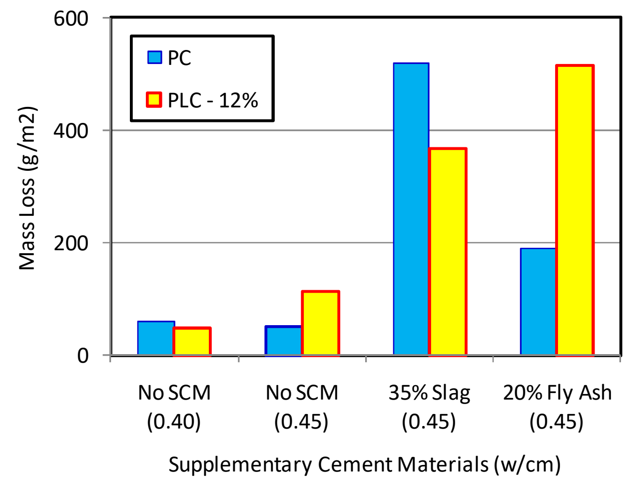
Chloride profiles for cores immersed in NaCl solution



Blair and Delagrave 2012

Performance of PLC Concrete

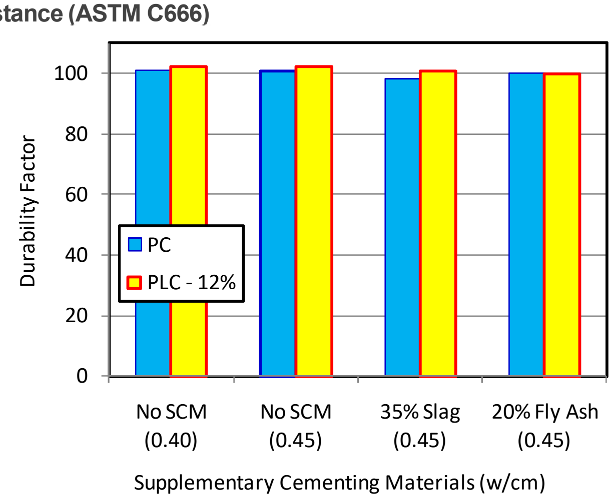
Scaling resistance (ASTM C672)



Thomas et al. 2010

Performance of PLC Concrete

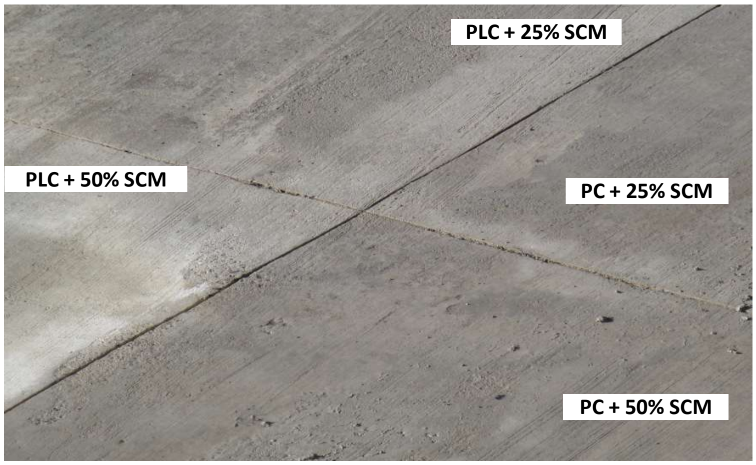
Freeze-Thaw Resistance (ASTM C666)



Thomas et al. 2010

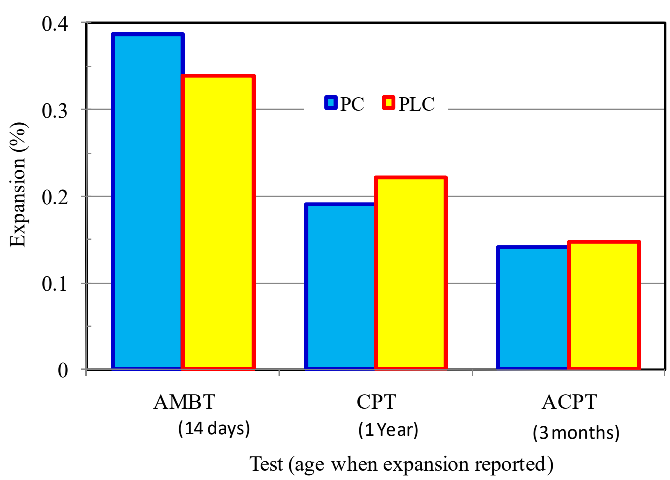
Performance of PLC Concrete

Field Trials: Pavement slab after one winter



Performance of PLC Concrete

ASR resistance



Thomas et al. 2010

PLC for Special Properties

Cement modifiers

Sulfate resistance – MS, HS

Sulfate-containing soils

Sulfate-containing groundwaters

Heat of hydration – LH, MH

Not generally required

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

PLC and Sulfate Resistance

Same approach as for other blended cements

Use additional SCMs and low w/cm

Use moderate- or high-sulfate resistant types:

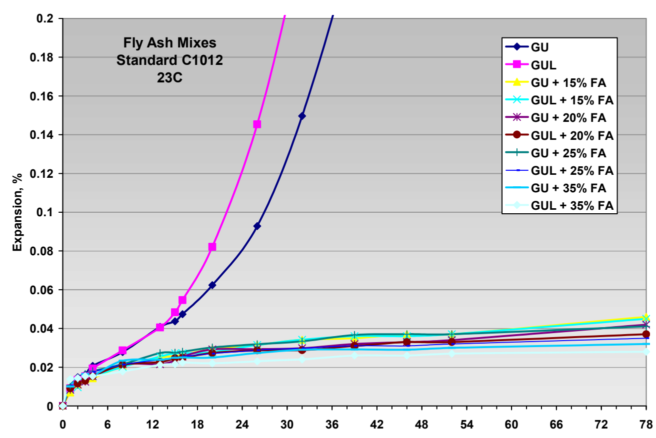
Type IL(MS)

Type IL(HS)

Type IT(MS)

Type IT(HS)

Performance confirmed by numerous research studies and decades of field exposures on real-world installations



PLC and Heat of Hydration

Temperature control for pavements

- Warm weather
  - Not necessary
  - Mass placements uncommon for pavements (less than 3 ft (1 m) thick)
- Cold weather
  - Not appropriate
  - Similar to OPC, may need set accelerators or blankets to maintain fresh concrete temperature as placed

Procuring PLC Concrete

Basics of specifying and ordering

- A simple revision to specifications: 1:1 replacement of OPC with PLC
- Same suppliers for your ready mix
- Same delivery and placing equipment

Specifying PLC Concrete

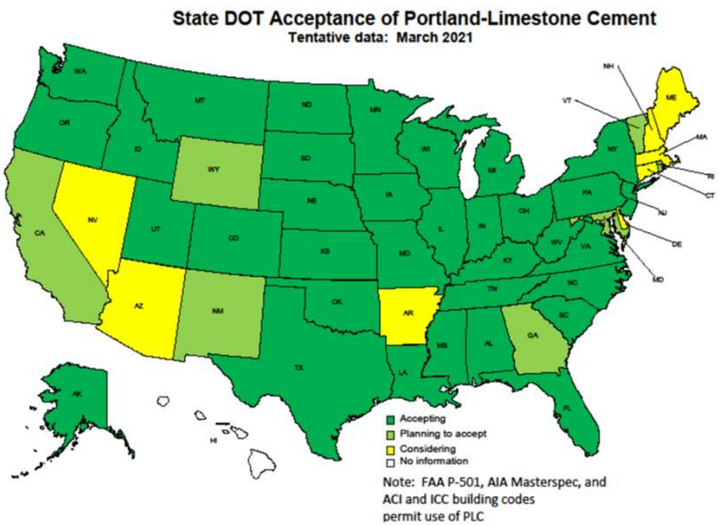
Parallel standards for Type IL

ASTM and AASHTO specifications

Adoption varies by state

ASTM C595 Type IL cement instead of ASTM C150 Type I portland cement

Or **AASHTO M 240 Type IL cement** instead of M 85 Type I portland cement



greenercement.com

A new resource

Calculator for CO2 savings

Benefits of PLC

Spec language

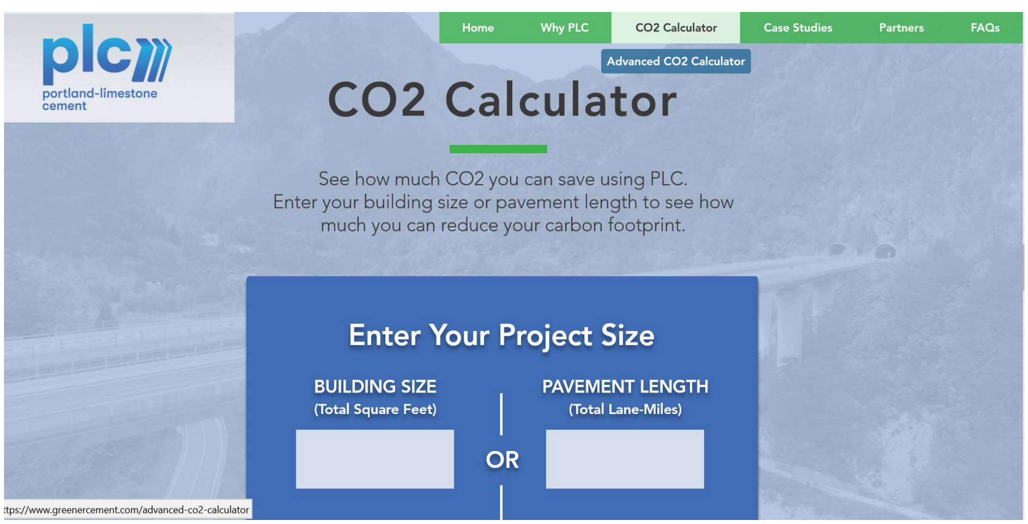
Case studies

FAQs

Contact an expert

Informative videos

Mobile friendly



plc portland-limestone cement

Greener Roads for Right Now!

"Excellent durability and improved sustainability"

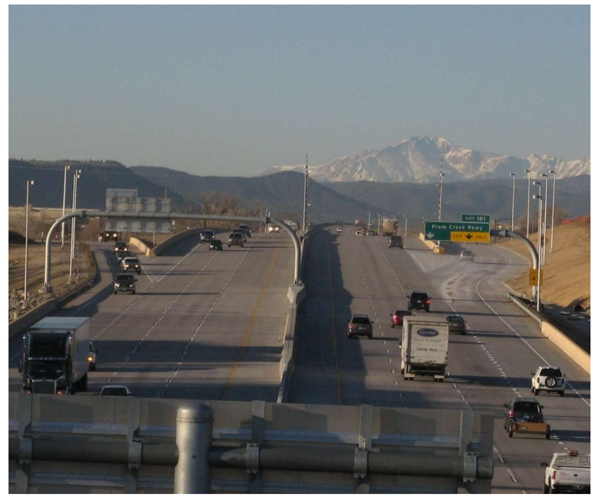
Proven technology

Easy to implement

Sustainable, resilient pavements

These states were some early adopters of PLC concrete pavements – more than a decade ago:

- Colorado
- Utah
- Oklahoma



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One Colorado Example

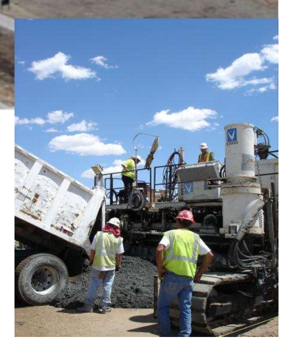
US HWY 287 Near Lamar

Built in 2008 – more than a decade of service

Carries heavy trucking & commerce, US - Mexico

Summertime construction – hot and dry (100°F)

- 7 miles paving and shoulder widening
- PLC (10%L), 20% Class F fly ash
- 695 psi average 28-day flexural strength
- Contractor received quality incentive from CDOT



ACPA Activities

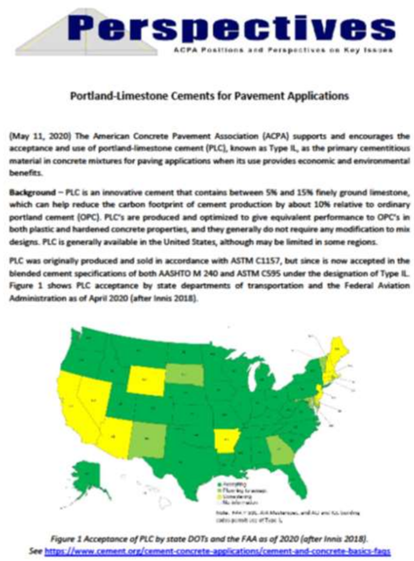
Portland-Limestone Cements for Pavement Applications

ACPA Position Paper May 2020

- PCA worked with ACPA to address PLCs for paving
- “ACPA supports and encourages PLCs for economic and environmental benefits”
- FHWA encourages DOT’s use of PLCs for more sustainable concrete pavements

Point users toward greenercement.com

- ACPA reports lots of interest in this



Perspectives
ACPA Positions and Perspectives on Key Issues

Portland-Limestone Cements for Pavement Applications

(May 11, 2020) The American Concrete Pavement Association (ACPA) supports and encourages the acceptance and use of portland-limestone cement (PLC), known as Type IL, as the primary cementitious material in concrete mixtures for paving applications when its use provides economic and environmental benefits.

Background – PLC is an innovative cement that contains between 5% and 15% finely ground limestone, which can help reduce the carbon footprint of cement production by about 10% relative to ordinary portland cement (OPC). PLC's are produced and optimized to give equivalent performance to OPC's in both plastic and hardened concrete properties, and they generally do not require any modification to mix designs. PLC is generally available in the United States, although may be limited in some regions.

PLC was originally produced and sold in accordance with ASTM C1157, but since is now accepted in the blended cement specifications of both AASHTO M 240 and ASTM C595 under the designation of Type IL. Figure 1 shows PLC acceptance by state departments of transportation and the Federal Aviation Administration as of April 2020 (after Innis 2018).

Figure 1 Acceptance of PLC by state DOTs and the FAA as of 2020 (after Innis 2018).
See https://www.cement.org/cement-concrete-applications/cement-and-concrete-basics-faqs

greenercement.com

PLC partners

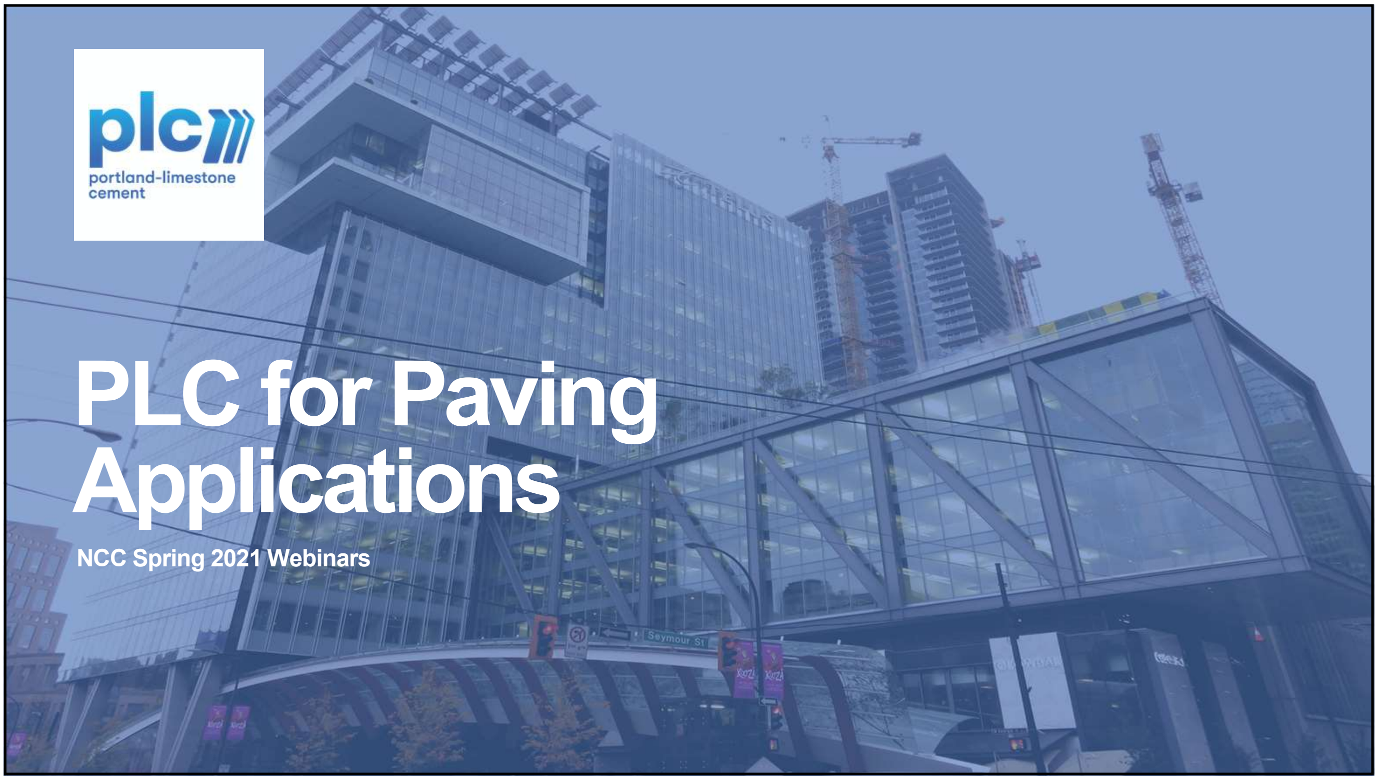
Working with many industry groups to raise awareness and educate about PLC

In addition, PCA is creating a roadmap to carbon neutrality by 2050:

- 5C’s: clinker, cement, concrete, construction, and carbonation

PLC is a key component of the roadmap, and as already shown, it’s a market-ready, proven, and effective way to reduce your CO2 by about 10%

Asking for PLC is a change you can make today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