



**SUMMIT**  
Materials



# PLC: Where are we now?

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Stephanie Hampton | Director of Technical Services |  
[stephanie.hampton@continentalcement.com](mailto:stephanie.hampton@continentalcement.com)

# OUTLINE



- **PLC / Type IL Overview**
- **Blended Cements in Concrete**
- **Sustainability Roadmap**



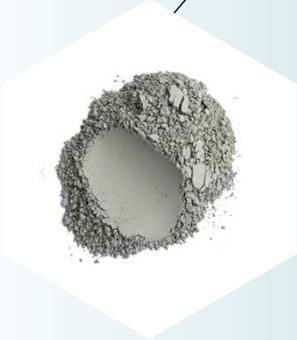
# PLC / Type II Overview



# Concrete 101



**Concrete** = Cement + SCM + Coarse Aggregates + Fine Aggregates + Water + Chemical Admixtures



# Solutions for Lowering Your Carbon Footprint



## ASTM C- 150 (AASHTO M-85) (Can contain up to 5% Limestone)

- **Type I** - Normal Portland Cement
- **Type II** – Moderate Sulfate Resistance
- **Type III** - High Early Strength
- **Type IV** – Low Heat of Hydration
- **Type V** - High Sulfate Resistance

## ASTM C-595 (AASHTO M-240)

- **Type IS**  
C150 cement clinker + Slag
- **Type IP**  
C150 cement clinker + Pozzolan
- **Type IL**  
C150 cement clinker + Limestone
- **Type IT**  
C150 cement clinker +  
more than one NCM

# What is Portland Limestone Cement?



## What is PLC?

- Type IL *blended cement* in ASTM C595/AASHTO M 240
  - 5% to 15% limestone by mass
- Type IL(X) where X is the amount of limestone
  - Type IL(10) includes 10% limestone by mass
  - Industry Target  $\pm 1\%$
  - ASTM Tolerance  $\pm 2.5\%$
- Same Clinker as Portland Cement
- Optional requirements can also apply
  - Type IL(MS)      Moderate sulfate resistant (comparable to Type II)
  - Type IL(HS)      Highly sulfate resistant (comparable to Type V)

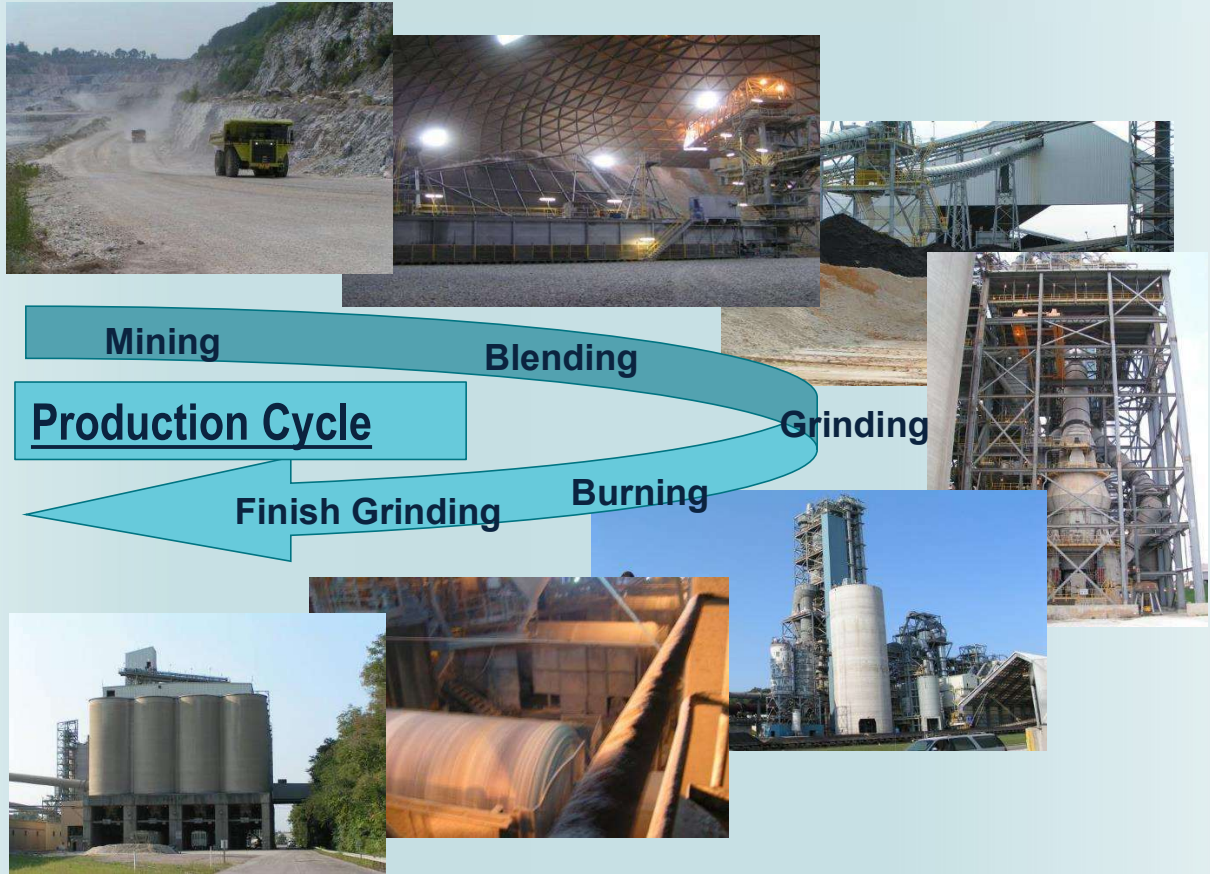
# What is Portland Limestone Cement?



Portland Cement Association: <https://www.greencement.com/>



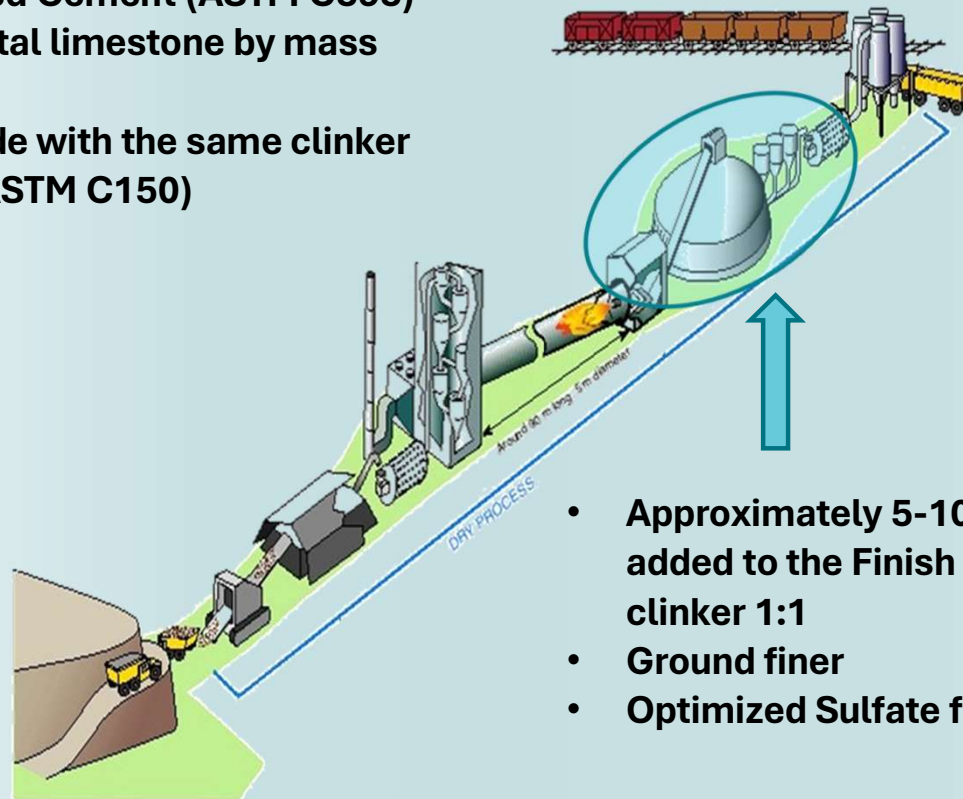
# Cement Production





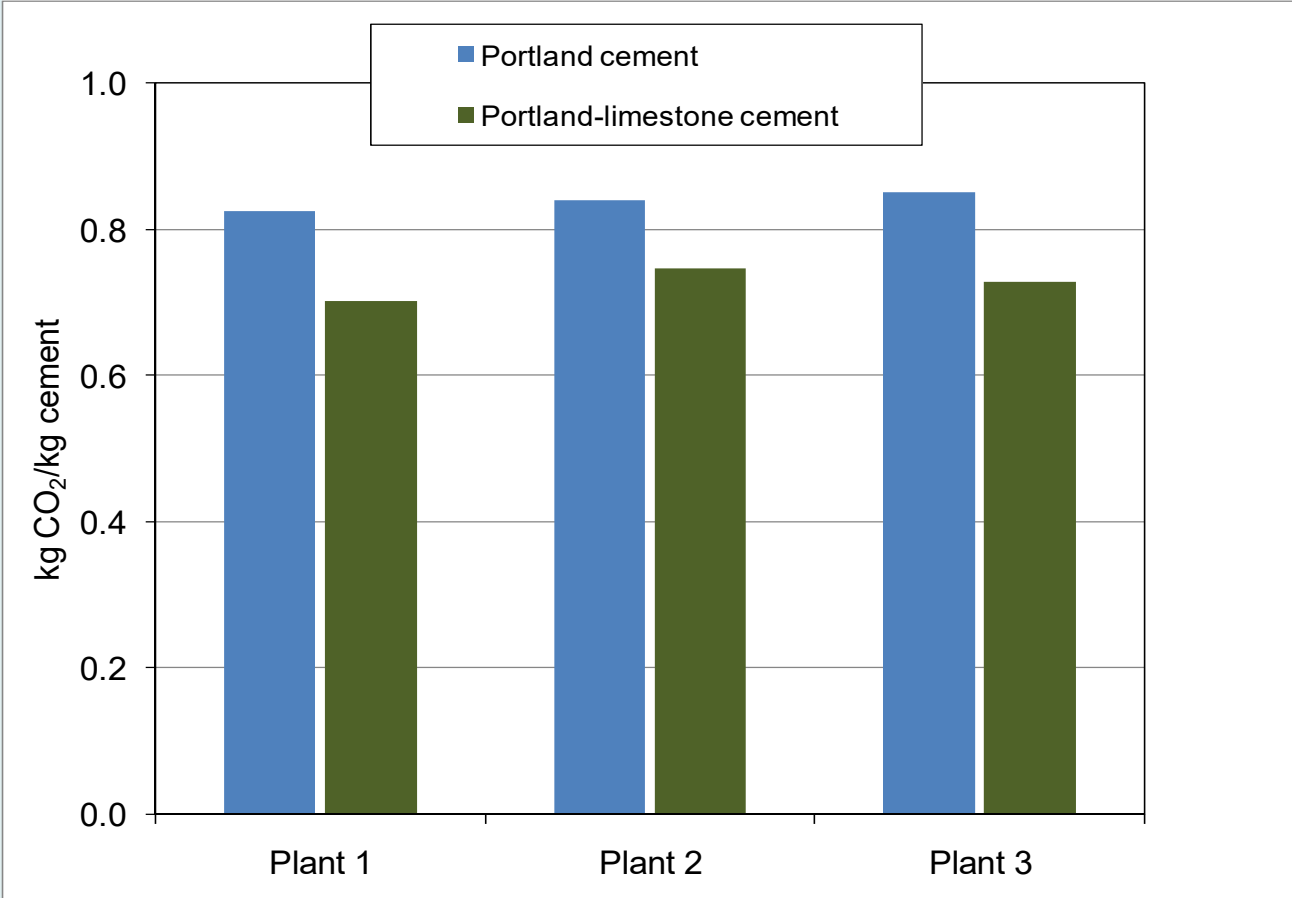
# Type IL Cement Production

- **Type IL is a Blended Cement (ASTM C595)**
  - **5% to 15% total limestone by mass permitted**
  - **Typically made with the same clinker as Type I/II (ASTM C150)**



- **Approximately 5-10% additional limestone added to the Finish Mill, replacing the clinker 1:1**
- **Ground finer**
- **Optimized Sulfate for Set Control**

# Type IL Benefits & Plant Comparisons





**PLC in Concrete**

# 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

## Type IL - Long Track Record

- 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

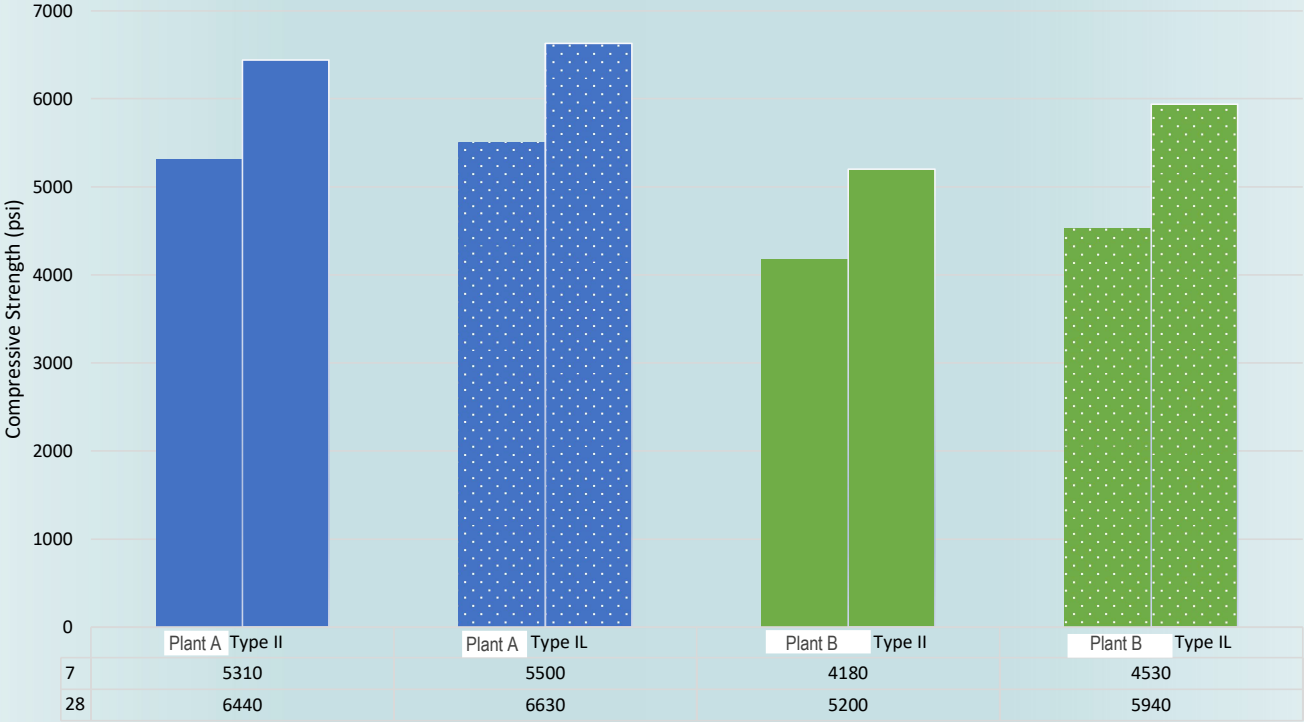




# Maryland State Highway Administration Mix 6 Testing at NRMCA



4500 psi, w/c: 0.45, 615 pcy



# Blended Cements in Construction



Online Access



Quality Control



Finishing & Curing



Communication



# Mix Designs with PLC

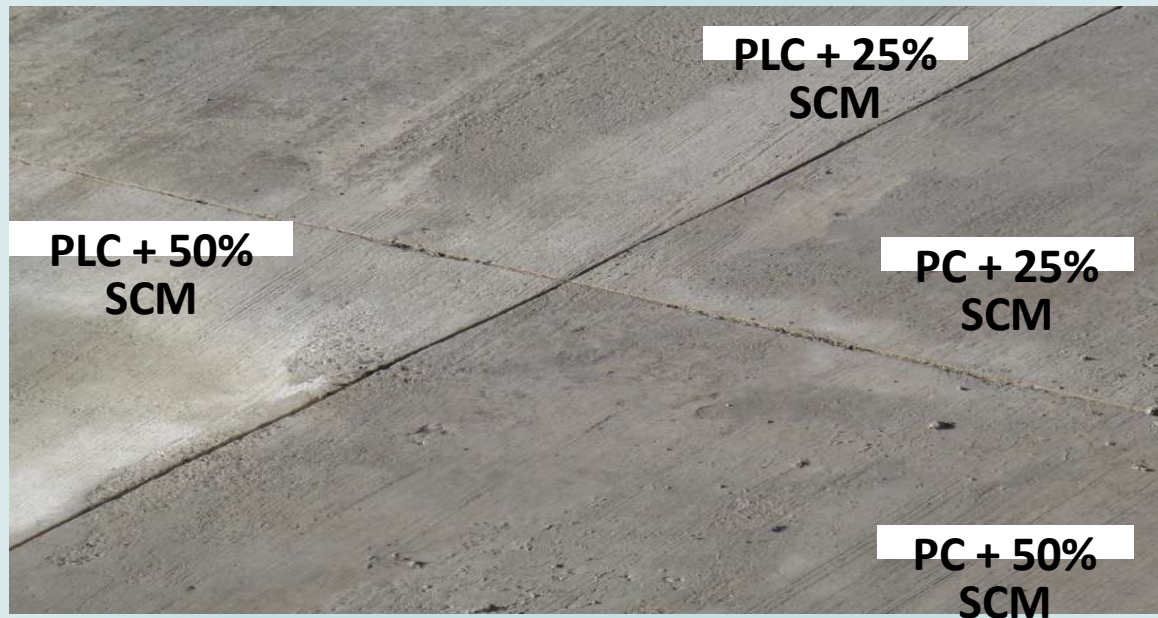
## Proportioning, batching, and mixing

- PLC replaces ordinary portland cement
  - Due to a slight difference in Specific Gravity, yielding the mix design is often required
- 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



# PLC Concrete Performance

## Field Trials: Pavement slab after one winter





# Green America Recycling Expansion Project

March 2021



Hannibal Type I-II

Hannibal Type II(10)



# Green America Recycling Expansion Project

April 2021



# MnROAD Study – Type IL (20)



[Use of Alternative Cementitious Materials in Concrete Pavements – NRRRA Rigid Team – MnDOT](https://www.dot.state.mn.us/mnroad/nrra/structure-teams/rigid/alternative-cementitious-materials.html)  
<https://www.dot.state.mn.us/mnroad/nrra/structure-teams/rigid/alternative-cementitious-materials.html>

- 3.5 mile I-94, original Westbound
- 3.5 mile I-94, Mainline
- 2.5 mile Low Volume Road (LVR)

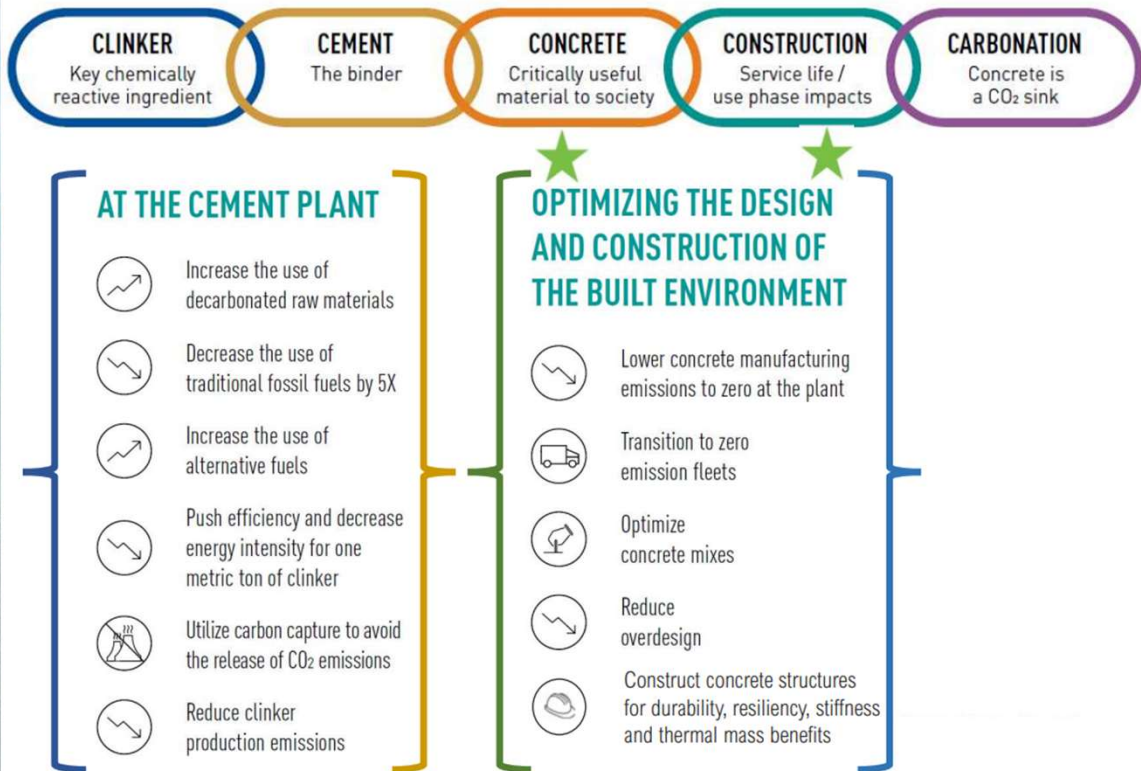
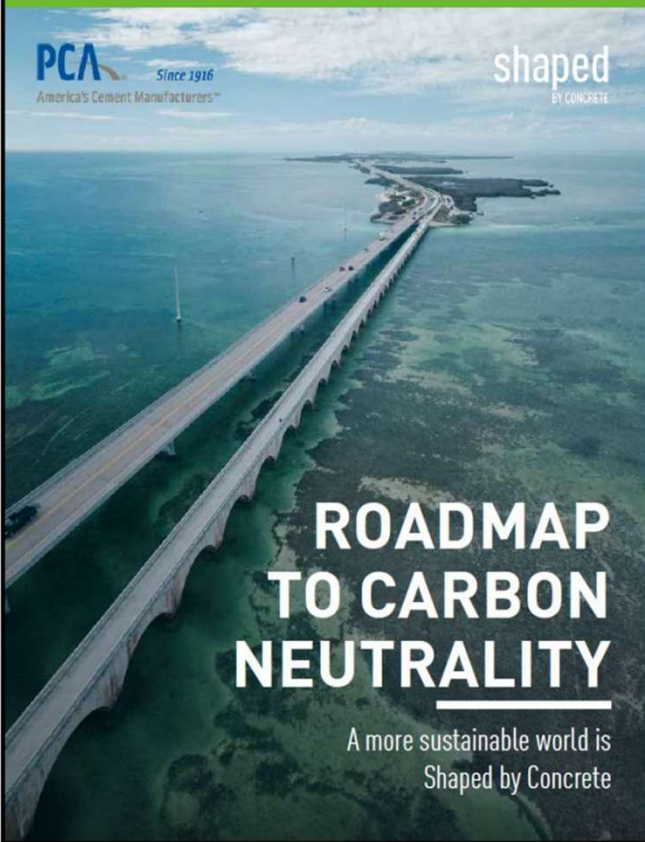






# Sustainability Roadmap

# Roadmap to Carbon Neutrality: Cement & Concrete



# Solutions for Lowering Your Carbon Footprint



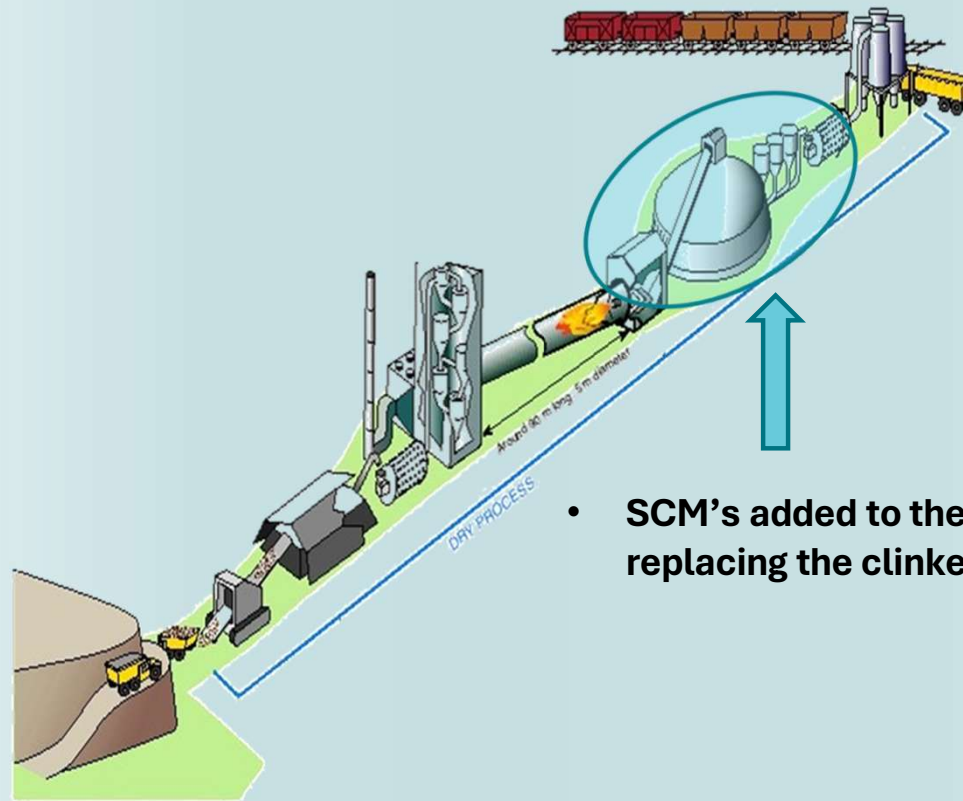
## ASTM C-595 (AASHTO M-240)

- **Type IS(X)**  
C150 cement clinker + Slag
- **Type IP (X)**  
C150 cement clinker + Pozzolan
- **Type IL**  
C150 cement clinker + Limestone
- **Type IT Y(X) , Z(X)**  
C150 cement clinker +  
more than one NCM

**Developing ASTM Standards for New Materials can take YEARS.**



# Blended Cement Production



- **SCM's added to the Finish Mill, replacing the clinker 1:1**

# How to Specify Portland Limestone Cement



Portland Cement Association: <https://www.greencement.com/>

**Get All the Facts**  
About Portland-Limestone Cement

[Download Fact Sheet](#) [How to Specify PLC](#)

## CO2 Calculator

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

**Enter Your Project Size**

<b>BUILDING SIZE</b> (Total Square Feet)	<b>PAVEMENT LENGTH</b> (Total Lane-Miles)
<input type="text"/>	<input type="text"/>
<b>CHOOSE ONE</b>	
<b>CEMENT SILO</b> (Capacity in Metric Tons)	<b>GEOTECHNICAL</b> (For Soil Treatment, volume in cu ft)
<input type="text"/>	<input type="text"/>
<a href="#">CALCULATE</a>	

To view the assumptions made on these calculations, see our [advanced calculator](#).

# How to Specify New Low Carbon Concrete Mixes

## Specifications – Prescriptive to Performance

- Design multiple concrete mixtures that meet performance specifications
- Allow innovation with materials and construction specification language while balancing risks
- Transitioning to performance-based specifications requires collaboration to share planning and risk among all participants



# Prescriptive Specifications



## •Part 1 General

- Provides an introduction, defines key terms, outlines the scope of the work, and specifies submission guidelines and quality assurance standards

## •Part 2 Products

- Provides information about the materials, equipment, and products that will be used in the project

## •Part 3 Execution

- Describes the installation or application protocols, including preparation, examination, installation, and confirmation of performance standards.

# Performance Specifications



**“A specification in which the requirements are stated in terms of required results with criteria for verifying compliance rather than specific composition, design, or procedure.” – ACI CT-23**



# Concrete Testing



**With new and varying constituent materials, we can NOT depend on Slump, Air, and Strength ALONE!**

- **Workability**
- **Consistency**
- **Segregation**
- **Bleed Water**
- **Set Time**

# Industry Partners



# Q & A | Contact



**Stephanie Hampton**  
Director of Technical Services  
[Stephanie.Hampton@continentalcement.com](mailto:Stephanie.Hampton@continentalcement.com)  
(302) 540-5620

# Thank You!

