

# Slag Cement Basics

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Heidelberg Materials  
Southeast Cement



# Presentation Overview

## What is Slag Cement?

- How is it produced
- How does it compare with other cementitious materials, physical and chemical attributes

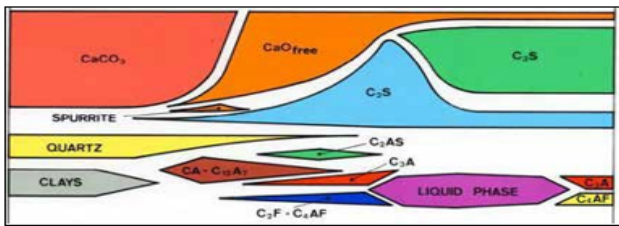
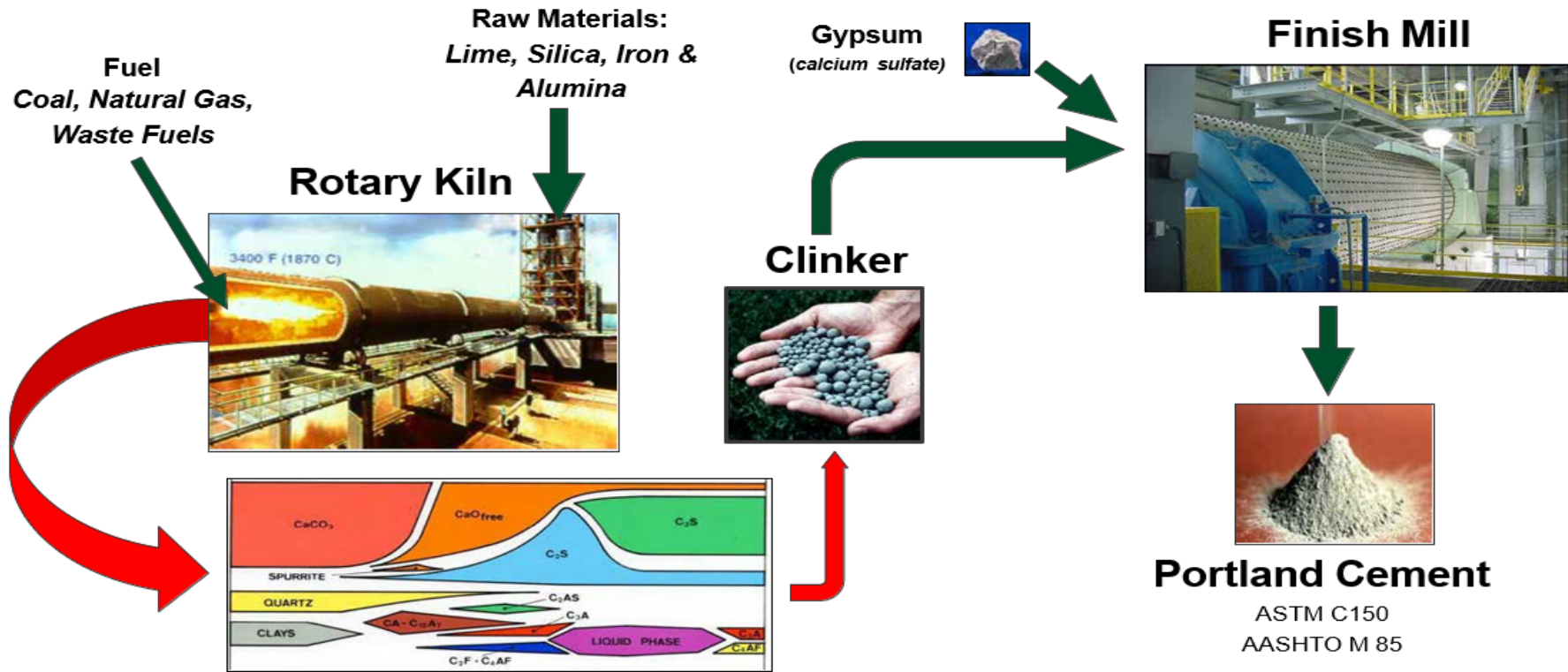
## Slag Cement in Concrete

- Effect on Concrete Mixtures, plastic and hardened properties
- Durable Properties, permeability, sulfate resistance and aggregate reactivity potential
- Sustainable attributes in lowering the carbon footprint and embodied energy in a cubic yard of concrete

## Slag Cement Information and Resources



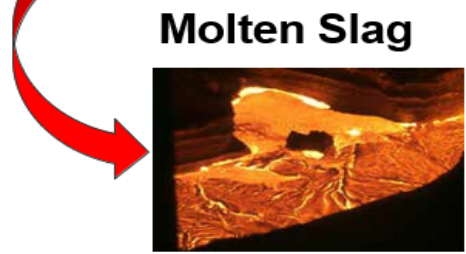
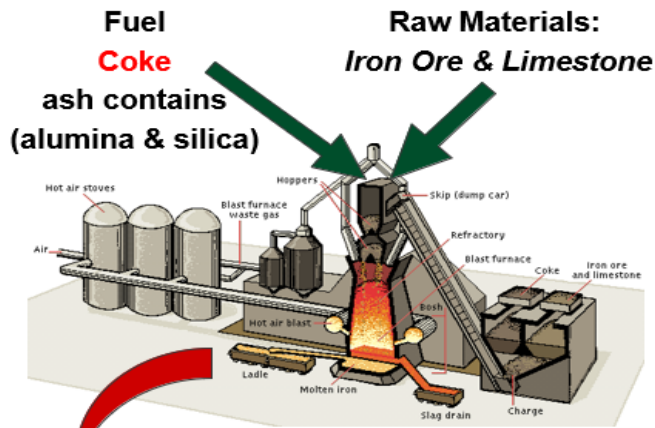
# Manufacturing Portland Cement



Heidelberg Materials | 01.27.2023 | P501 Concrete Seminar | ATL | PLC & SLAG | Wayne M Wilson



# Manufacturing Slag Cement



Heidelberg Materials

**Gypsum**  
(calcium sulfate)

**GBFS**

**Water Quench**



**Slag Cement**

ASTM C989  
AASHTO M 302

Designation: C989/C989M – 22

# Specifications:

Standard Specification for  
Slag Cement for Use in Concrete and Mortars<sup>1</sup>

Slag Activity Index with a CCRL  
Reference Cement:

**TABLE 1 Physical Requirements**

Item		
Fineness:		
Amount retained when wet screened on a 45- $\mu$ m (No. 325) sieve, max %		20
Specific surface by air permeability, Test Methods C204 shall be determined and reported although no limits are required.		...
Air Content of Slag Mortar, max %		12
	Average of Last Five Consecutive Samples	Any Individual Sample
Slag Activity Index <sup>A</sup>		
28-Day Index, min %		
Grade 80	75	70
Grade 100	95	90
Grade 120	115	110

<sup>A</sup> 7-Day Slag Activity Index shall be determined on Grades 100 and 120, and reported for informational purposes.

**TABLE 3 Alkali and Strength Limits of Reference Portland Cement for Slag Activity Tests**

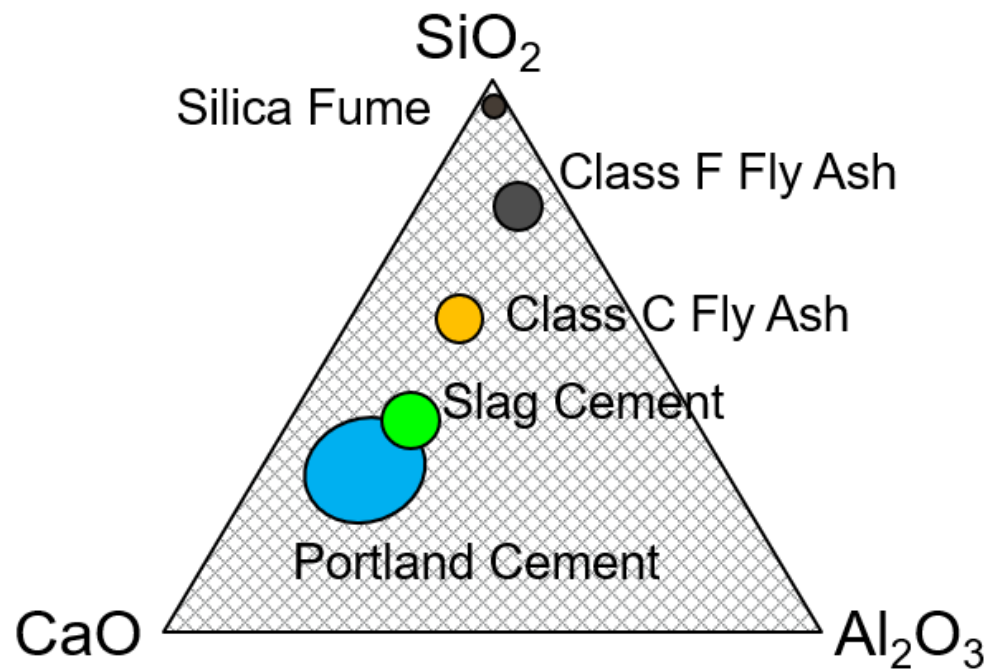
Total Alkalies (Na <sub>2</sub> O + 0.658 K <sub>2</sub> O)	min %	0.60
	max %	0.90
Compressive Strength, MPa, min, 28 days <sup>A</sup>		35 [5000 psi]

<sup>A</sup> The minimum strength limit is based solely on the strength of the Test Method C109/C109M mortar cubes, as required in Specification C150/C150M, regardless of the strength of the flow-controlled Specification C989/C989M mortar cubes.

Note:

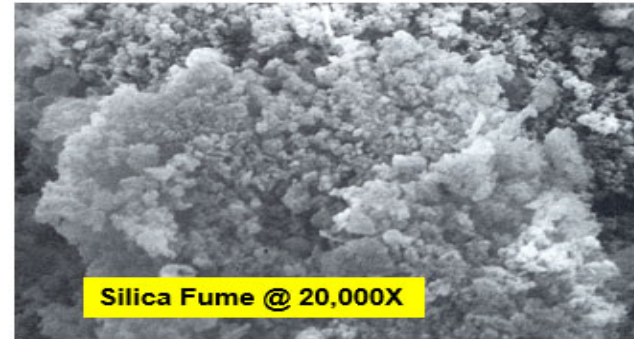
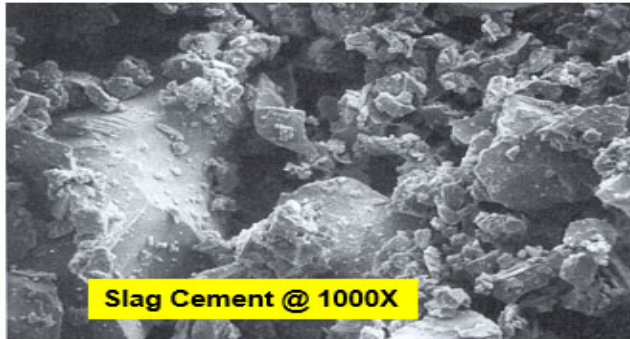
Slag Cement Reactivity is measured using the CCRL Reference Cement tested in ASTM C109 Mortar Cubes @ a 50% slag cement replacement

# How does slag cement compare with other cementitious materials (chemistry):





# How does slag cement compare with other cementitious materials (particle shape):



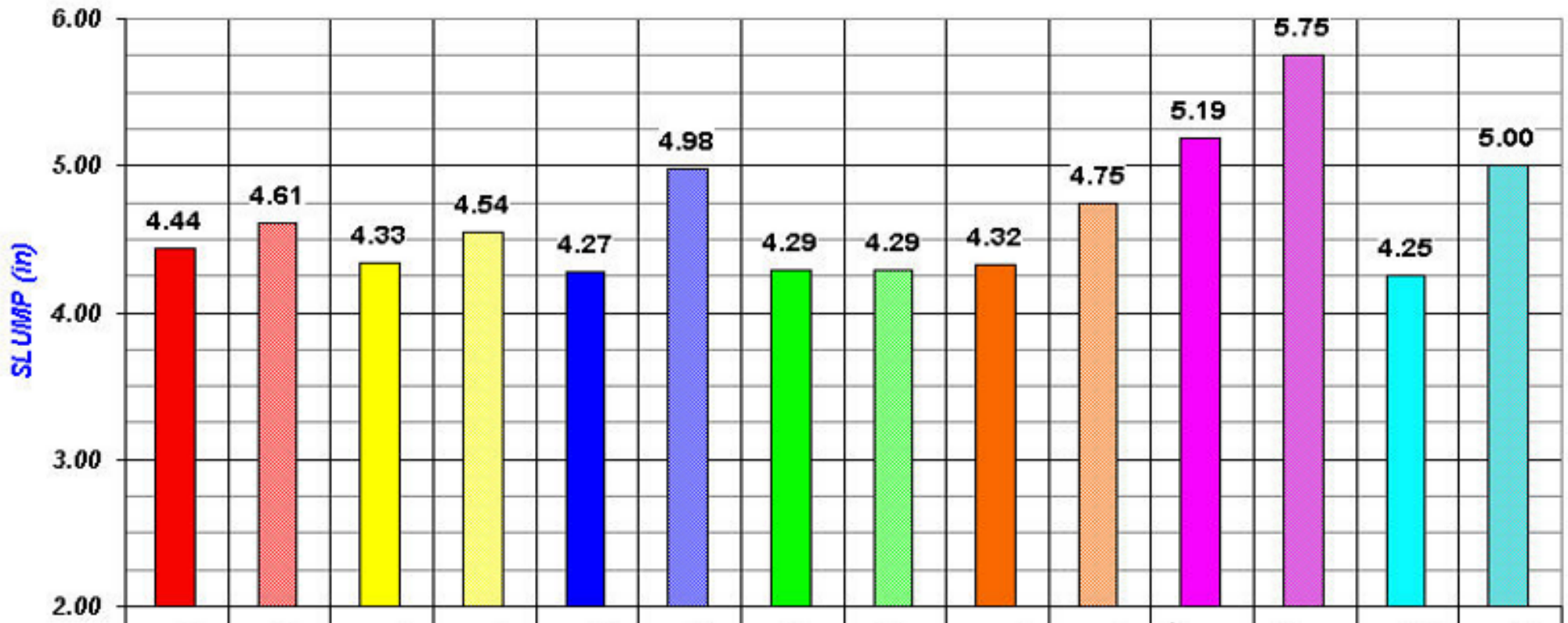
# Concrete Properties:

General Concrete Properties*			
Plastic Concrete		Hardened Concrete	
Water Demand	↓	Early Strength	↓
Workability	↑	Later Age Strength	↑
Bleeding & Segregation	↓	Permeability	↓↓
Air Content	↓	Chloride Ingress	↓
Heat of Hydration	↓	ASR Potential	↓↓
Setting Time	↑	Sulfate Resistance	↑↑
Finishability	↑	Freeze Thaw Resistance	↔
Pumpability	↑	Abrasion Resistance	↔
Plastic Shrinkage	↔	Drying Shrinkage	↔

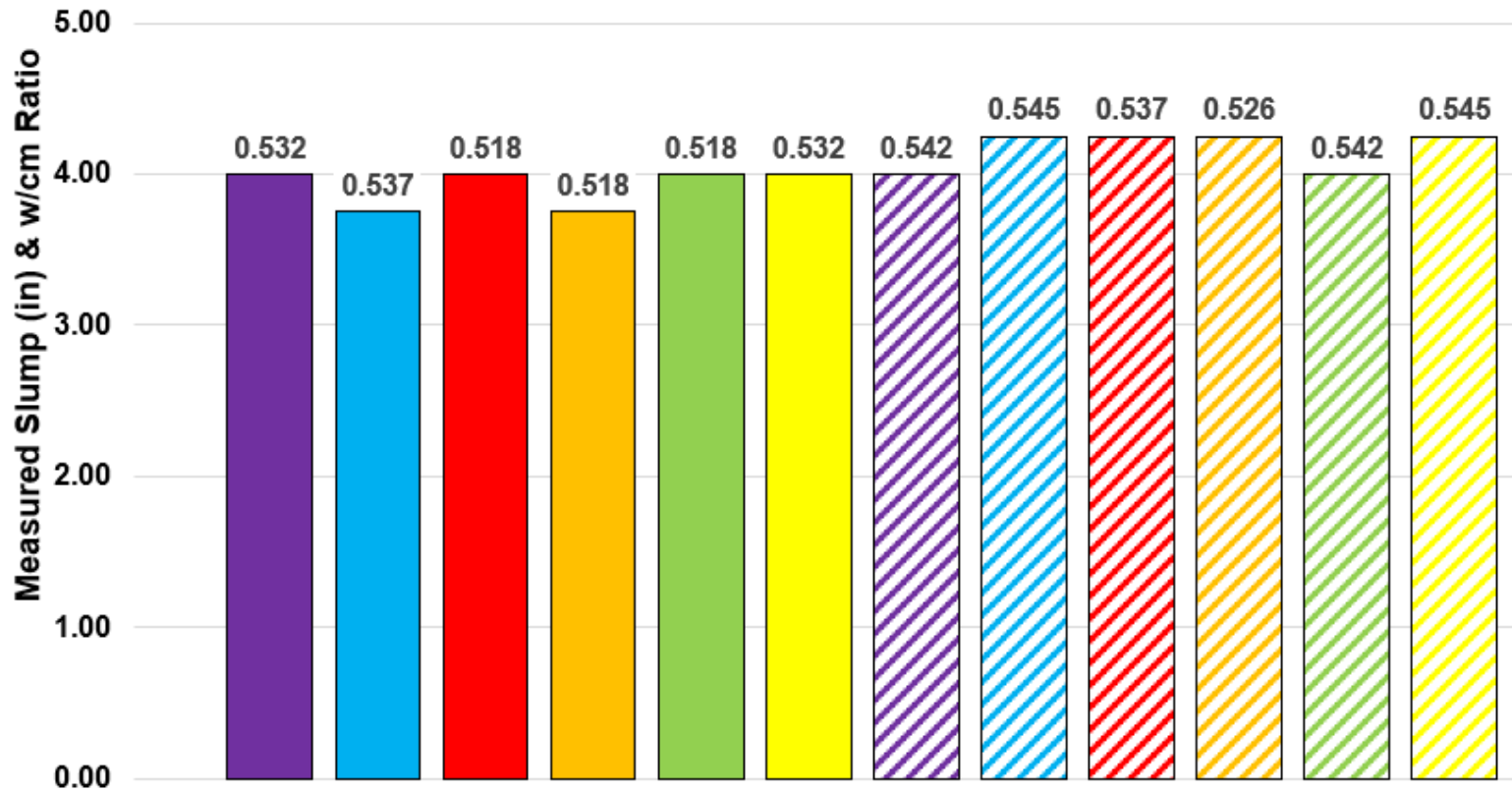
\*General guidance properties, concrete making materials and mixture proportions will determine project specific properties of any given concrete mixture.



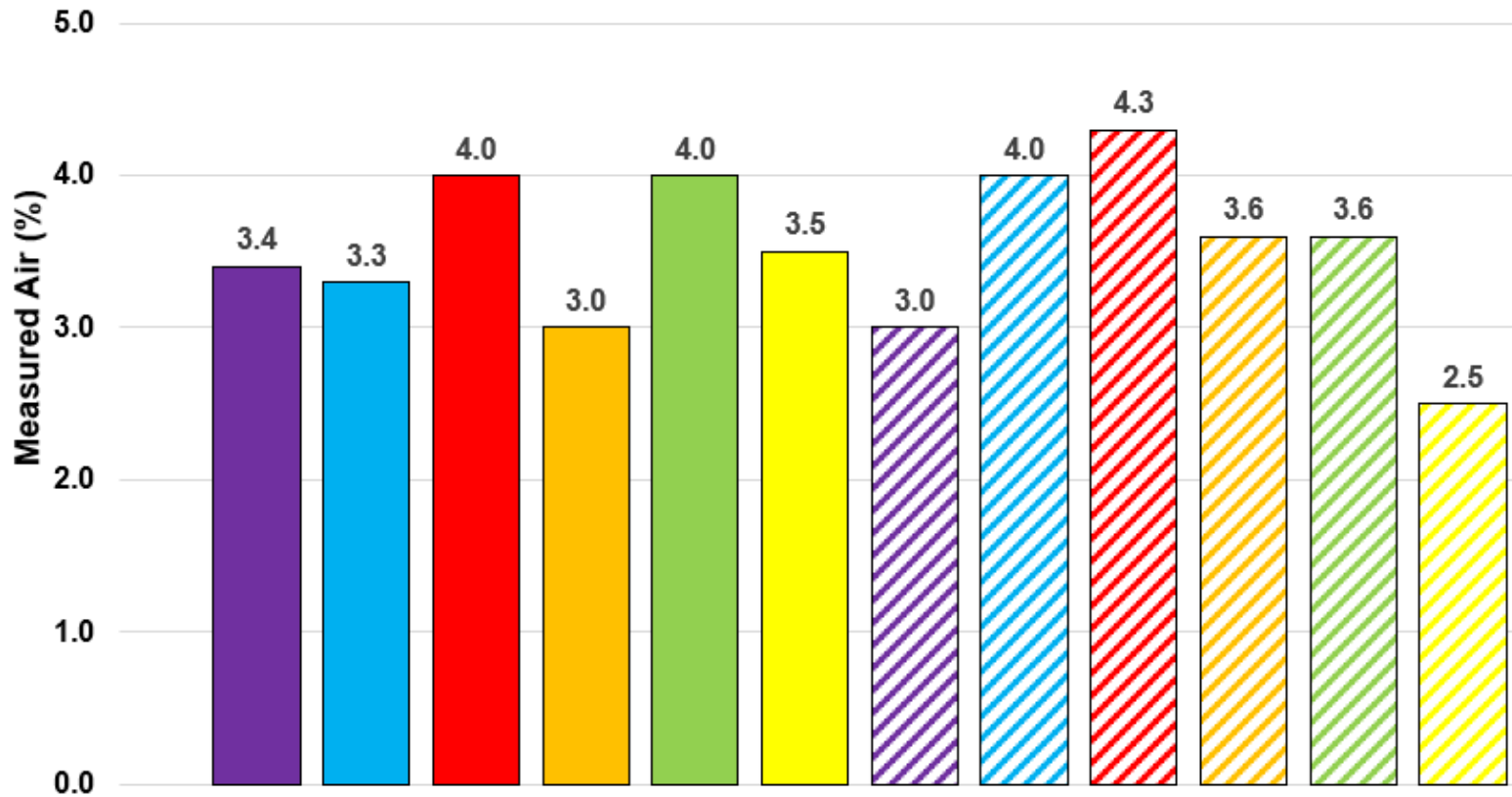
# Water Demand:



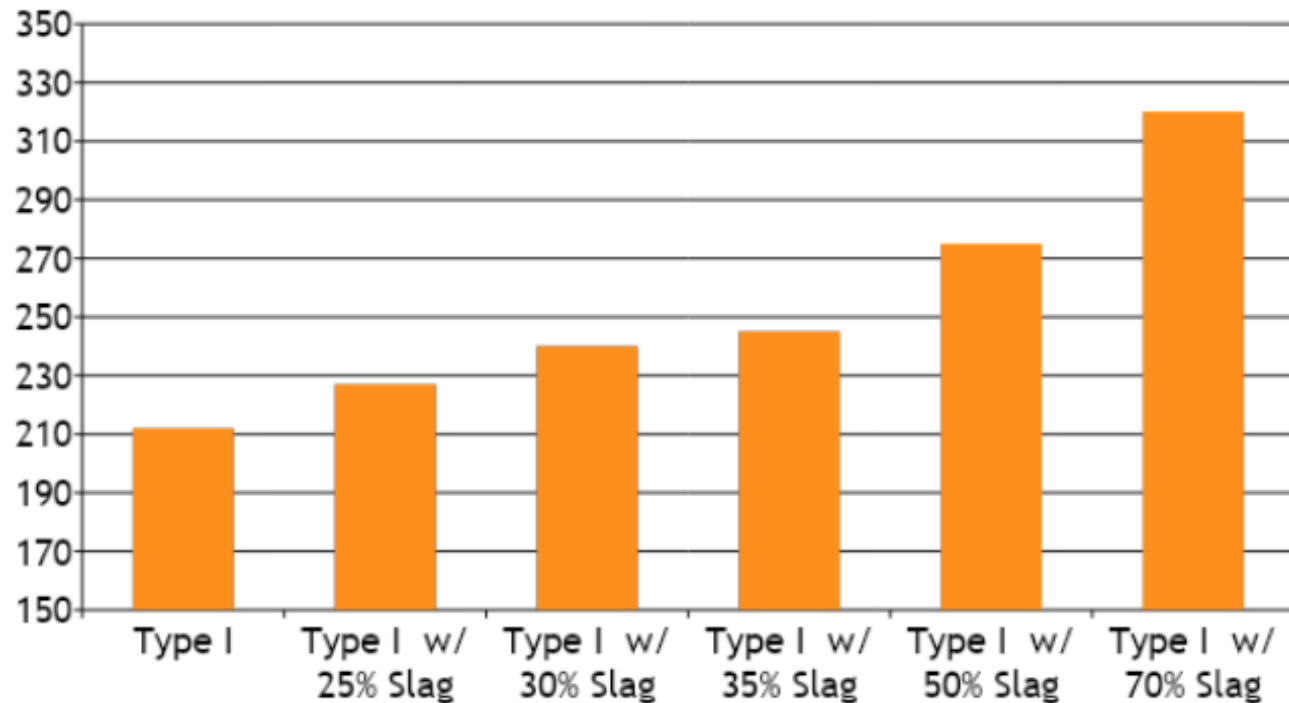
# Water Demand:



# Air Content:



## Time of Set @ different replacement levels:



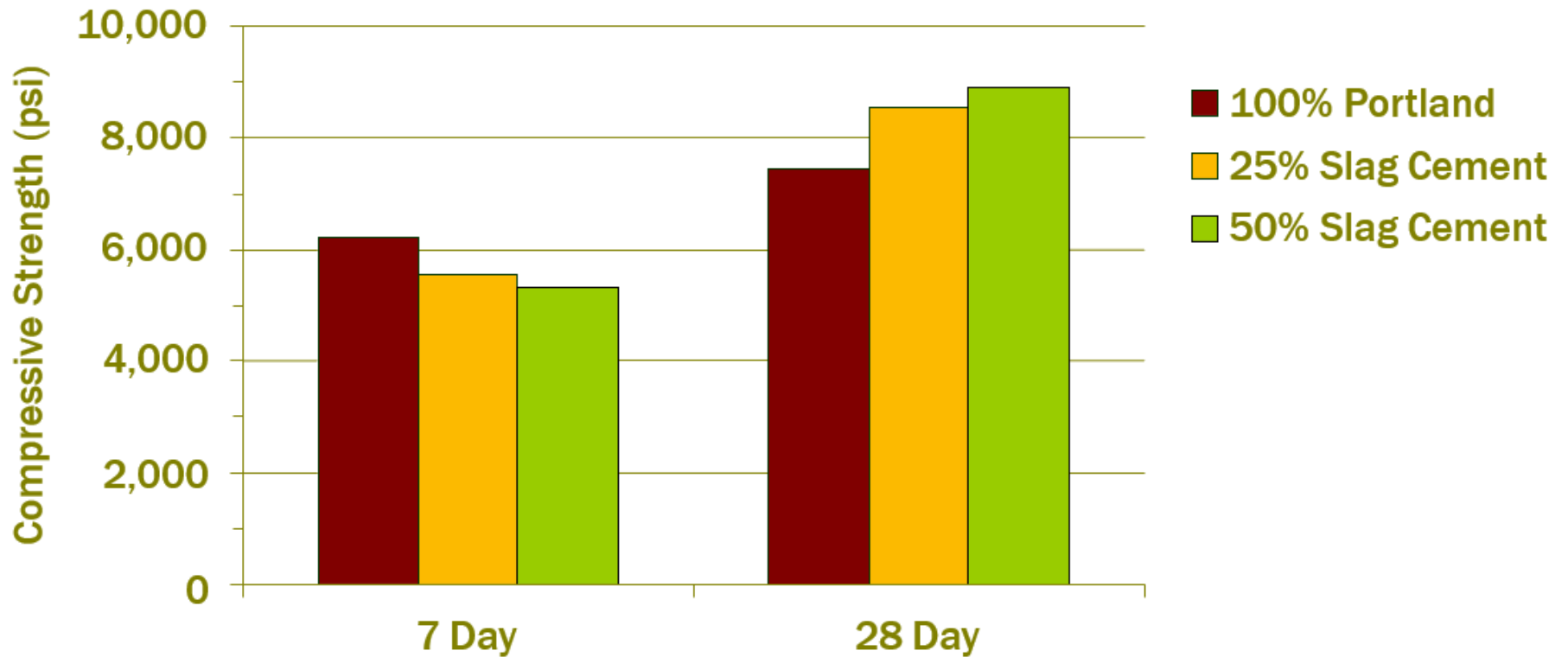
70°F lab non-air 550 pcy OPC/Slag mixes @ 0.48 w/cm ratio

# Time of Set @ different placement temps:

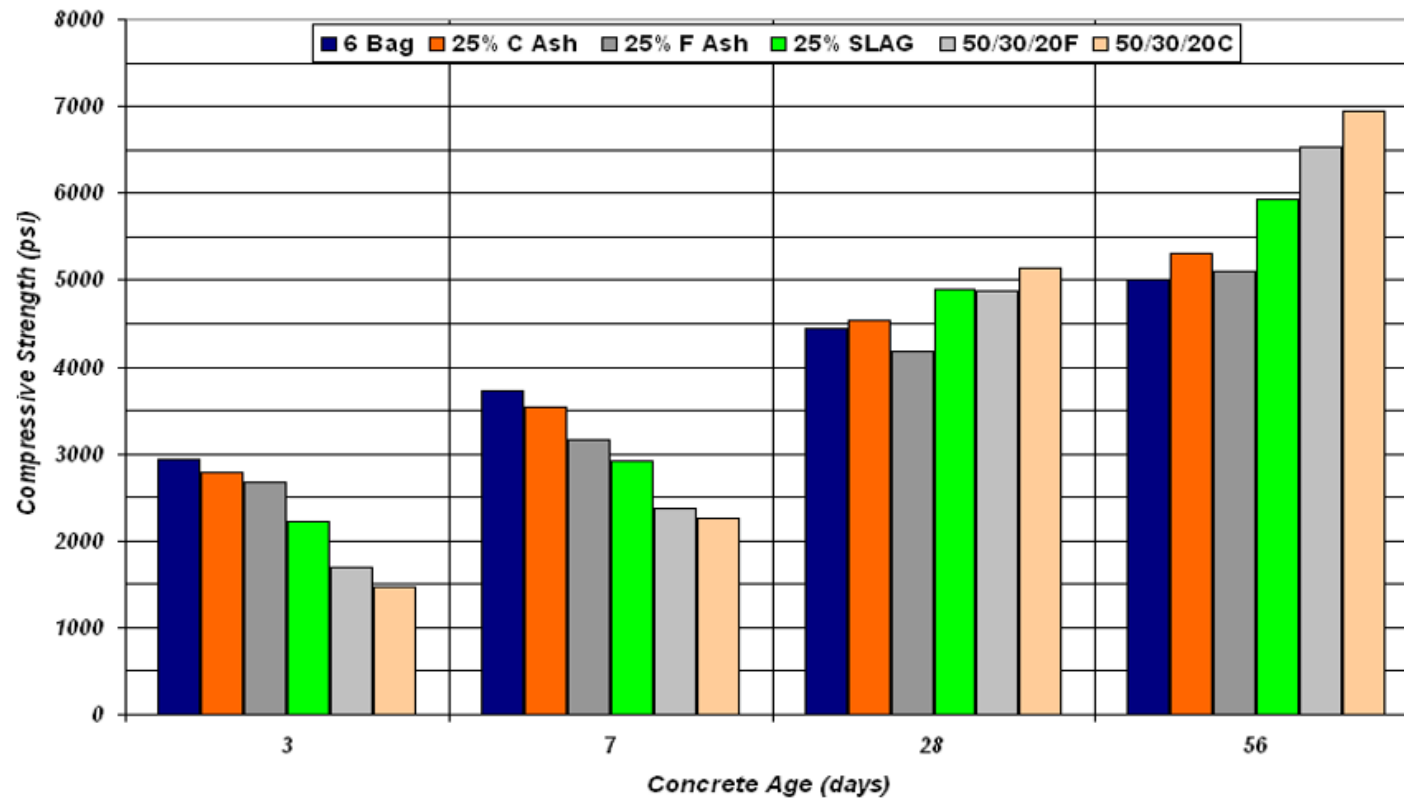




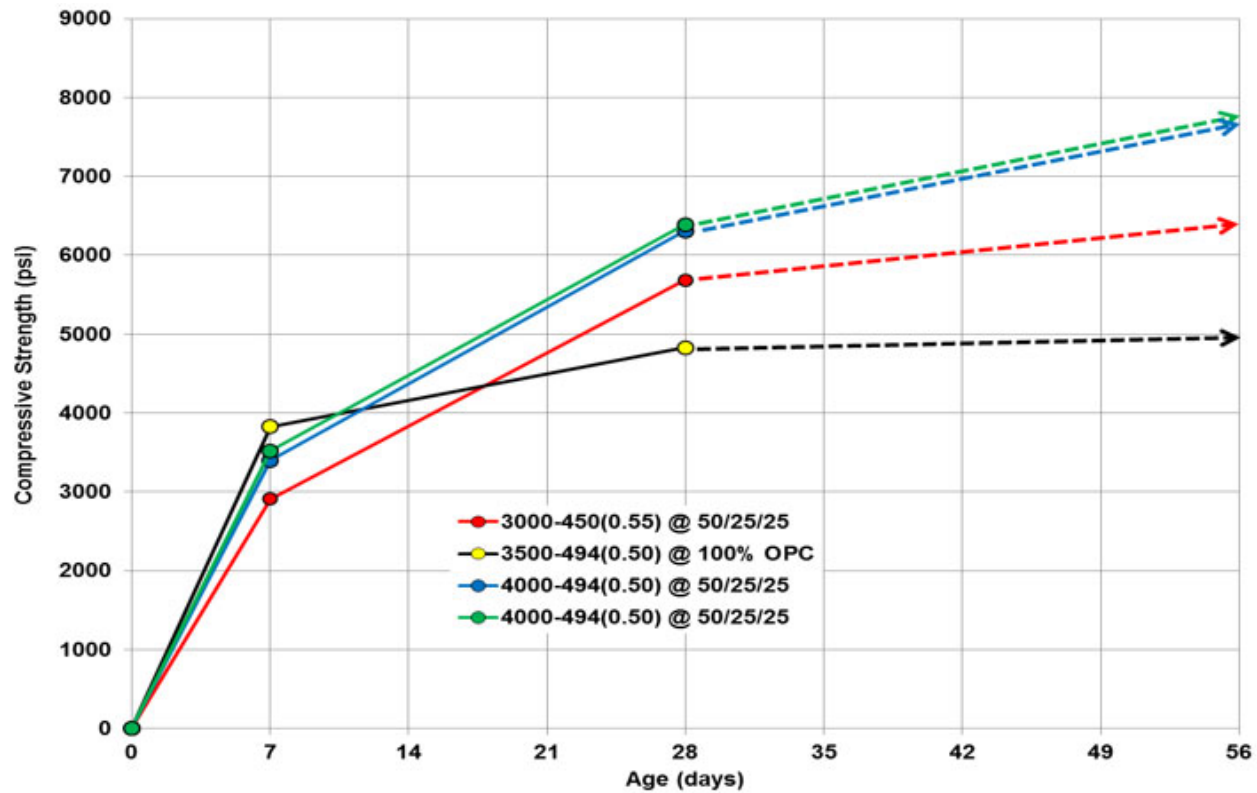
# Compressive Strength:



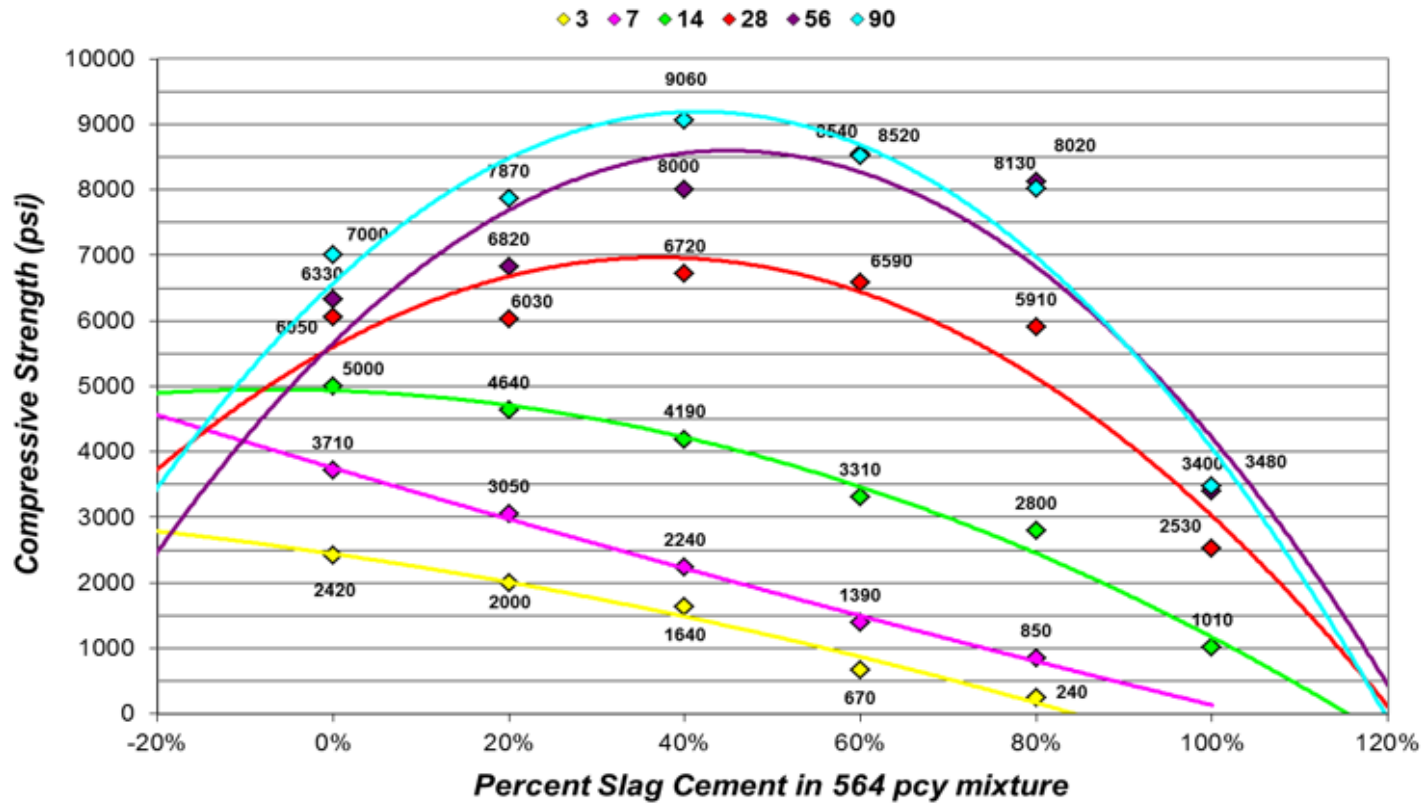
# Compressive Strength:



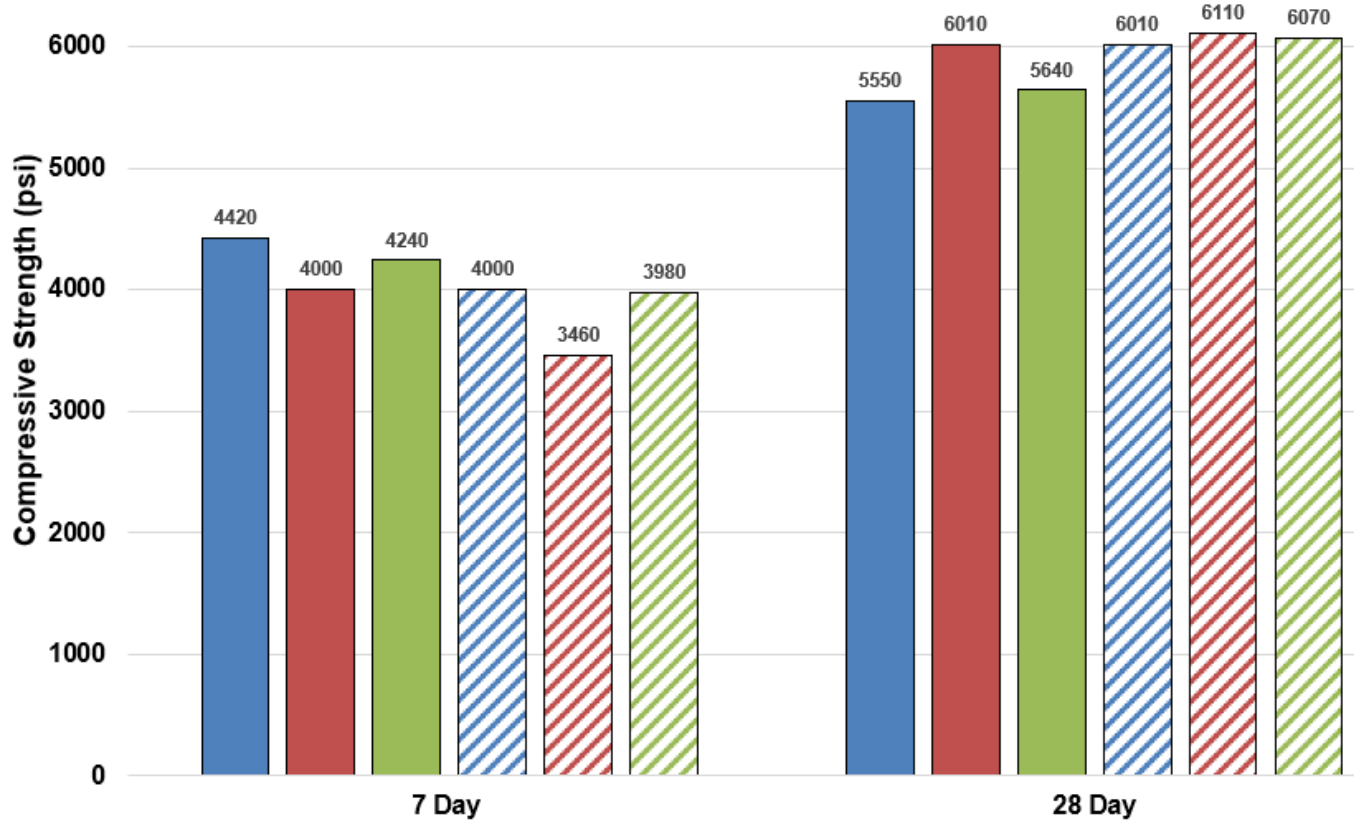
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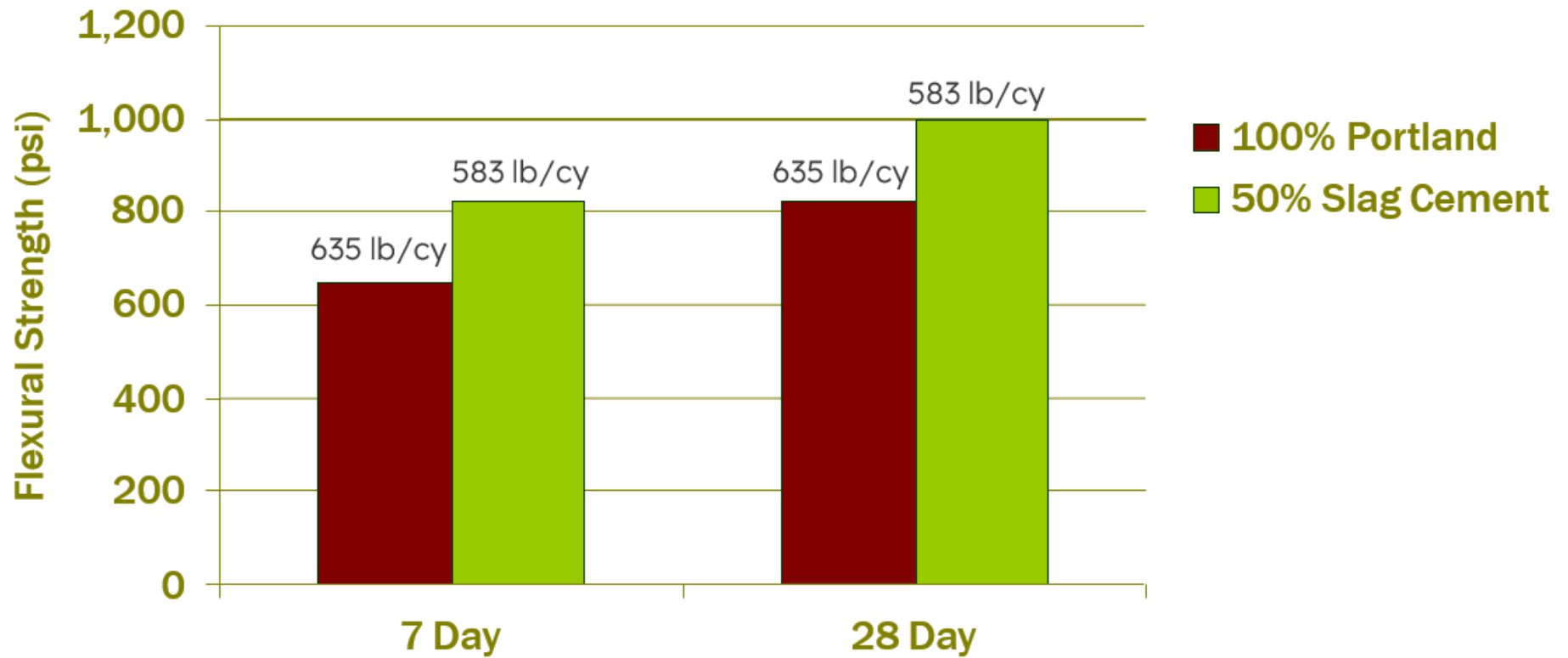


# Compressive Strength:

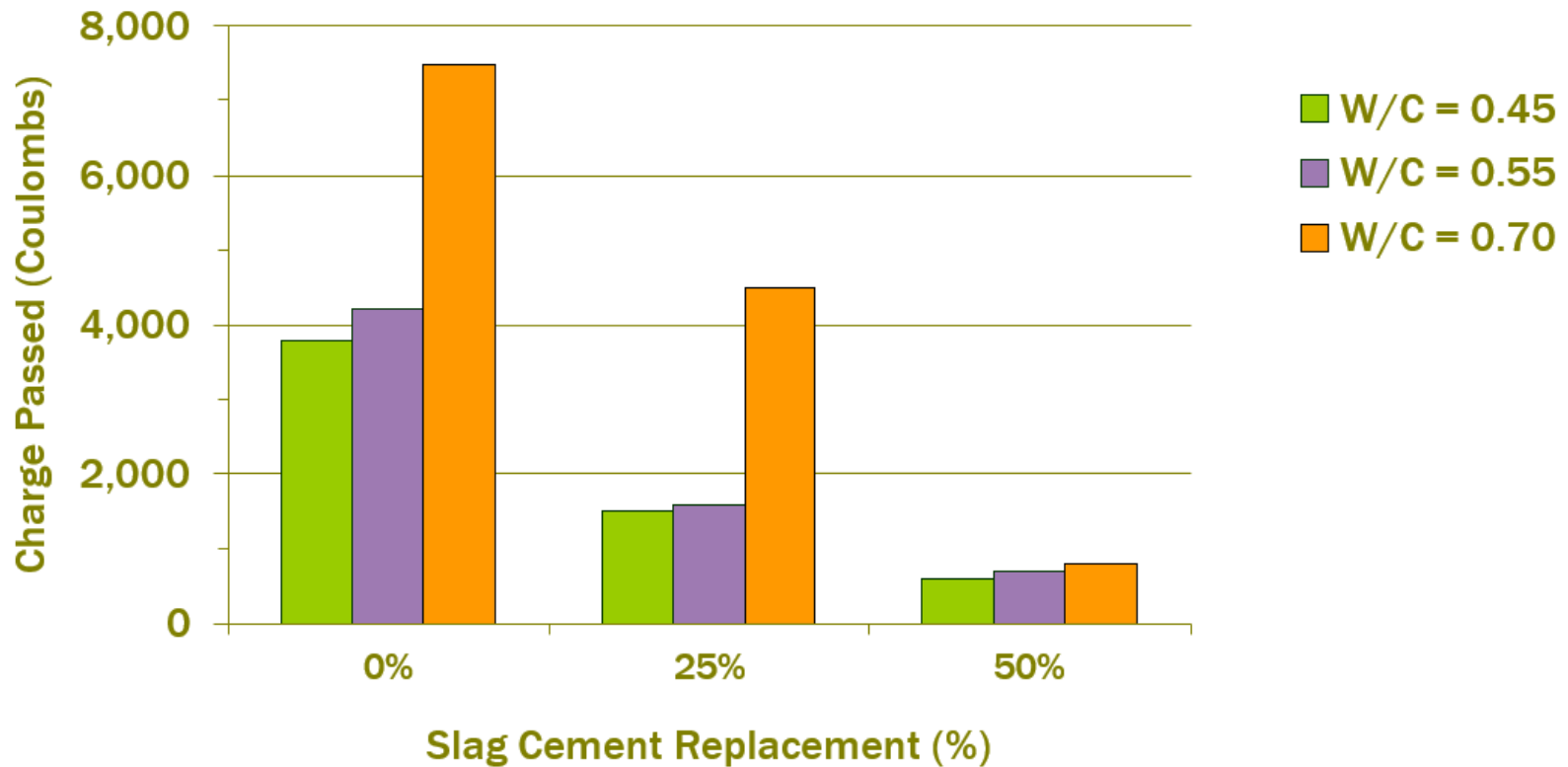




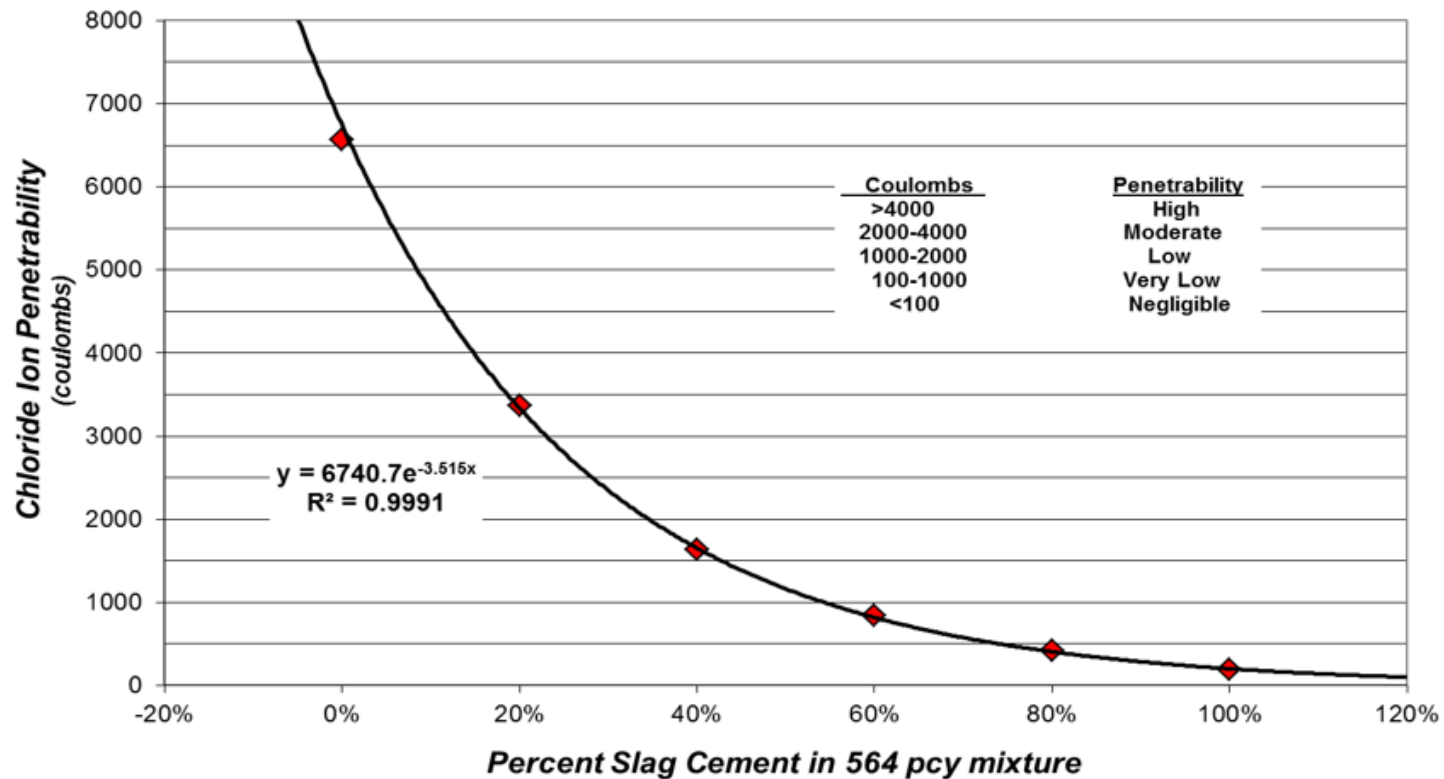
# Flexural Strength:



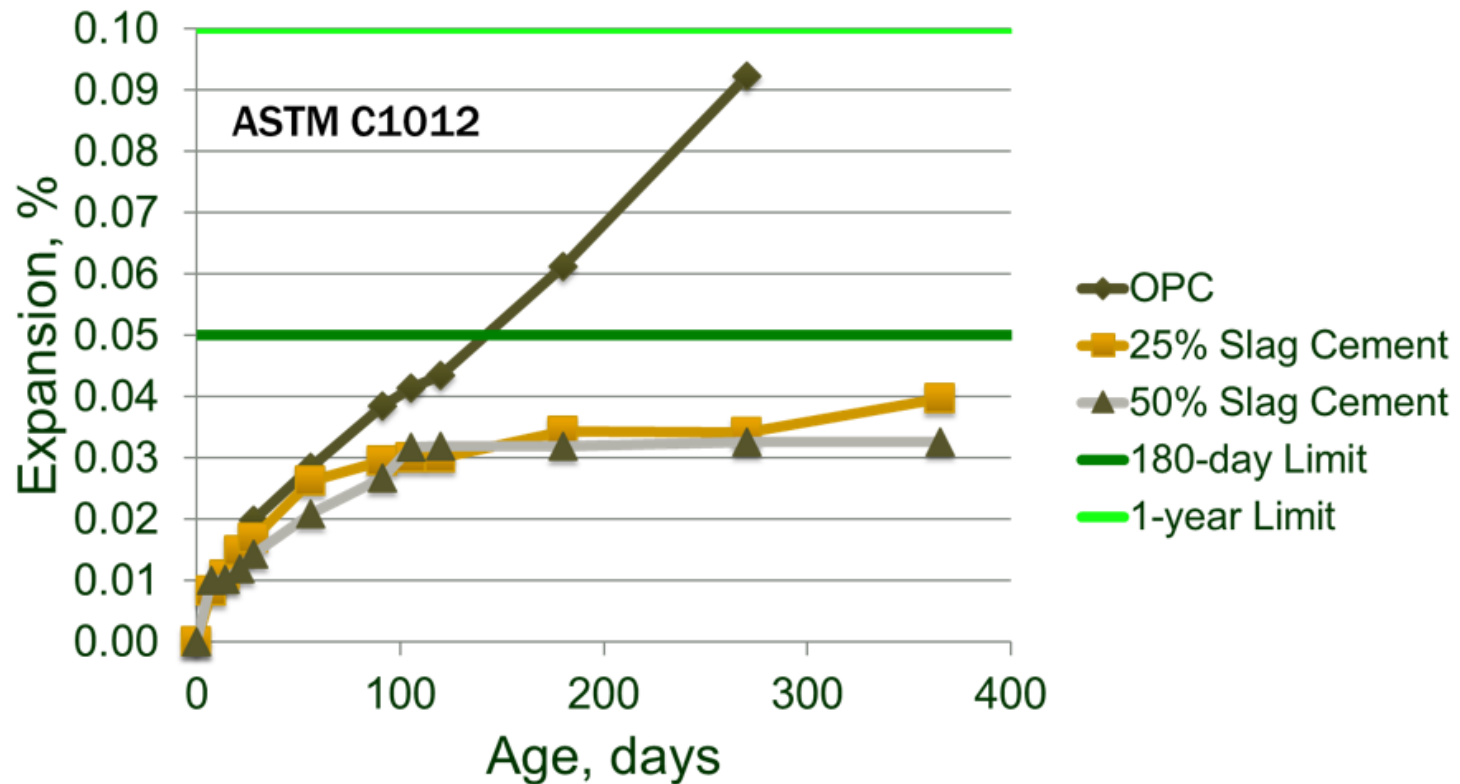
# Permeability, ASTM C1202



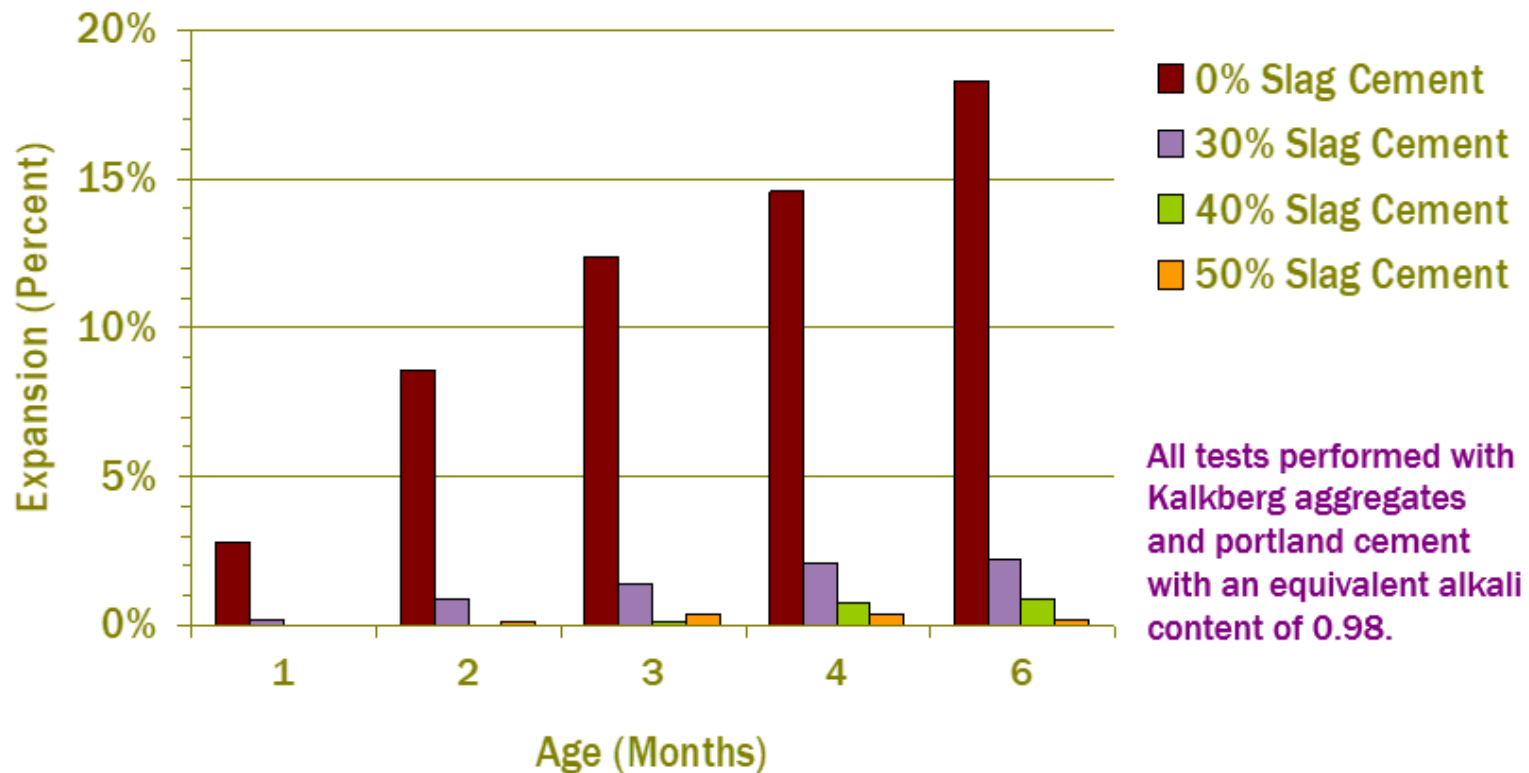
# Permeability, ASTM C1202



# Sulfate Exposure, ASTM C1012

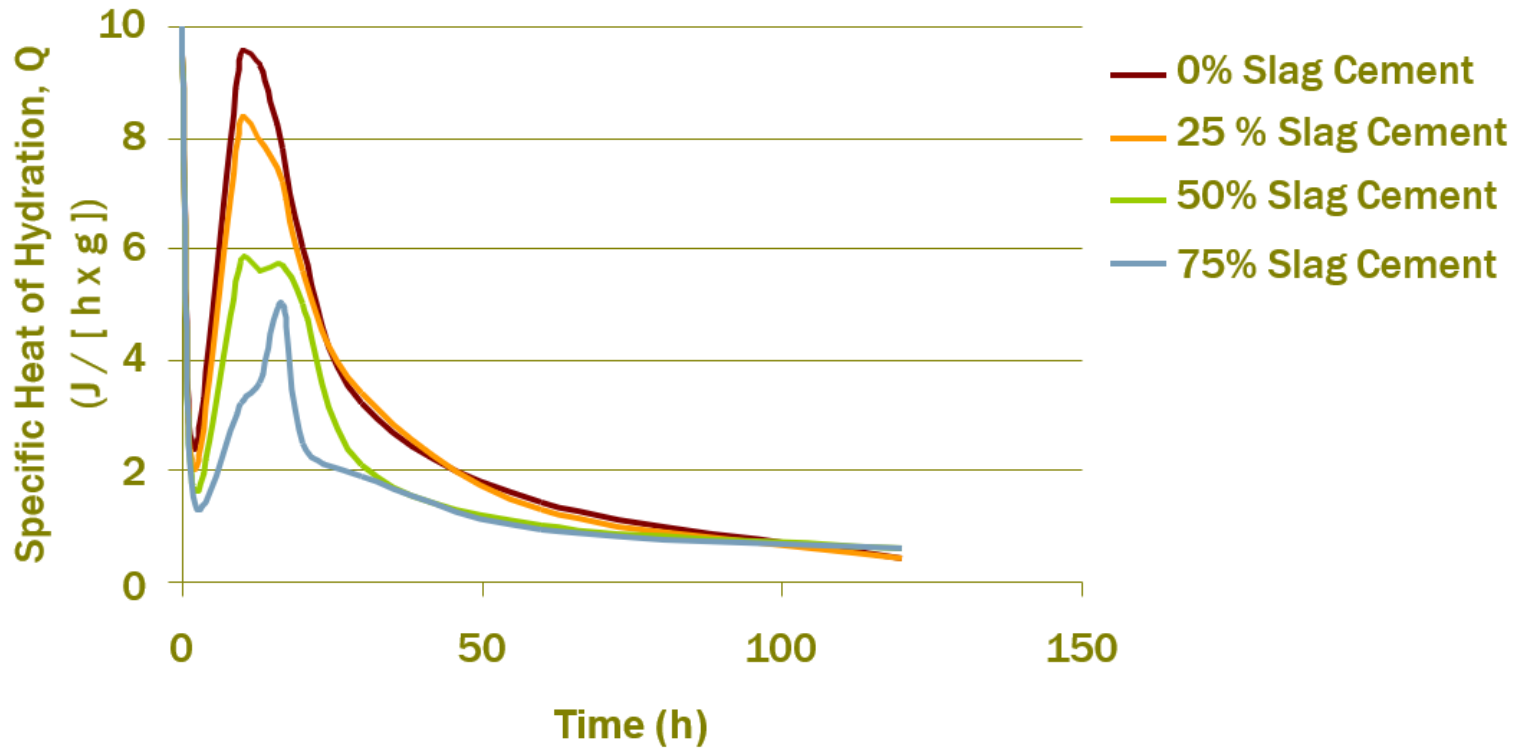


# ASR Potential, ASTM C227

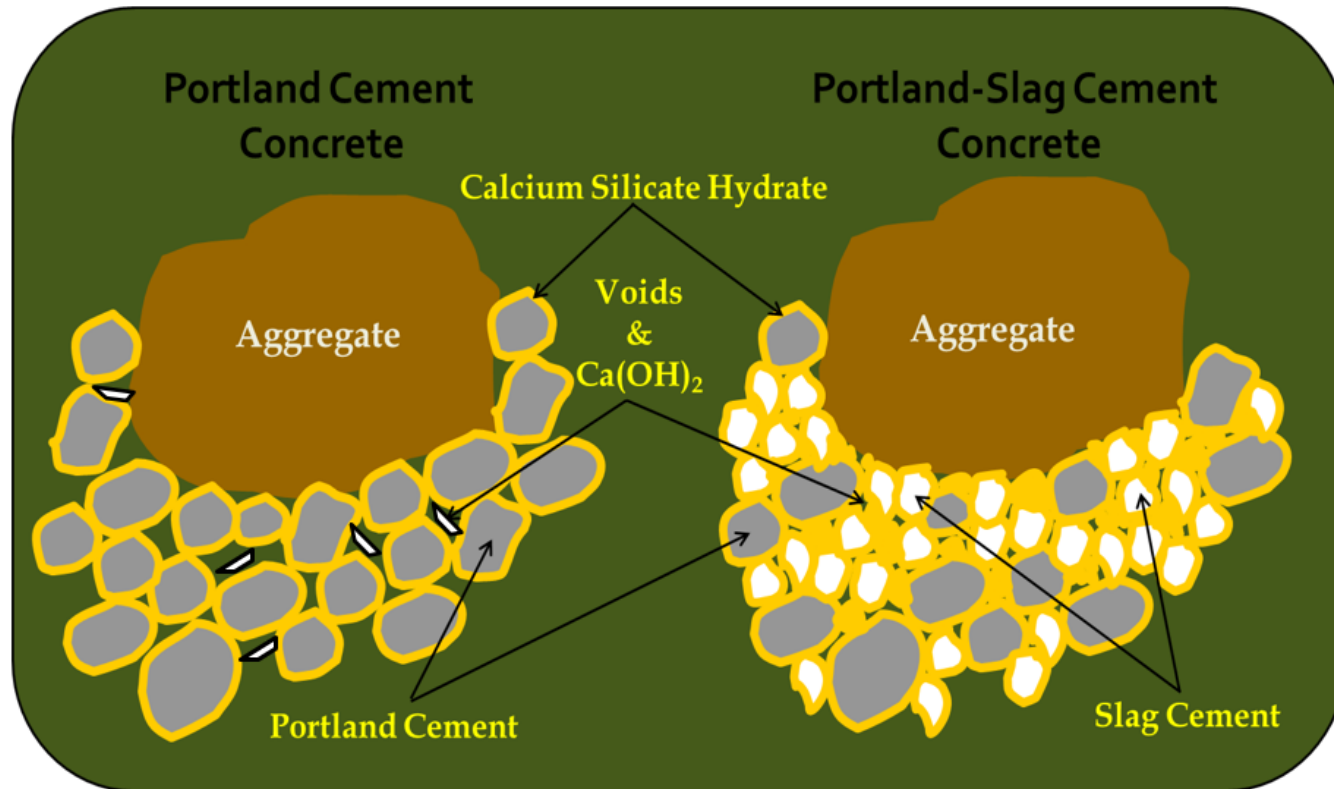




# Heat of Hydration:



# Why does slag cement work?



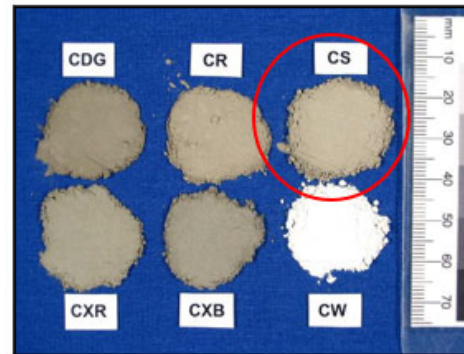
# Color (solar reflectance):

**PCA**  
 Portland Cement Association  
 Research & Development Information

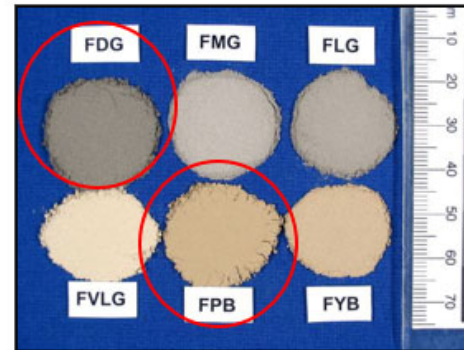
PCA R&D Serial No. 2982

*Solar Reflectance of Concretes for  
 LEED Sustainable Sites Credit:  
 Heat Island Effect*

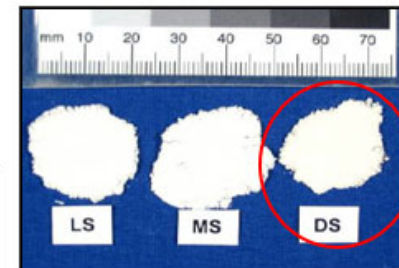
by Medgar L. Marceau and Martha G.  
 VanGeem



**Portland Cements**



**Fly Ashes**



**Slag Cements**

# Color (solar reflectance):

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*Research & Development Information*

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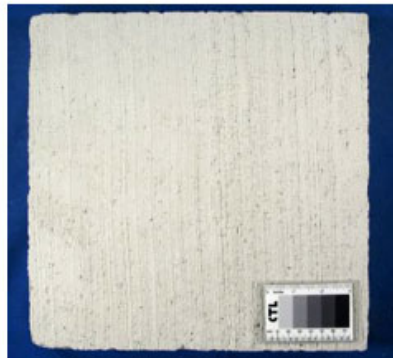
by Medgar L. Marceau and Martha G.  
VanGeem



Portland Cement CS



Portland Cement CS w/ Ash FDG

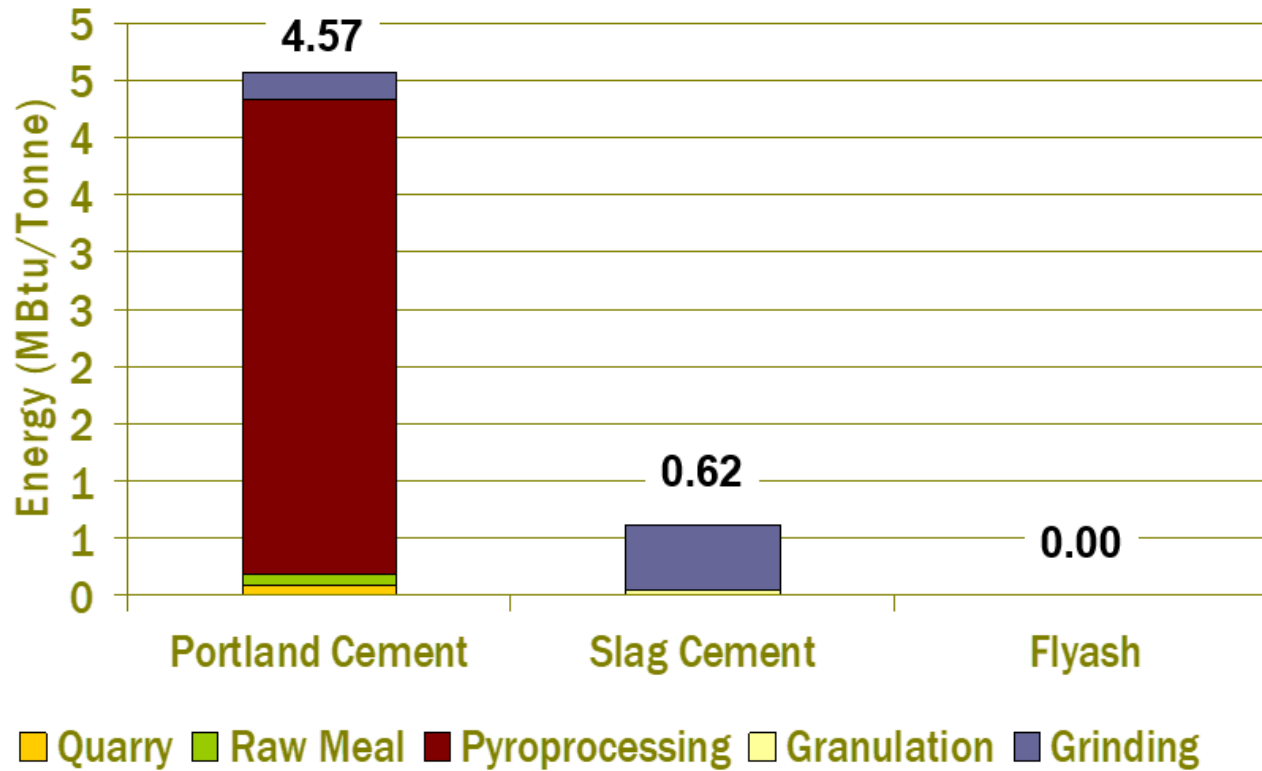


Portland Cement CS w/ Ash FPB



Portland Cement CS w/ Slag DS

## Environment, production energy:





# Environment, Industry Average EPD's (GWP):

## **Portland Cement:**

- 922 kg of CO<sup>2</sup> per metric ton of cement

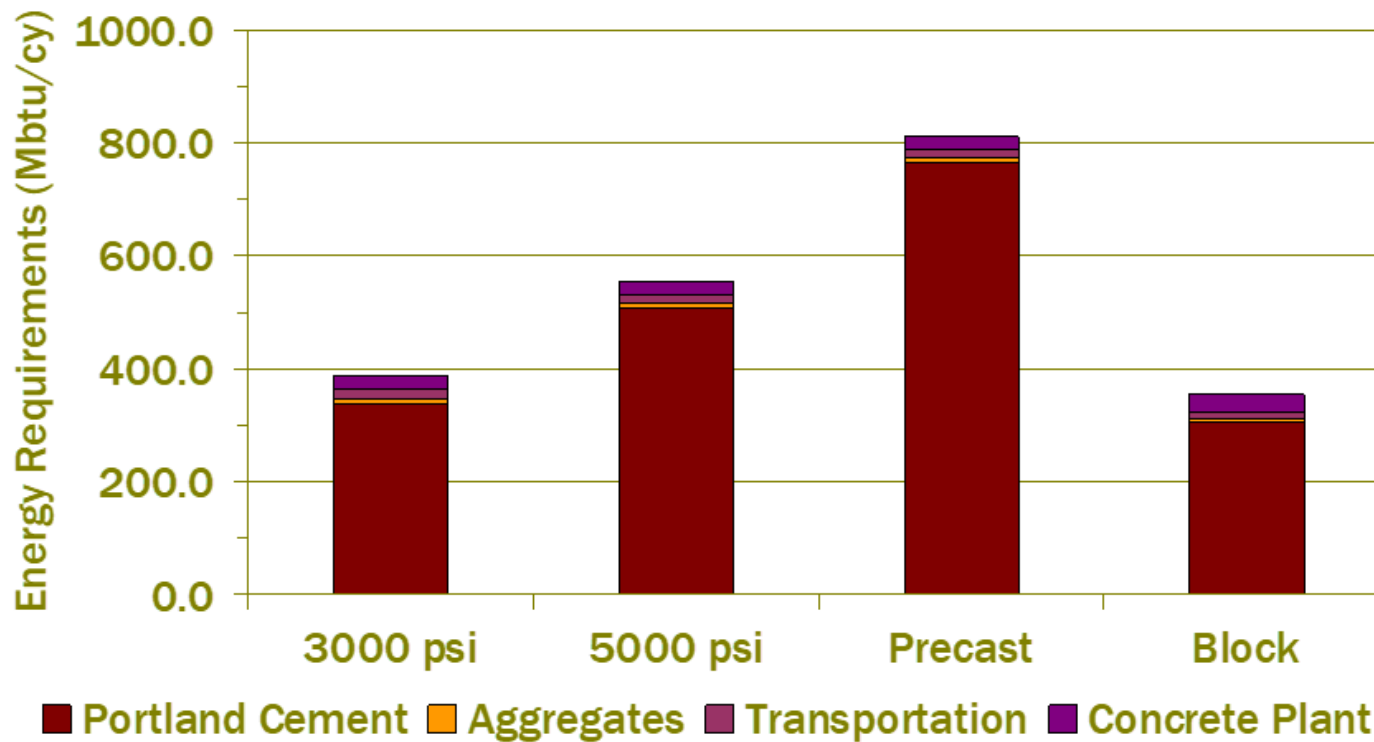
## **Portland-Limestone Cement:**

- 846 kg of CO<sup>2</sup> per metric ton of cement

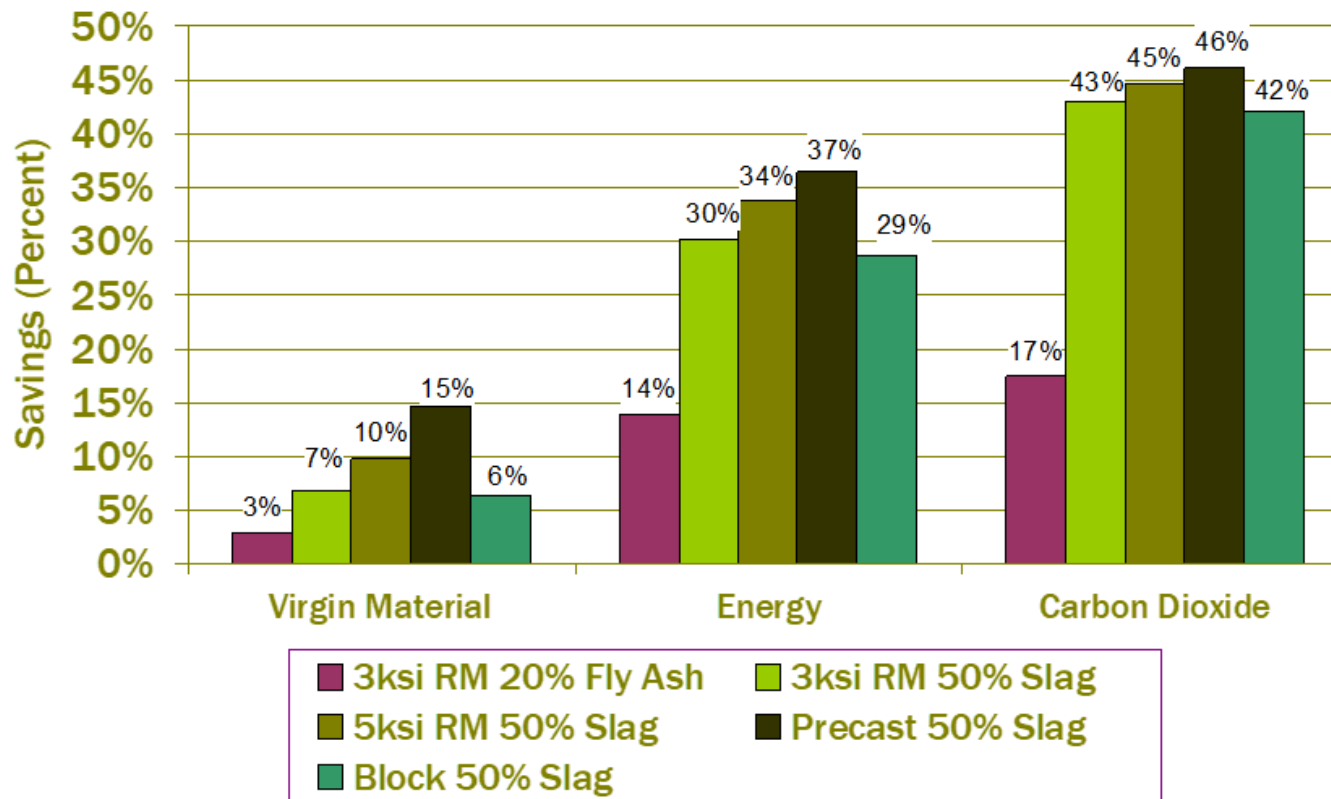
## **Slag Cement:**

- 147 kg of CO<sup>2</sup> per metric ton of cement

# Environment, concrete embodied energy:



## Environment, concrete materials, energy & CO<sup>2</sup> savings:



# SCA website, [www.slagcement.org](http://www.slagcement.org):

Welcome to the Slag Cement Association

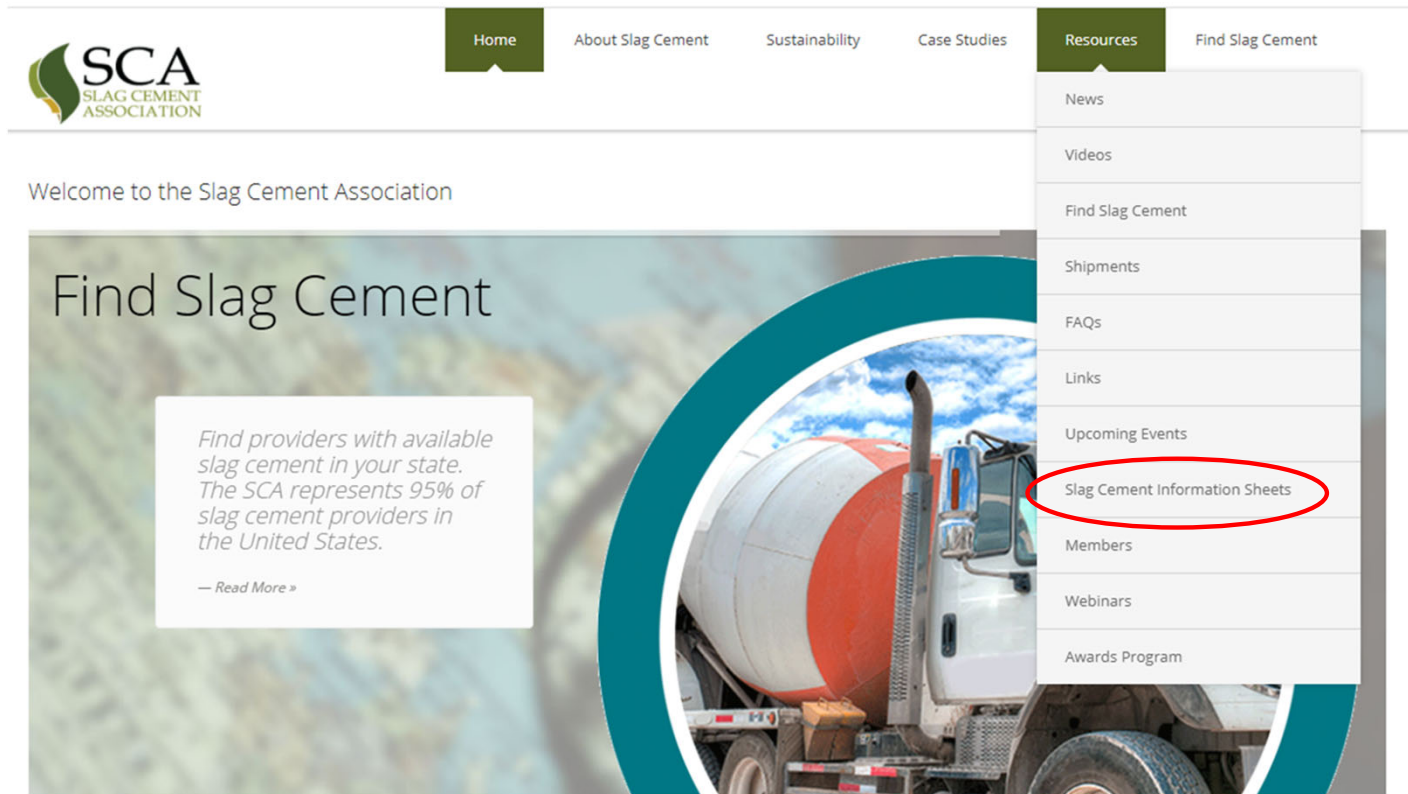
## SCA Awards Program

*Register for 2020 Awards Ceremony,  
April 15th, 2021 @ 1pm EST*

[— Read more »](#)



# SCA website, [www.slagcement.org](http://www.slagcement.org):



The screenshot shows the SCA website homepage. The navigation bar includes links for Home, About Slag Cement, Sustainability, Case Studies, Resources, and Find Slag Cement. The Resources dropdown menu is open, listing various options, with "Slag Cement Information Sheets" circled in red. The main content area features a "Find Slag Cement" section with a text box containing the following text:

Find providers with available slag cement in your state. The SCA represents 95% of slag cement providers in the United States.

— Read More »

## SCA website, [www.slagcement.org](http://www.slagcement.org):

Number	Title
1	<a href="#">↓ About Slag Cement</a>
2	<a href="#">↓ Concrete Proportioning</a>
3	<a href="#">↓ Concrete Time of Set</a>
4	<a href="#">↓ Saw Cutting Joints</a>
5	<a href="#">↓ Producing and Placing Slag Cement Concrete</a>
6	<a href="#">↓ Reducing Permeability</a>
7	<a href="#">↓ Mitigating Sulfate Attack</a>
8	<a href="#">↓ Mitigating Alkali-Silica Reaction</a>
9	<a href="#">↓ Download Reducing Thermal Stress</a>
10	<a href="#">↓ Greening</a>
11	<a href="#">↓ Slag Cement and Fly Ash</a>
12	<a href="#">↓ Terminology and Specifications</a>
13	<a href="#">↓ Download Suggested Specification Provision for Slag Cement in Concrete</a>
14	<a href="#">↓ Compressive and Flexural Strength</a>
15	<a href="#">↓ Slag Cement in High Performance Concrete</a>
16	<a href="#">↓ Producing Precast and Prestressed Concrete with Slag Cement</a>
17	<a href="#">↓ Producing Concrete Pipe with Slag Cement</a>
18	<a href="#">↓ Producing Concrete Block with Slag Cement</a>
19	<a href="#">↓ Slag Cement in Residential Concrete</a>
20	<a href="#">↓ Download Ternary Concrete Mixtures with Slag Cement</a>
21	<a href="#">↓ Download Blended Cements</a>
22	<a href="#">↓ Slag Cement and the Environment</a>
23	<a href="#">↓ Slag Cement and Life Cycle Prediction Models</a>
24	<a href="#">↓ Slag Cement and Controlled Low Strength Material</a>
25	<a href="#">↓ Use of Slag Cement in Soil Cement</a>
26	<a href="#">↓ Waste Solidification using Slag Cement</a>
27	<a href="#">↓ Effect of Slag Cement on Shrinkage in Concrete</a>
28	<a href="#">↓ Slag Cement and LEED</a>
29	<a href="#">↓ Reduce Scaling with Slag Cement and Good Concreteing Practices</a>

# Questions?

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