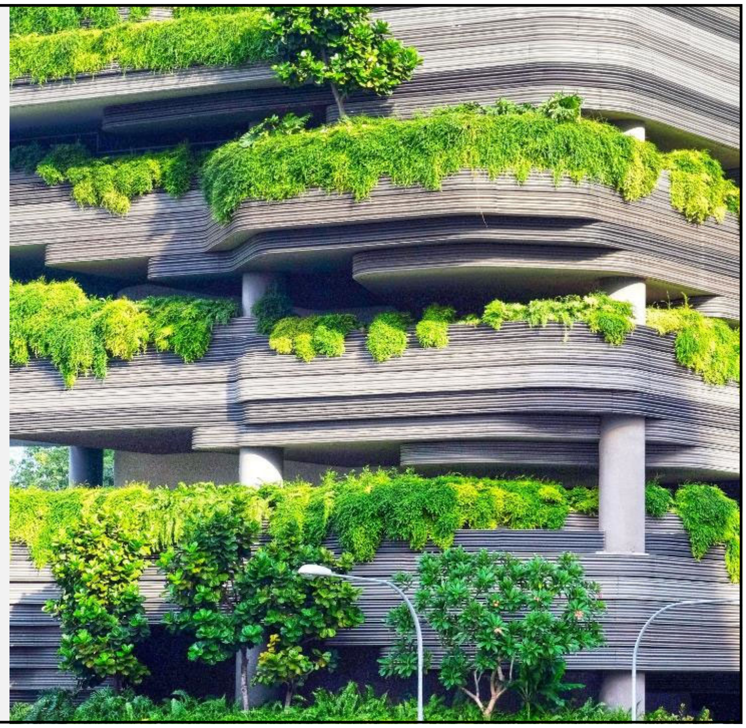
The Next Generation of Cement and Concrete

SOLIDIA®

CONCRETE INNOVATIONS



Our Mission

The leading provider of viable decarbonization technologies and sustainable solutions for the global concrete construction and building materials industries

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The Global Cement & Concrete Challenge

By 2050…

- 9.8 billion world population (68% in cities)
- 5 gigaton annual global cement production (up 20% from today)
- $1 trillion global concrete market

Sources: McKinsey & Company, CleanTechnica, ClimateWatch, Global Cement & Concrete Association

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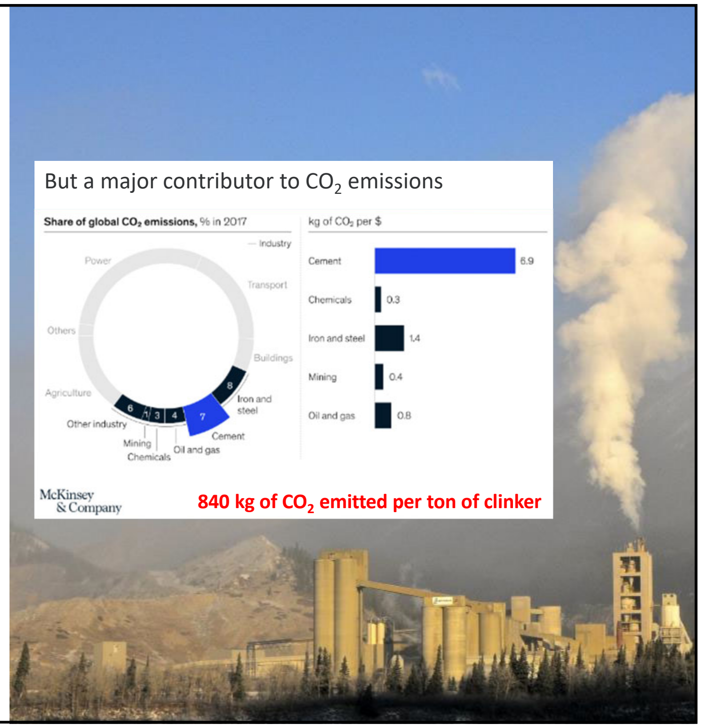


Industry Response to the Global Challenge

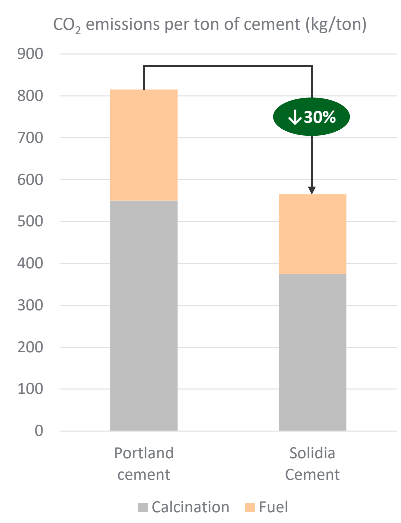
Source: McKinsey & Company

Solidia's Focus

Solidia Cement® (S-CEM)

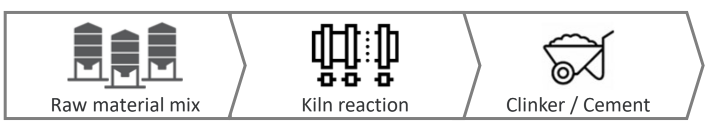
The building block of the future

- Non-hydraulic cement; hardens with CO_2
- Utilizes existing assets & processes
- 12% greater yield per ton of material
- Mineralizes 20%+ CO_2 per ton
- Easier storage than portland cement
- ASTM C1905 Standard Spec



OPC vs. S-CEM Process

Less calcination, less energy = **a better and more sustainable cement**



	Raw material mix	Kiln reaction	Clinker / Cement
OPC	$5\,CaCO_3 + 2\,SiO_2$	1450 °C	$Ca_3SiO_5 + Ca_2SiO_4 + 5CO_2$
	less limestone	*less energy*	*new chemistry*
Solidia	**$CaCO_3 + SiO_2$**	**1250 °C**	**$CaSiO_3$** + CO_2
	=	=	=
Impact	***less CO_2 from raw material calcination***	***less CO_2 emission from fuel***	***more cement per ton of raw material***

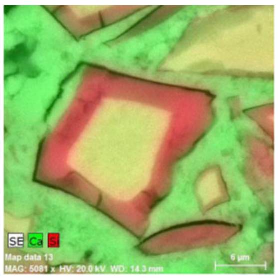
Precast Concrete and SCM Applications with Low-CO_2 Footprint

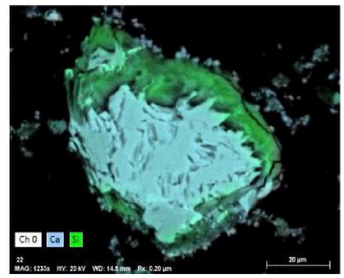
- Carbonation reaction with S-CEM occurs in the presence of water and CO_2
- Amorphous silica rim generated on the surfaces of the reactive phases by leaching of Ca_2^+ ions

In a compact, the reaction creates a dense microstructure, **Precast application.**

As a powder, amorphous silica phase functions as a pozzolan, **SCM application.**

CS = $CaSiO_3$
Si = Silica
Ca = $CaCO_3$



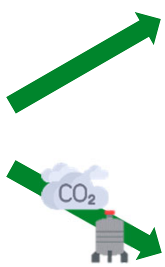


The Solidia Story

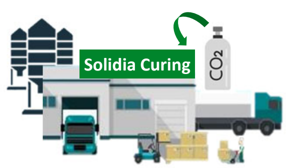
Three integrated platforms to significantly reduce GHG emissions through CO_2 reduction, avoidance & mineralization

Solidia Cement® (S-CEM)

30% CO_2 reduction in cement manufacturing process



Solidia Concrete™



Additional 20% CO_2 mineralized in manufactured concrete products

> 50% less CO_2

Solidia SCM™ (S-SCM)

Additional 20% CO_2 captured in SCM for use in ready-mix concrete

Market Tested, Ready to Scale

All three platforms have been manufactured, tested, and used in market

Solidia Cement®

- Multiple campaigns with full scale cement kilns
- 17,000 mt produced
- New ASTM C1905 standard spec and C1910 standard test methods

Solidia Concrete™

- Commercialized in NY tri-state with EP Henry
- 30+ trials with dry cast plants across 12 EU countries
- Dry cast concrete greenfield plant in 2024

Solidia SCM™

- MVP produced and tested per ASTM C1709
- Trial pour w/ 35% replacement
- Large lab line in San Antonio, TX to produce material for trials

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SCM Value Proposition

- Increased STRENGTH
- Improved DURABILITY
- Reduced PERMEABILITY
- Reduced CARBON INTENSITY
- Reduced COST

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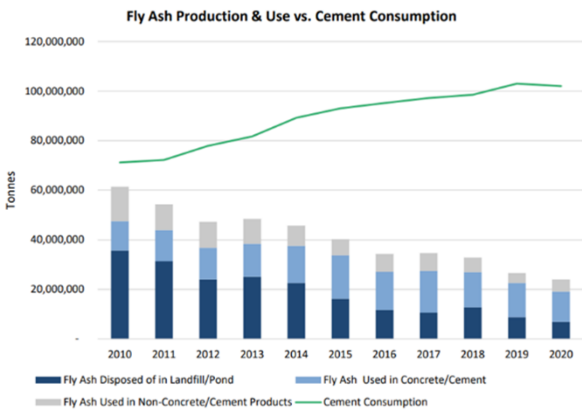
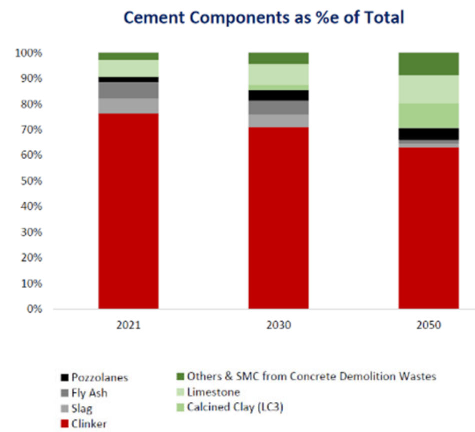
Growing Demand for SCMs to Reduce Industry’s Carbon Intensity

Decline in traditional SCM supply



Source: American Coal Ash Association

Growing need for SCMs to bridge the gap



Source: On Field Global Cement Outlook May 2023

Solidia SCM (S-SCM)

Engineered, high-performance, low-carbon pozzolan

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Amorphous silica, pozzolanic material

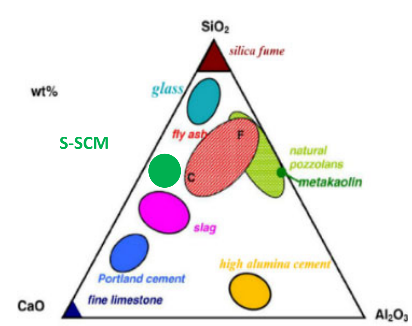
S-CEM + CO_2 → $CaCO_3$ + SiO_2

C-S-H primary “glue” that binds together aggregates and provides strength & impermeability

Cement + H_2O → C-S-H + CH + other phases

CH + S → C-S-H

Reacts with CH (from portland cement hydration) to form more “glue” imparting higher strengths and reducing permeability

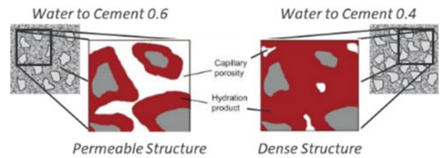


Key Challenge for SCMs

Water demand and optimizing for performance, workability, and cost

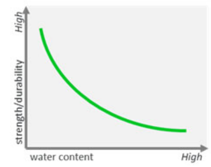
Consideration 1

1. Water content in concrete dictates:
   - strength, durability
   - workability



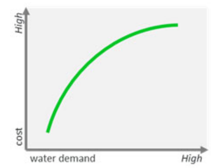
Consideration 2

2. Water content influences density
   - higher density provides better performance



Consideration 3

3. Customers prefer cement with low water demand while maintaining workability → *less cement to achieve target concrete strength and slump*



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S-SCM Achievements

Solidia has resolved the water demand problem that challenges most synthetic SCMs

S-SCM Development Goals

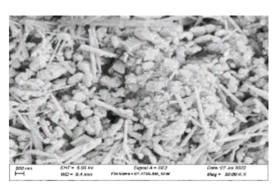
Problem	Reduce water demand of concrete due to SCM addition
☑ **Solution**	Use admixtures
Problem	Minimize cost increases
☑ **Solution**	Balance mechanical and chemical processing

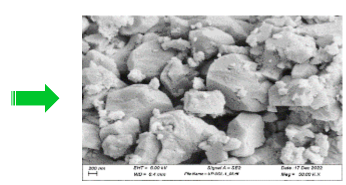
S-SCM

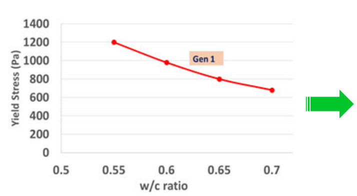
improved water demand = improved performance and cost

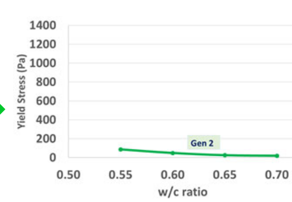
Poor Rheology (workability) w/ High Water Demand

Excellent Rheology w/ Reduced Water Demand









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S-SCM Testing Program per ASTM C1709

Evaluation of Alternative Supplementary Cementitious Materials (ASCM)

■ On deck   »» In progress   ✓ Passed   ✗ Failed

ASTM / AASHTO	Test	Lab	Status
Stage 1: Material Characterization			
C1365 (XRD)	XRF, XRD, QXRD, TGA chemical content	Purdue	✓
Stage 2: Suitable Fineness & Mortar Tests			
C403	Fineness	Purdue	✓
C109 / T106	Compressive strength @ 1, 3, 7, 28, 90 days	CTL	✓
Stage 3: Comparisons to Specification ASTM C618 / AASHTO M 295 (fly ash)			
C1218	Chlorides	CTL	»»
C114 / T105	Soluble alkalis	CTL	»»
D3987	Leachable heavy metals	CTL	»»
C1709	Air void stability	CTL	»»
C1897	Reactivity	Purdue	✓
Stage 4: Concrete Performance			
	Fresh Concrete Properties		
C143 / T119	Slump	CTL, Braun	✓
C231	Air content	CTL, Braun	✓
C1064	Temperature	CTL, Braun	✓
C403 / T197	Setting time	Purdue	✓
C138 / T121	Fresh density	CTL, Braun	✓
C232 / T158	Bleeding	CTL, Braun	✓
C1437	Workability	Purdue	✓

Stage 4: Concrete performance (continued)			
	Hardened Concrete Properties		
C39 / T22	Compressive strength @ 1, 3, 7, 28, 56, 90 days	CTL[1], Braun[2]	✓
C78 / T97	Flexural strength	CTL	»»
C157 / T160	Length change	CTL[1], Braun[2]	✓
C311	Mortar SAI	CTL	✓
C457	Air void system parameters	CTL	»»
C469	Modulus of elasticity & Poisson's ratio	CTL	»»
C666 / T161	F/T durability in 3% NaCl solution	Braun[2]	✓
C672	Scaling	Braun[2]	✓
C1012	Sulfate resistance via length change	CTL,Braun[3]	✓
C1567	Length change (alkali-silica reactivity) – 14 days	CTL[1], Braun[2]	✓
C1293	Length change (alkali-silica reactivity) – 2-year	CTL, Braun	✓
C1702	Heat of hydration	Purdue	✓
C1585	Water absorption	Purdue, CTL	✓
C1202 / T277	Chloride ion resistance	CTL[1], Braun[2]	✓
C1556	Chloride diffusion	Braun[2]	✓

[1]CTL concrete tests: non-air entrained; 650 pcy (385 kg/m^3) & 517 pcy (307 kg/m^3); SCM replacements: S-SCM @ 20%, 35%, 50%; Fly ash @ 20%, 35%; Slag @ 35%, 50%

[2]Braun concrete tests: air-entrained; 650 pcy (385 kg/m^3) & 460 pcy (273 kg/m^3); SCM replacements: S-SCM @ 20%, 35%, 50%; Fly ash @ 20%, 35%; Slag @ 35%, 50%

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S-SCM Performance in Concrete

A viable SCM comparable in performance to traditional SCMs

*** DISCLAIMER ***

- Results based on 2nd generation S-SCM
- Tests conducted by CTL and/or Braun
- Reports provided upon request

Concrete Mix

- base cement: Type IL
- total cementitious content: 650 pcy (385 kg/m3)
- w/c ratio: 0.45
- air-entrained

Fresh Concrete Properties	Test Method	S-SCM[1]	ASTM C618 Class F Fly Ash[1]	ASTM C989 Slag
Target Slump, in.	ASTM C143	6	5.25	6.75
Air Content, %	ASTM C231	8	6.8	6.75
Density, pcf	ASTM C138	141	144	144
Initial/final Set Time, min	ASTM C403	184/332	-	-
Water Demand, %	ASTM C618	<106	<105	-
SAI compared to control, %	ASTM C618	>85	>75	-
Hardened Properties				
Compressive Strength 28 d, psi	ASTM C39	>5000	>4500	>6500
Chloride Permeability Rating	ASTM C1202	Low	Low	Low
Sulfate Expansion, 546 days, %[2]	ASTM C1012	<0.1	-	-
ASR Concrete Length 28 days, %	ASTM C1567	<0.1*	>0.1	>0.1
Freeze Thaw Durability Factor	ASTM C666	90	90	93
Deicer Scaling, mass lost, kg/m^2	ASTM C672	2.9	1	2.9
CaOxyCl Formation g/100 g of paste	AASHTO T 365	8	-	-

[1] PLC Replacements: S-SCM at 35%; Fly Ash at 20%; Slag at 50%
[2] Type I/II cement
** S-SCM at 50% PLC replacement*

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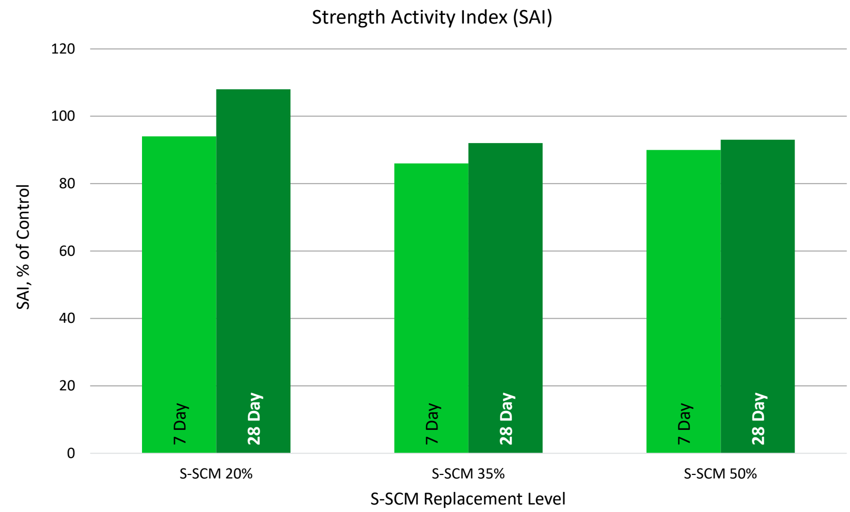
S-SCM Performance in Concrete
Acceptable Strength Development (ASTM C618)



Type IL – Compressive Strength
- 1 day: 2500 psi
- 7 day: 4390 psi
- 28 day: 4860 psi

Notes: Evaluation by CTLGroup

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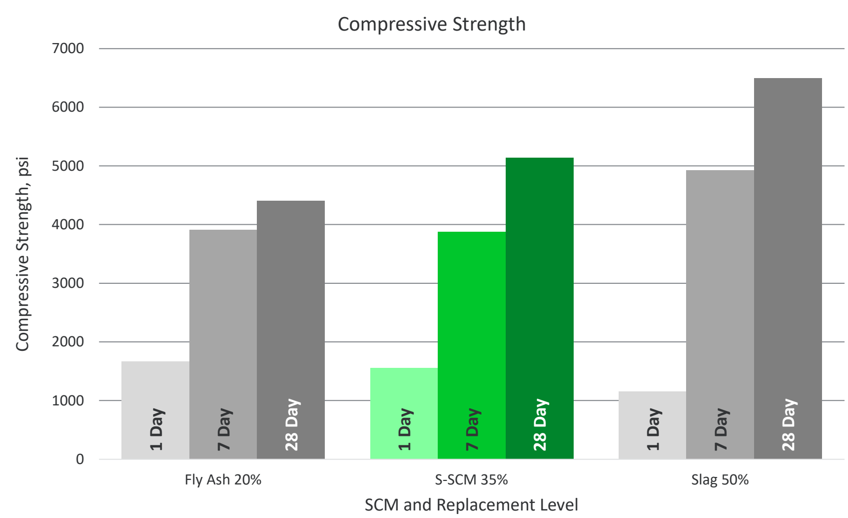
S-SCM Performance in Concrete
Compressive Strength (C39/C39M)



Type IL – Compressive Strength
- 1 day: 2500 psi
- 7 day: 4390 psi
- 28 day: 4860 psi

Notes: Evaluation by Braun Intertec

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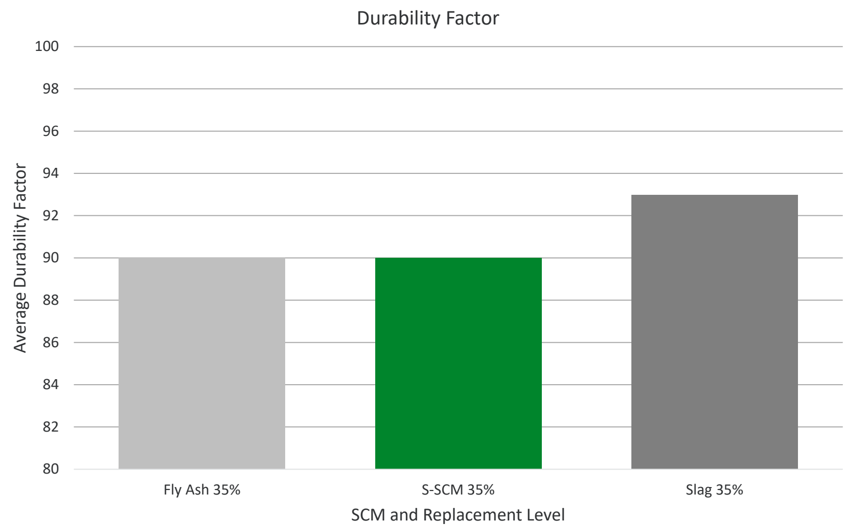
S-SCM Performance in Concrete

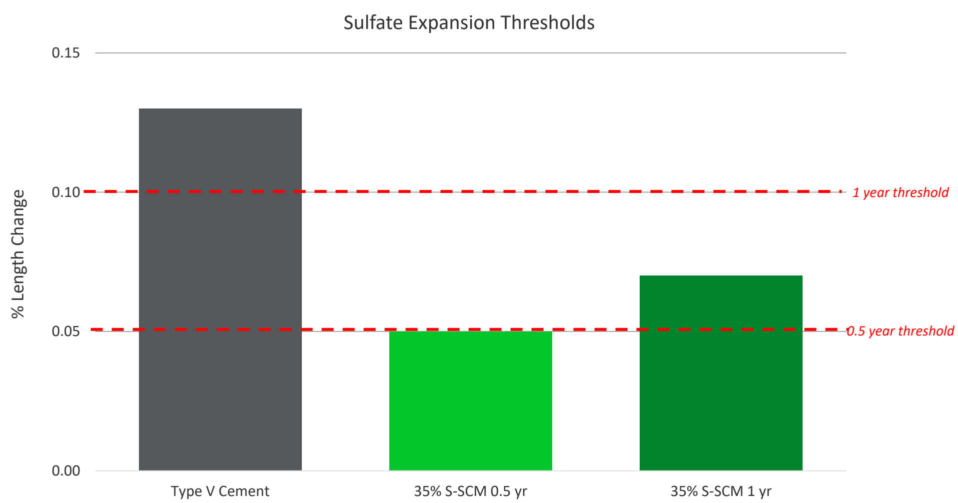
Resistance to Rapid Freeze-Thaw (ASTM C666/C666M)



Notes: Evaluation by Braun Intertec

S-SCM Performance in Concrete

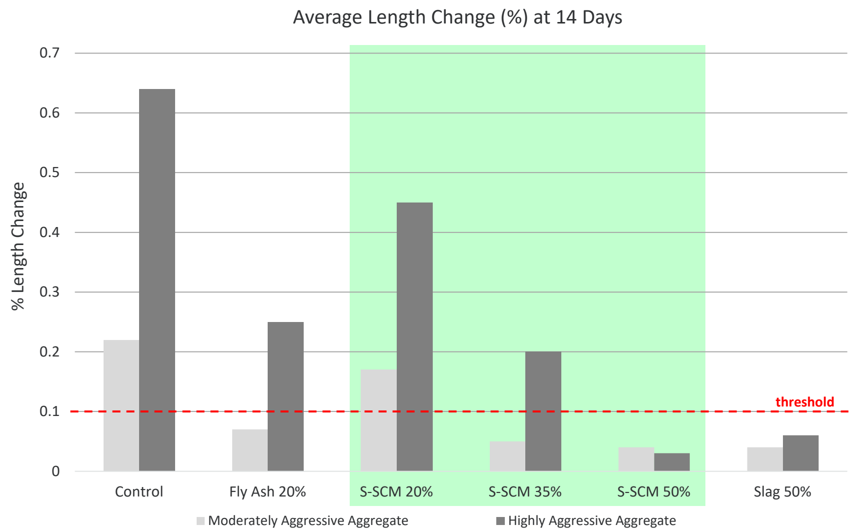
Sulfate Resistance (ASTM C1012/C1012M)



Notes: Evaluation by Braun Intertec

S-SCM Performance in Concrete

Length Change of Mortar Bars Due to ASR (ASTM C1567)



Notes: Evaluation by Braun Intertec

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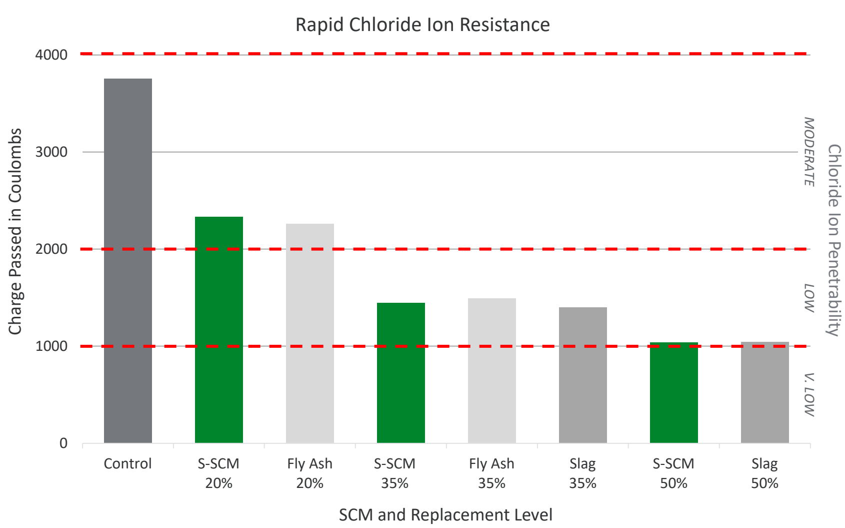
S-SCM Performance in Concrete

Resistance to Fluid Penetration (ASTM C1202)



Notes: Evaluation by Braun Intertec

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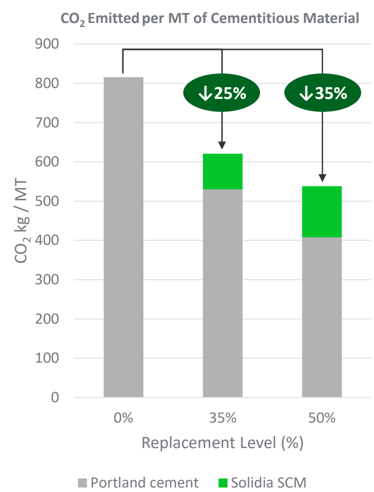
Solidia SCM™ (S-SCM)

A viable, engineered, high-performance SCM

- High pozzolanic activity
- 35%+ OPC replacement level
- 20%+ permanent CO_2 capture from kiln flue gas
- Significant reduction in permeability
- Improved workability
- Alkali silica reactivity (ASR) reduction
- Good air entrainment
- Engineered = reliable quality & performance
- Fills growing SCM supply gap



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S-SCM Roadmap

Innovating together to make an impact

Product Optimization	3rd Party Lab Validation	Field Trials	Commercial Launch
SOLIDIA	CTL Group Braun Intertec – The Science You Build On. Georgia Tech Purdue University Oregon State University	**Specifiers** MnROAD Texas Department of Transportation ** your logo here ** **Ready Mix Producers** ** your logo here **	

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S-SCM Field Trials

Seeking customers to conduct field evaluations and validate market acceptance

Test S-SCM with your mix designs and applications to :

- Examine variations of fresh concrete properties (e.g., slump, air concrete, setting time, workability)
- Provide observations on its effect on concrete finishing characteristics
- Test compatibility with chemical admixtures
- Confirm performance (e.g., strength, durability)
- Evaluate exposed concrete in challenging environments (e.g., freeze-thaw cycles in presence of de-icing chemicals)
- Identify beachhead applications and projects

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