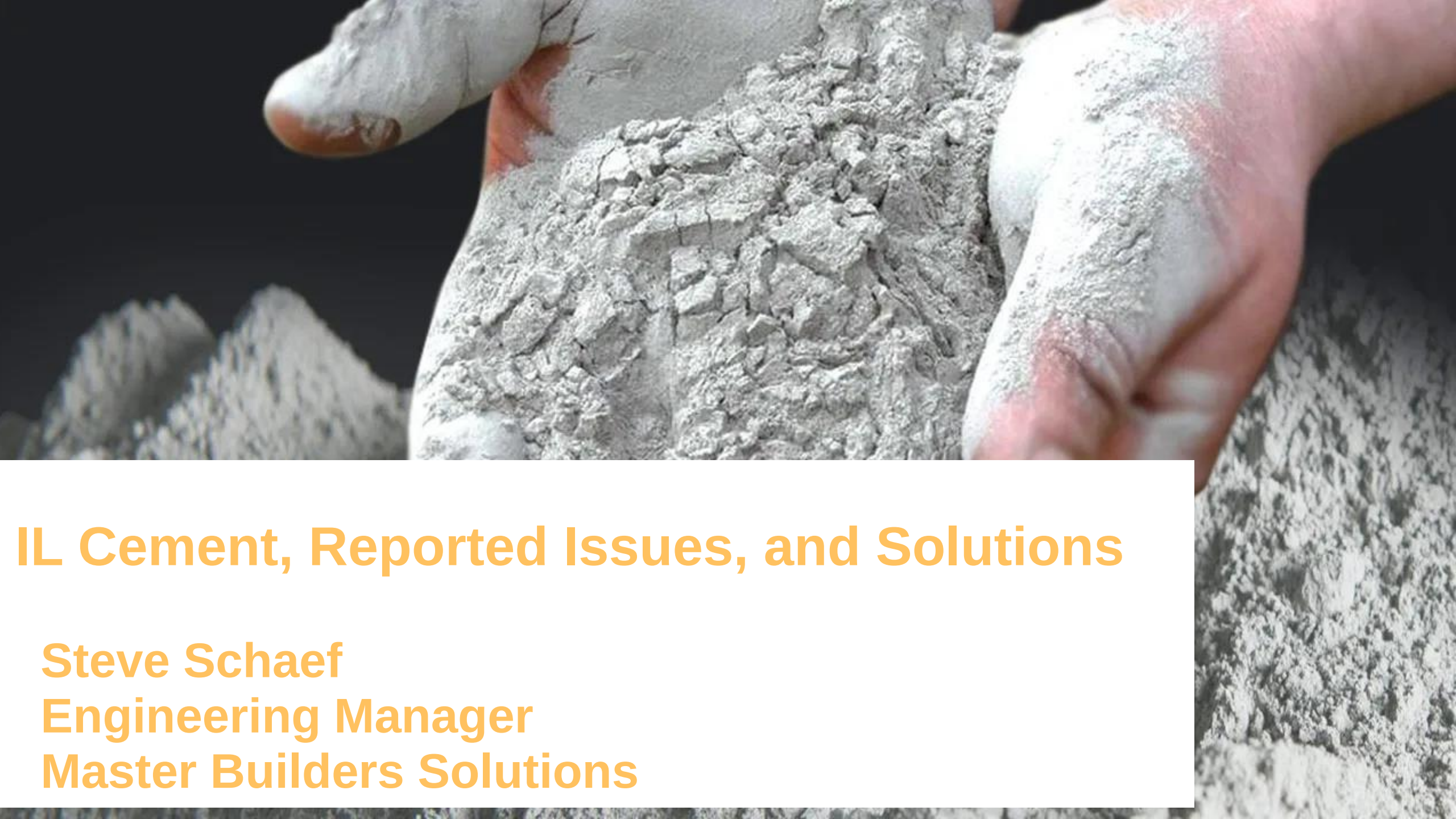
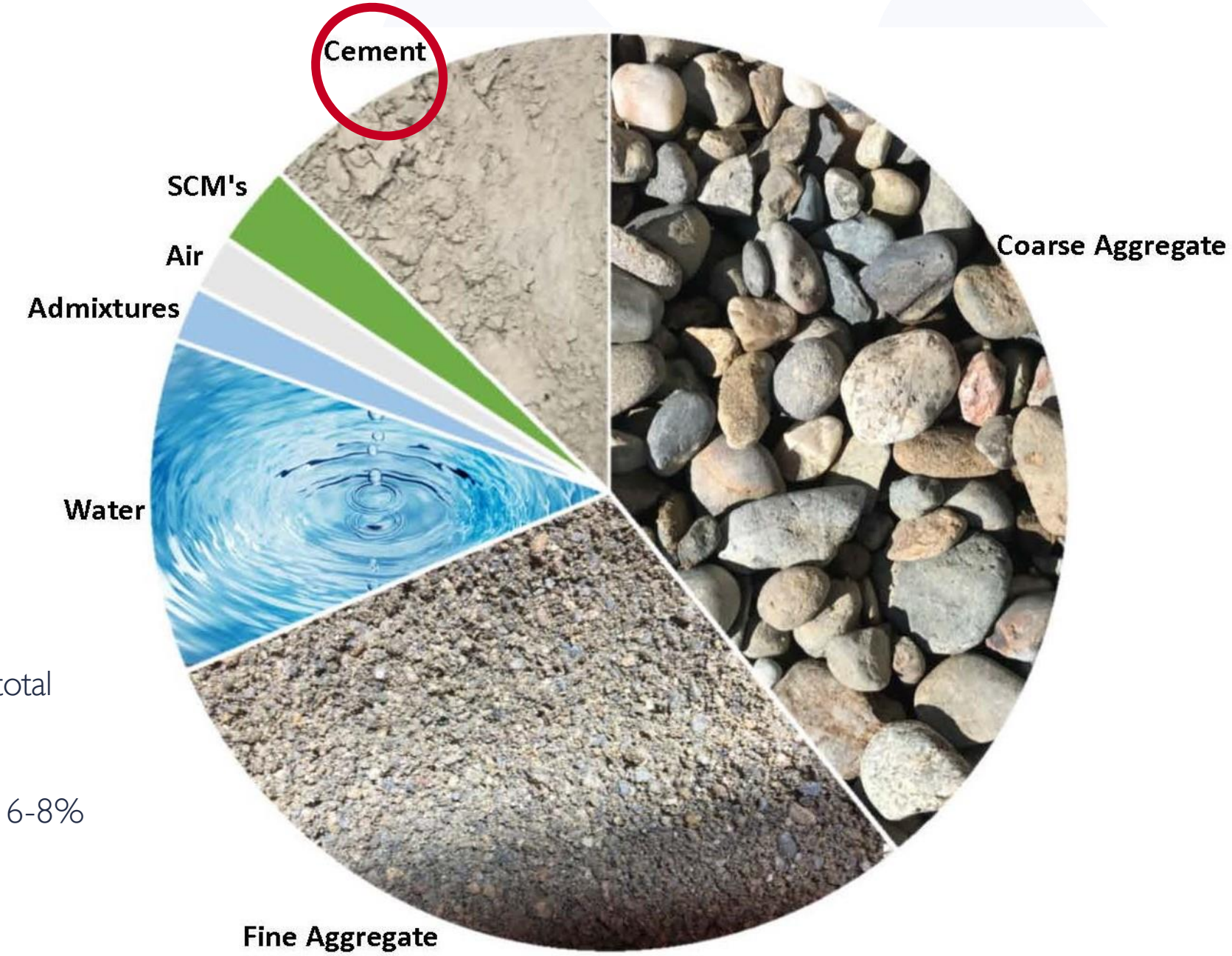


IL Cement, Reported Issues, and Solutions

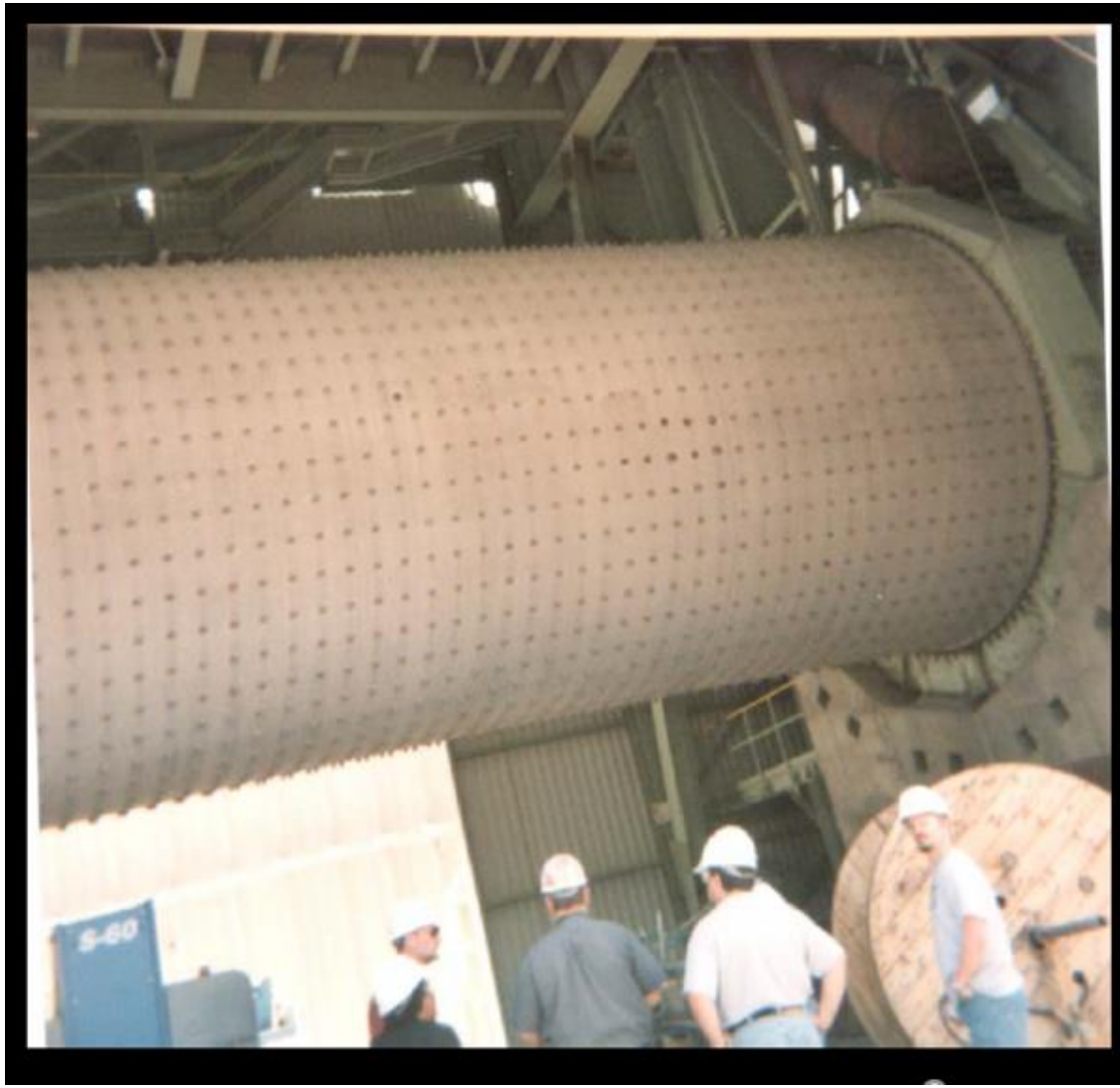
Steve Schaef
Engineering Manager
Master Builders Solutions



- "Glue" of the system
- Highest material cost ~ 60% of total cost
- Cement production accounts for 6-8% of global CO_2 emissions

View Inside Cement Kiln

Ball Mill Cement Grinding (Finish)

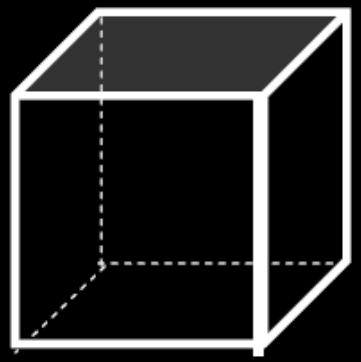


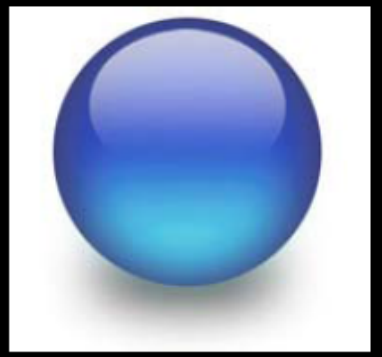
Loud Process
Acoustic Sensing

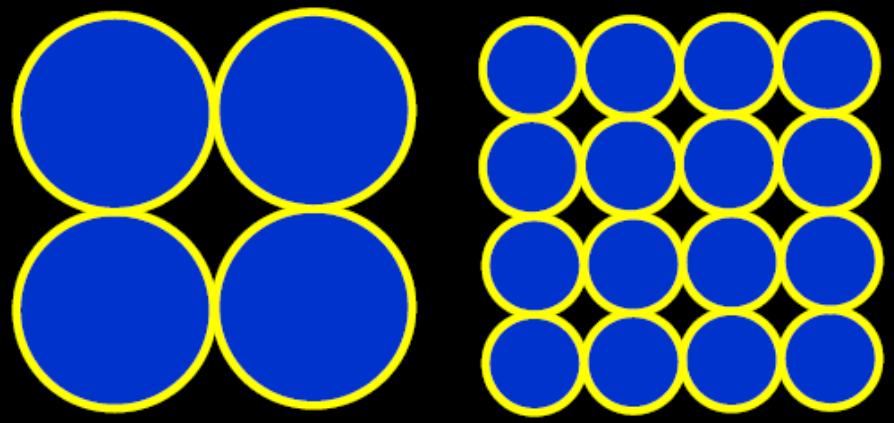
Fineness Influences
Performance

Cement Fineness

- Finer = Faster
- Finer = More Surface Area
- Reaction rate is a function of the amount of surface area







Types of Portland Cement

Portland, Blended, and Other Hydraulic Cements

ASTM C 150 (AASHTO M 85)

I	Normal
IA	Normal, air-entraining
II	Moderate sulfate resistance
IIA	Moderate sulfate resistance, air-entraining
III	High early strength
IIIA	High early strength, air-entraining
IV	Low heat of hydration
V	High sulfate resistance

ASTM C 595 blended cement types

- Type IS portland blast-furnace slag cement (95% maximum slag cement)
- Type IP portland-pozzolan cement (40% maximum pozzolan)
- Type IL portland-limestone cement (5-15% limestone)
- Type IT ternary blended cement

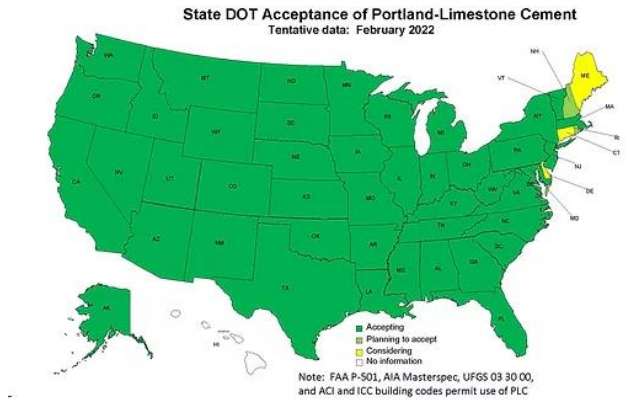
Global acceptance of Portland limestone cement

Europe - 2000, European cement standard allows 5% minor additional constituent (typically limestone) in all 27 common cements and categories CEM II/A-L and CEM II/B-L set ranges for limestone content of 6%-20% and 21%-35%

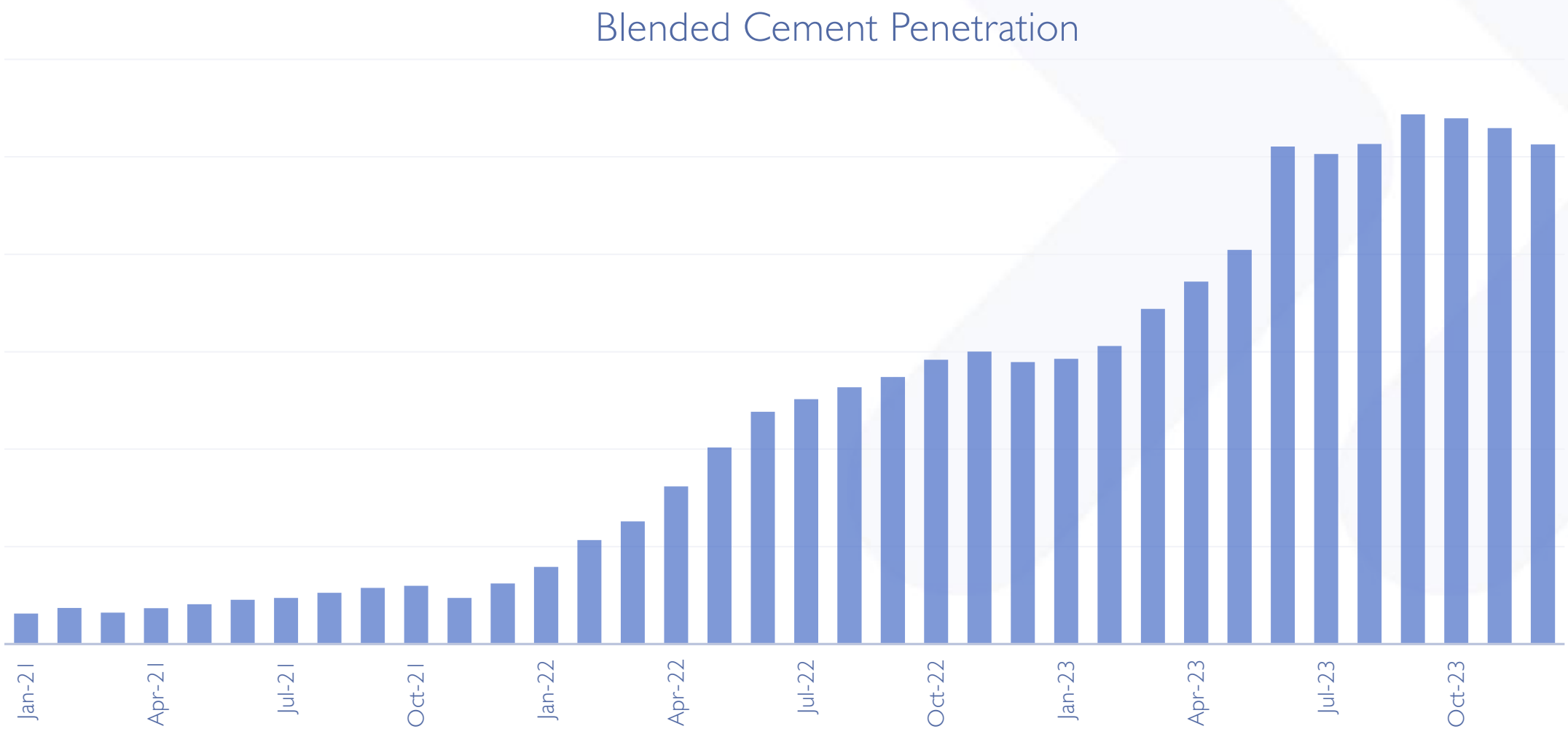
USA 2012 - ASTM C595 Standard Specification for Blended Hydraulic Cements includes Type IL (Portland – limestone cement)

1990 2000 2010 2020

Canada - 2008, portland-limestone cement containing 5%-15% limestone added to portland cement standard (no longer categorized as blended cement)



US Cement Trends



Cement Producers set ambitious CO_2 global targets

US Industry Average	
OPC:	992
PLC:	846

2030 and 2050 net CO_2 emissions reduction objectives by player

	HOLCIM	Heidelberg Materials	TITAN	CRH	CEMEX	Votorantim
Target verified	1.5°C[1]	2°C	2°C	2°C	CARBON TRUST 2°C	Committed
2030 objectives (kg CO_2/ton cementitious product)	475	<500[2]	500	<520	520	520
2050 objectives	SBTi[3] roadmap for net zero pathway	Net zero concrete	Net zero concrete	Net zero concrete value chain	Net zero concrete	Net zero concrete

1. LafargeHolcim signed 1.5°C pledge with intermediate targets for 2030 approved by SBTi; 2. Current target (<500) not verified according to the new scenario B2DS (Beyond 2°C Scenario), former target (2030: 525) aligned with 2DS (2°C Scenario) and verified by SBTi; 3. SBTi = Science-Based Targets initiative;
Source: Sustainability Report 2020 LafargeHolcim; 2020 Climate Action Panel Cemex; Sustainability Report 2020 HeidelbergCement; 2020 Titan Integrated annual report, Votorantim 2030 commitments report; CRH Sustainability Report 2020

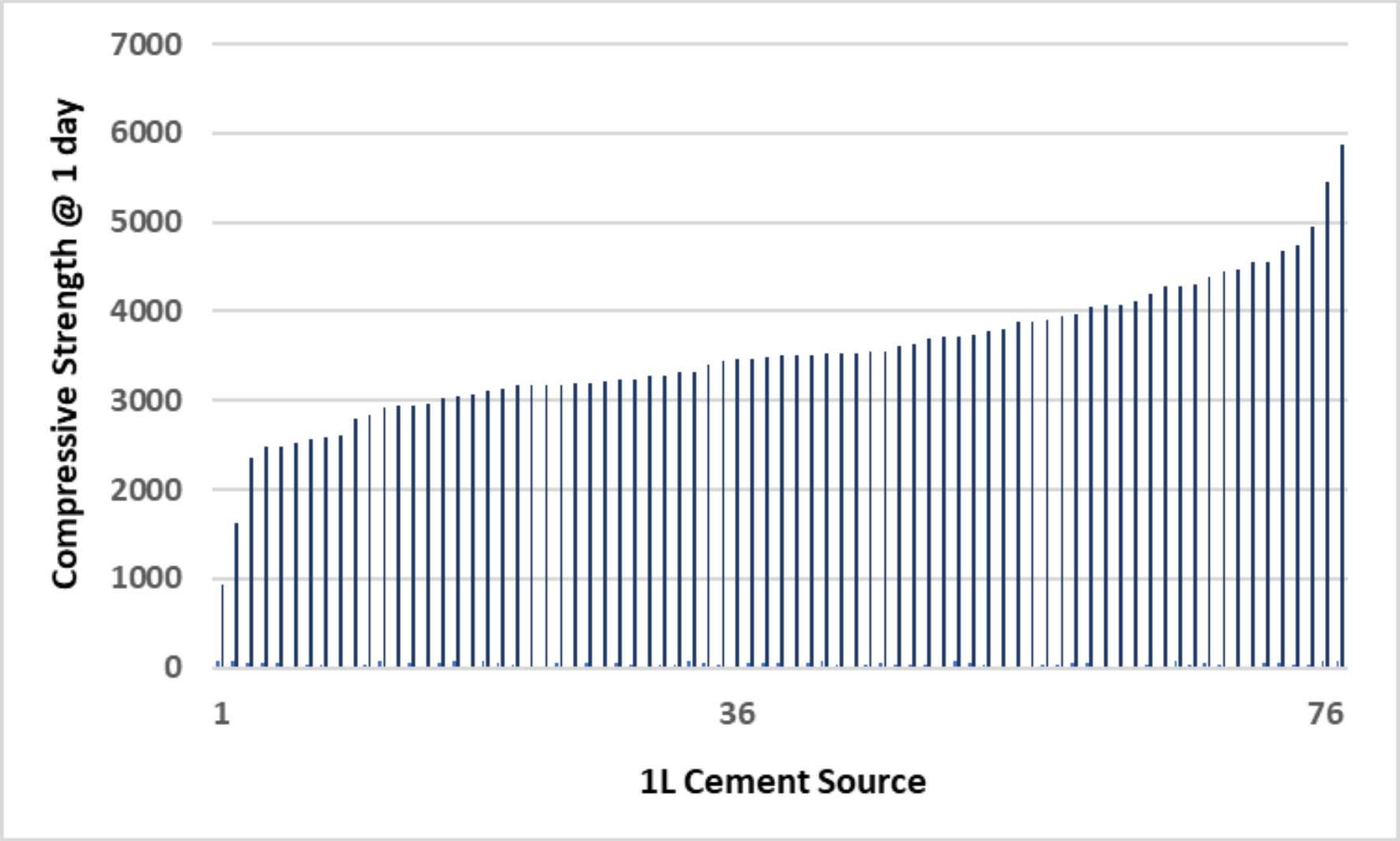
CARBON TRUST Target verified by "Carbon Trust Standard"

Target verified by "Science-based target" to be in line with a global warming scenario

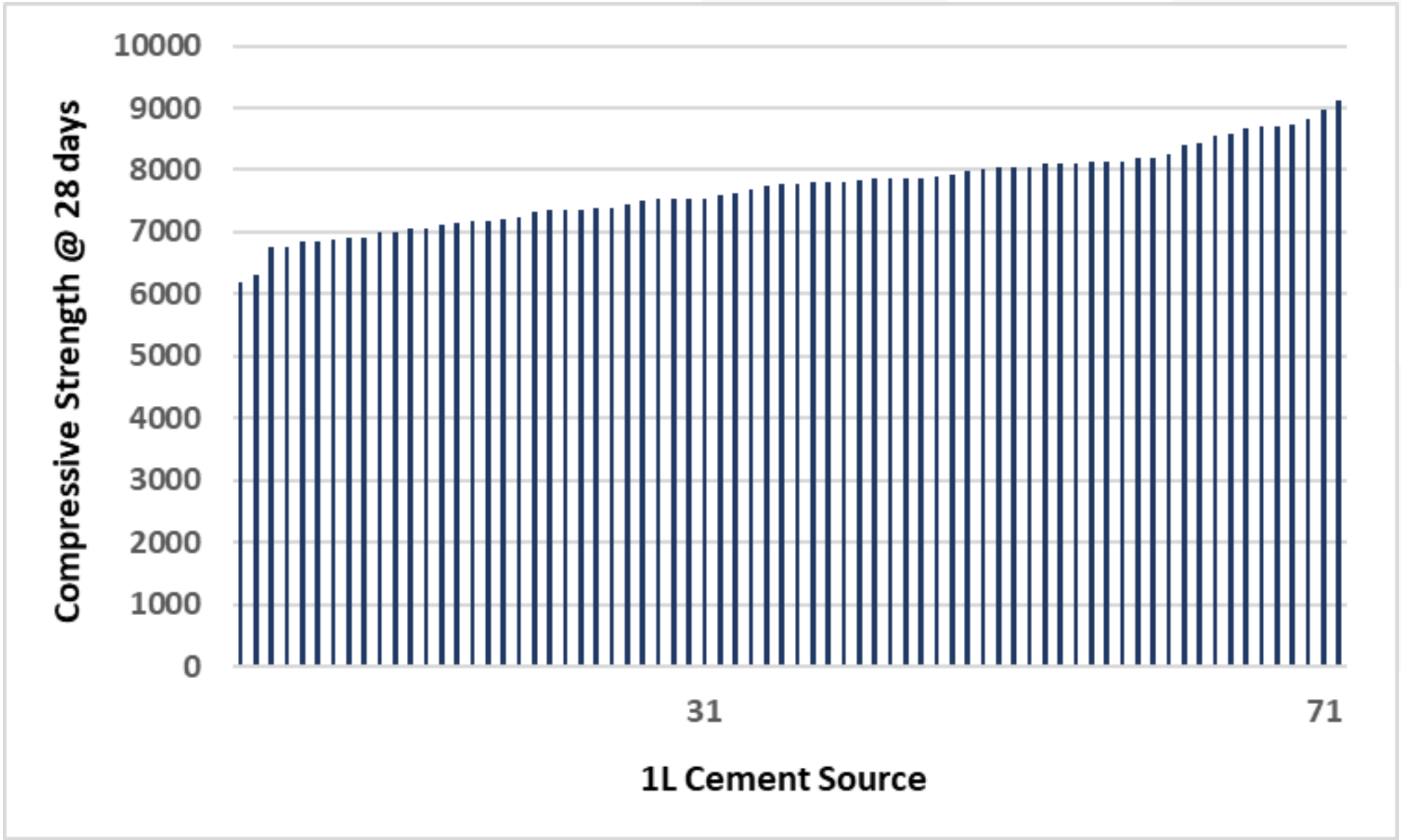
Type IL Cement

- Approximately 90% Type I Cement (Reactive) + 10% limestone powder (Less Reactive)
  - Cement fineness increased to offset strength deficiency from limestone powder
  - The higher the limestone powder, the higher the cement fineness needed
  - The higher the cement fineness, the more grinding aids may be used
- Benefit for the cement industry
  - Instantaneous reduction in carbon footprint with minor changes to the man. process
- Challenges
  - Reported variability of IL cement characteristics
    - Blaines ranging 363 – 543 m^2/kg for limestone content 9-15%
  - Higher water demand
  - Lower compressive strength
  - Slightly less bleeding, may impact finishability of flatwork
  - Higher plastic air

Not all IL cements are equal, same went for OPC



Mortar Mix design: Cement = 564 lb/yd^3 & Sand = 1250 lb/yd^3, w/c = 0.47, water = 265 lb/yd^3, Coarse aggregate vol. = 42.37% for Design Purpose Only, Design Air = 2.5%



Mortar Mix design: Cement = 564 lb/yd^3 & Sand = 1250 lb/yd^3, w/c = 0.47, water = 265 lb/yd^3, Coarse aggregate vol. = 42.37% for Design Purpose Only, Design Air = 2.5%

ACI-ASCC Survey on Portland-Limestone Cement

15 survey questions and 173 respondents (published in Concrete International Feb 2024)

- 80%
  - Ready mixed concrete producers
  - Concrete contractor
  - Architects/engineers
- 20%
  - Owners
  - Testing agencies
  - Construction manager/general contractors
  - Admixture suppliers
  - Cement producers

Perception of occurrence of issues associated with change in cement type, tabulated by profession (role)

Profession	The same frequency, %	Lower frequency, %	Greater frequency, %
Owner	20	0	80
Architect/engineer	47	0	53
Testing agency	40	0	60
CM/GC	40	0	60
Concrete contractor	26	2	72
Concrete producer	60	2	38
Admixture supplier	11	0	89
Cement producer	86	0	14
Other	30	0	70

ACI-ASCC Survey on Portland-Limestone Cement

Comparison of survey responses

Issue	ACI-ASCC Fall 2023	NRMCA Summer 2023	TCA June 2023	ASCC December 2022
1. Strength, %	45	50	35	50
2. Water demand, %	75/60*	60	65	60
3. Set time, %	45	40	60	50
4. Bleed water, %	40	NA†	50	NA†
5. Plastic shrinkage cracking, %	45	X‡	35	30
6. Saw cut, %	70	NA†	30	NA†
7. Finishing, %	45	X‡	35	35
8. Cement content, %	35	20	50	NA†

https://www.greenercement.com

PLC: Greener Cement | Home

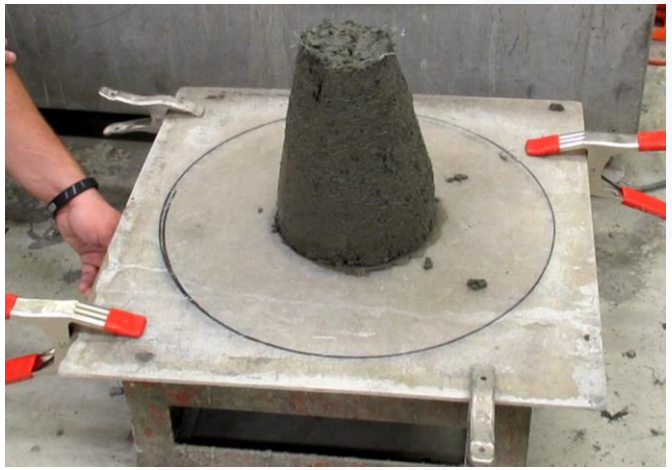
Portland-limestone cement is engineered with a higher limestone content. PLC (Type IL) gives specifiers, architects, engineers, producers, and designers a greener way to execute any structure, paving, or geotech project, with virtually no modifications to mix design or placing procedures.

Solutions to Address IL Cement Challenges
Water-Reducing and Conditioning Admixture

Key Benefits

- **Enhanced Pumping Efficiency:** Lowers pumping pressure, increases output volume. Ideal for long-distance and high-rise applications.
- **Improved Placement Rate:** Increases the rate of concrete discharge from trucks and equipment.
- **Reduced Consolidation Effort:** Minimizes the need for extensive vibration and consolidation.
- **Easier Finishing:** Reduces the number of passes needed during floating and troweling.
- **Superior Surface Finish:** Improves surface finish, reducing defects and enhancing durability.
- **Handling Robustness:** Maintains ease of handling over time, even with decrease in slump.
- **Consistent Quality:** Helps achieve consistent concrete performance across batches, minimizing the need for on-site retempering or redosing.

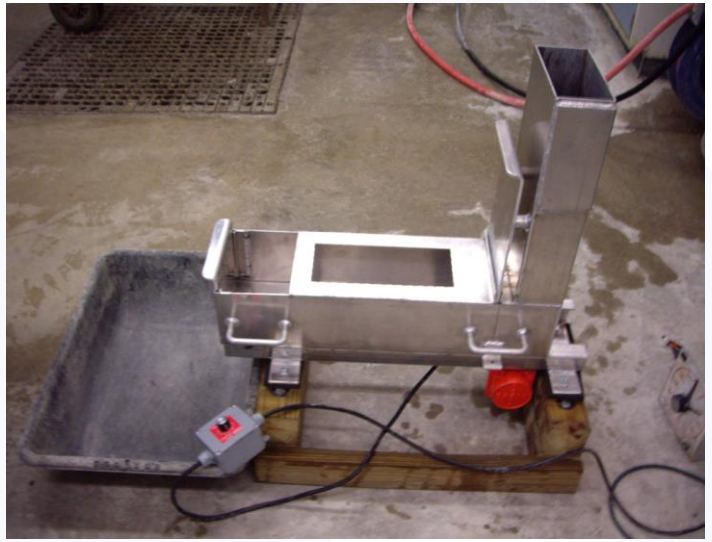
Identical 4” slump FRC concrete mix designs vibrated for 10 sec.

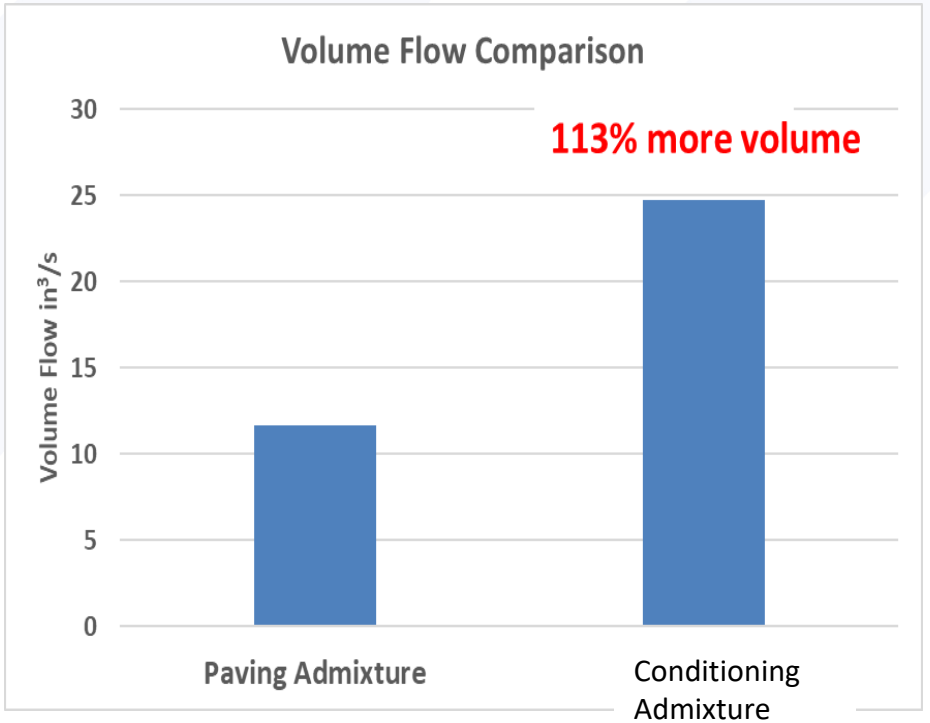


Lignin based MRWR

Conditioning Admixture

Response to Vibration





Solutions to Address IL Cement Challenges
Fiber Additives – Plastic Shrinkage Crack Control

Occurrence Time: 0.5 - 3 hrs from placement

Cause: Rapid water loss initiates surface microcracking

- Predominate during low humidity and high wind conditions

Microfibers

- Excellent reduction in plastic shrinkage cracking
- Measurably reduces plastic settlement

Q&A

- What are the freeze-thaw characteristics of 1L concrete? Are they different than Type 1?
- Does 1L concrete require different curing procedures?
- How do microfibers impact bleeding?
- Other?

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