

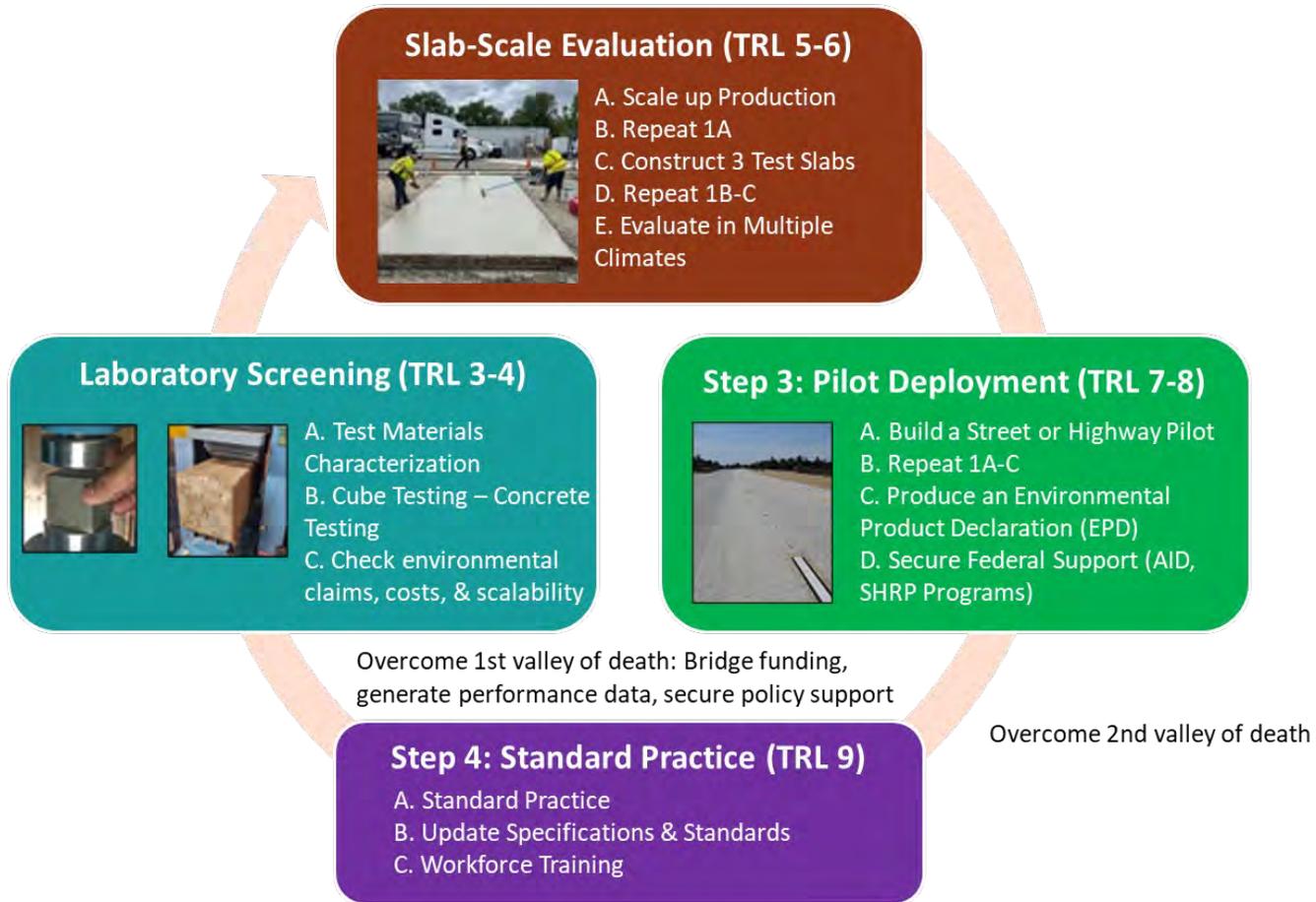
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Concrete Construction Recap: Placement, Sampling, and Findings

Cells 1 and 3: Construction on April 17, 2025
Coal fly ash (control) and Purebase Metakaolin-blend SCM

August 2025

Lab2Slab2Practice



Initial Laboratory Screening



- **Activation and Characterization**

Activation: Size reduction, thermal activation, Characterization: oxide composition, mineral phases, particle size, absorption, density, loss on ignition



- **Pozzolanic / hydraulic reactivity testing (PRT) (ASTM C1897 and R3)**

Determine level of reactivity based on heat release and calcium hydroxide consumption



- **Water demand and Strength activity index 7-28d (80%+) or 90d (80%+) (ASTM C311)**

Use SAI results alongside PRT results



- **Alkali-silica reaction (ASR) (ASTM C1567) and soundness**

Have been using a very highly reactive sand looking for an alternative

ASTM C1945 Compliance

PHASE 1

- Physical Properties

Sample	Purebase SCM
Al ₂ O ₃ +SiO ₂ +Fe ₂ O ₃ (%)	96.9
Class	N
SO ₃ (%) < 4%	0.4
Density (g/cm ³)	2.59
Moisture content (%) < 3%	0.8
Loss on ignition @750°C (%) < 10%	2.4
Particle size, mass % passing 45-μm (No. 325) sieve > 66%	90.6
Total equiv. alkalis: Na ₂ O _{eq} (%)	1.4

TABLE 1 Chemical Requirements

	Class
	N
Silicon dioxide (SiO ₂) plus aluminum oxide (Al ₂ O ₃) plus iron oxide (Fe ₂ O ₃), min, %	70.0
Calcium oxide (CaO), %	report only
Sulfur trioxide (SO ₃), max, %	4.0
Moisture content, max, %	3.0
Loss on ignition, max, %	10.0

TABLE 2 Physical Requirements

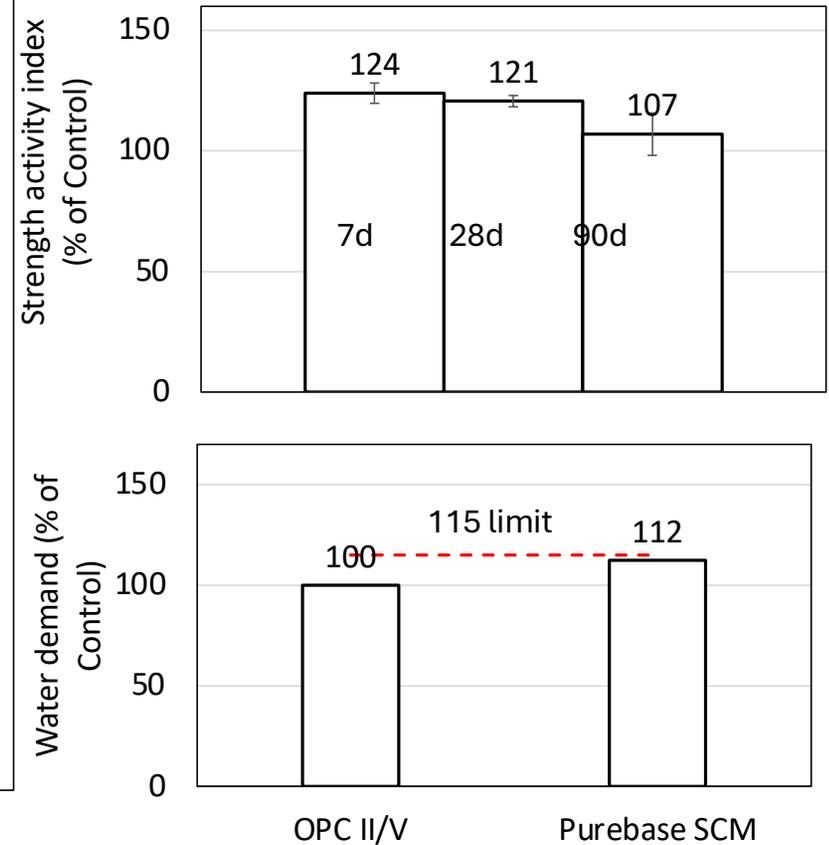
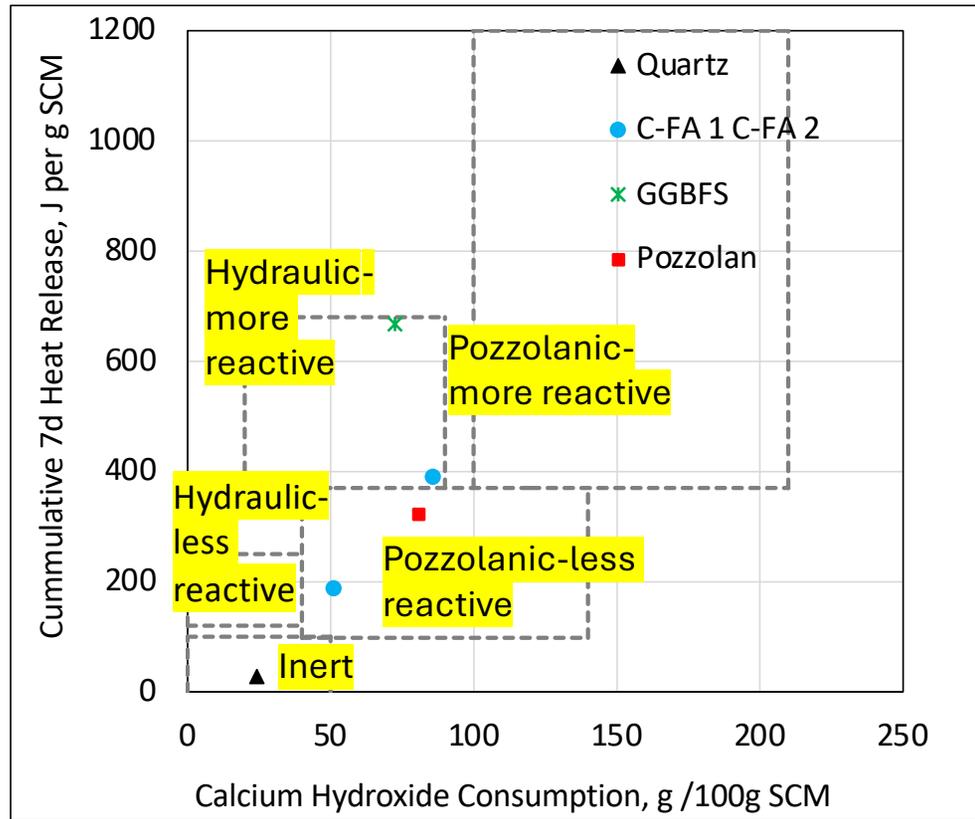
	Class
	N
<i>Fineness:</i>	
Amount retained when wet-sieved on 45 μm (No. 325) sieve, max, %	34
<i>Strength activity index:^a</i>	
With portland cement, at 7 days, min, percent of control	75 ^B
With portland cement, at 28 days, min, percent of control	75 ^B
Water requirement, max, percent of control	115
<i>Uniformity requirements:</i>	
The density and fineness of individual samples shall not vary from the average established by the ten preceding tests, or by all preceding tests if the number is less than ten, by more than:	
Density, max variation from average, %	5
Percent retained on 45-μm (No. 325), max variation, percentage points from average	5

^a The *strength* activity index with portland cement is not to be considered a measure of the compressive strength of concrete containing the natural pozzolan. The mass of natural pozzolan specified for the test to determine the *strength* activity index with portland cement is not considered to be the proportion recommended for the concrete to be used in the work. The optimum amount of natural pozzolan for any specific project is determined by the required properties of the concrete and other constituents of the concrete and is to be established by testing. *Strength* activity index with portland cement is a measure of reactivity with a given cement and is subject to variation depending on the source of the natural pozzolan and the cement.

^B Meeting the 7 day or 28 day *strength* activity index will indicate specification compliance.

Pozzolanic Activity Results

PHASE 1



Mortar → Laboratory Concrete Scale



- **Foam Index (ASTM C1827)**

Compatibility of high-LOI SCMs with air-entraining admixtures



- **Slump (ASTM C143)**
- **Air and density ASTM C231, C138**
- **Heat of hydration and maturity**

Fresh properties, workability & constructability, admixture demand



- **Compressive strength (ASTM C39)**
- **Flexural strength (ASTM C78)**
- **Modulus of elasticity (ASTM C469)**

Mechanical properties development



- **Drying shrinkage (ASTM C157)**
- **Surface Resistivity (ASTM C1876 or AASHTO TP 95)**

Durability and long-term performance

Laboratory Concrete Testing – Trial Batching

PHASE 1

- Fresh Properties and Mix Designs

Sample	PLC IL(10)	Purebase SCM
Temperature (°C)	25	25.7
Slump (in)	1.75	1.75
Air Content (%)	2.8	3.7
Unit Weight (lb/ft ³)	150.3	149.9



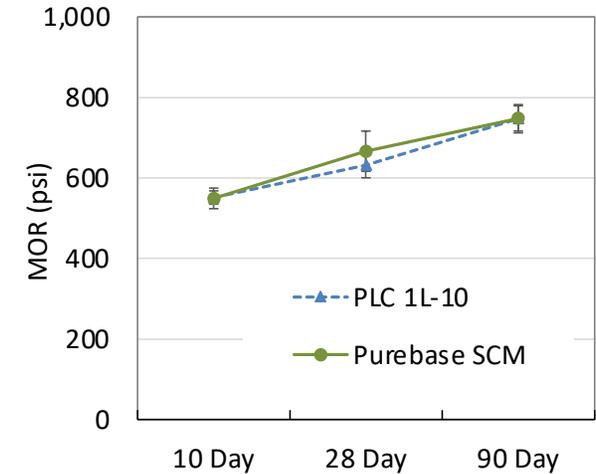
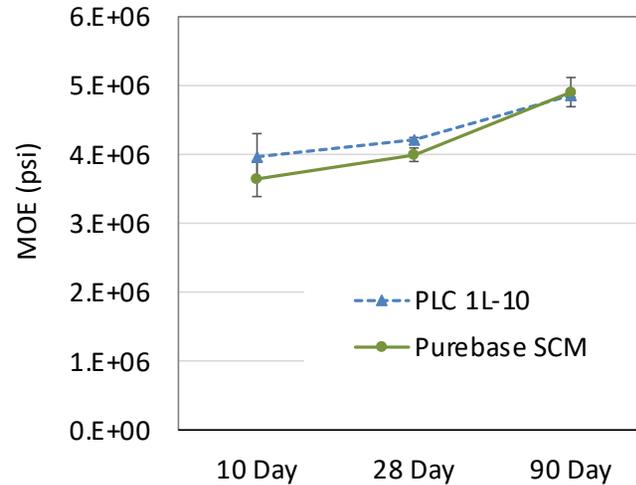
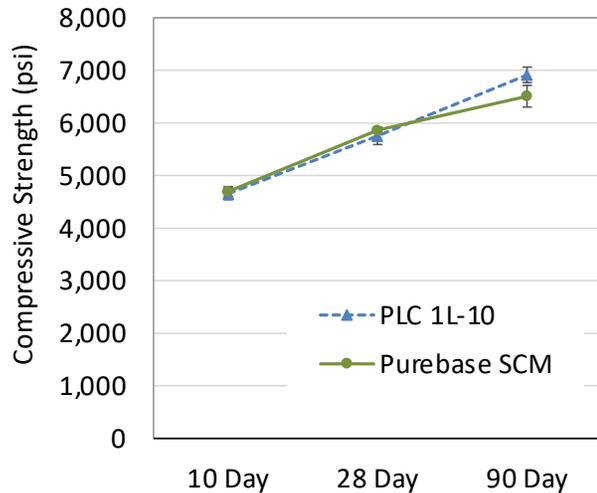
Material Description	PLC IL(10)	Purebase SCM	Units
Cement	590 (PLC)	442.5 (PLC)	lb/cy
SCM (25% wt replacement)	0	147.5	lb/cy
Water	260 (31.17)	260 (31.17)	lb (gal)/cy
Coarse Aggregate	1470	1470	lb/cy
Intermediate Aggregate	293	293	lb/cy
Fine Aggregate	1454	1431	lb/cy
Air Entrainer	0.3	0.3	oz/cwt
Viscosity modifier admix	8.35	8.35	oz/cwt
Polycarboxylate HRWA	5.8	15.1	oz/cwt
Shrinkage reducing admix	10.8	10.8	oz/cwt

Laboratory Concrete Testing – Mechanical

PHASE 1

Properties

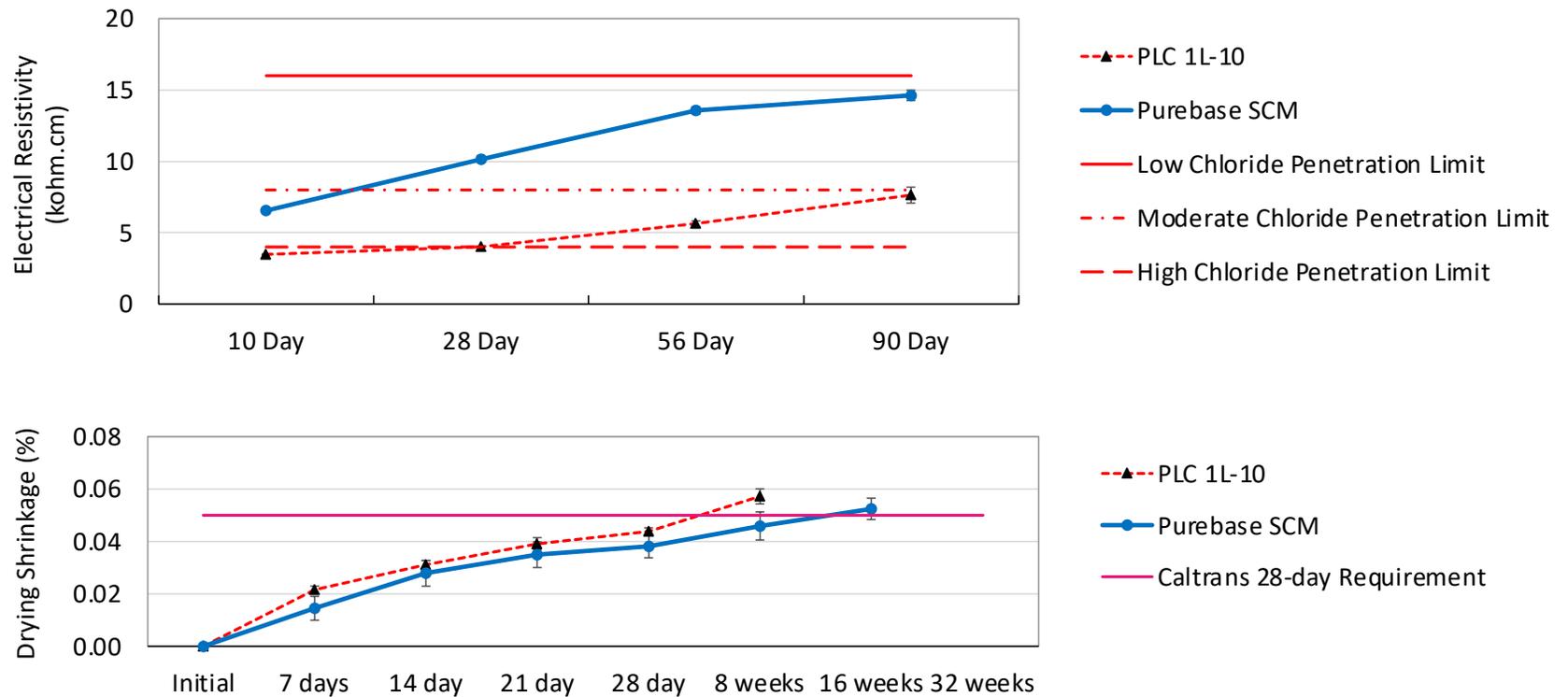
- Based on a Student's t-test, the Purebase SCM mix showed no statistically significant difference in strength compared to the control at 10, 28, and 90 days across all tested properties.



Laboratory Concrete Testing – Durability

PHASE 1

- Good durability performance compared to PLC control



Laboratory Concrete Scale → Test Slab Scale

PHASE 2



- **Prepare supersacks of test material**

Prepare and package test material in supersacks for 2 or 3, 6 cu. yd. of concrete



- **Lab Trial Batch**

Last round of small trial batches in the lab



- **Field Trial Batch**

Full load size trial batch at ready-mix plant



- **Build 10ft x 22ft Slab**

Construction demonstration slabs for constructability and performance evaluation

Trial Batches & Final Batched Mixes

PHASE 2

Component	Units	OPC II/V + C-FA (25%) lab trial batch	Purebase (w/c = 0.45) Lab trial batch 1	Purebase (w/c = 0.477) Plant trial batch	OPC II/V Batched on 4/17	Purebase Batched on 4/17
W/C	-	0.450	0.450	0.477	0.416 (batched)	0.461 (batched)
Cement	lb/cy	442.5	442.5	442.5	440.8	447
SCM	lb/cy	147.5 (25%)	147.5 (25%)	147.5 (25%)	149.2 (25%)	149 (25%)
Water	lb (gal)/cy	266 (31.87)	266 (31.87)	281 (33.67)	246 (29.51)	275(32.93)
Coarse Aggregate	lb/cy	1565	1565	1565	1860	1577
Intermediate Aggregate	lb/cy	285	285	285	In CA	283
Fine Aggregate	lb/cy	1287	1307	1265	1317	1313
Polycarboxylate HRWR	oz/cwt	3.0	9.0	5.0	5.0	6.85
Lignosulfonate WR admix	oz/cwt	2.0	5.0	4.0	3.0	5.20

Slab Scale – Construction Evaluation

PHASE 2

- **Quality control and constructability evaluation:**
 - Mixability & transport: Water and admixture demand
 - Placement & finishing: bleed water, setting & saw cutting time
 - Quality control sampling:
 - Fresh properties
 - Mechanical properties
 - Durability



Fresh Concrete – Properties Results

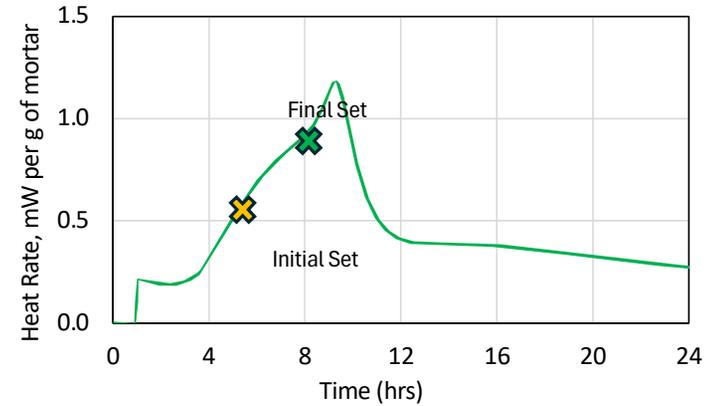
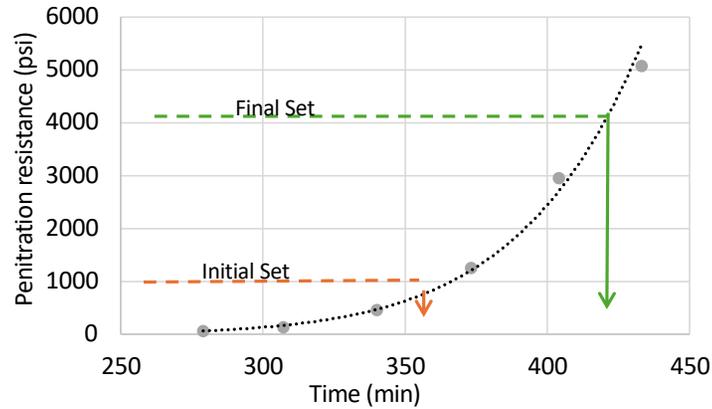
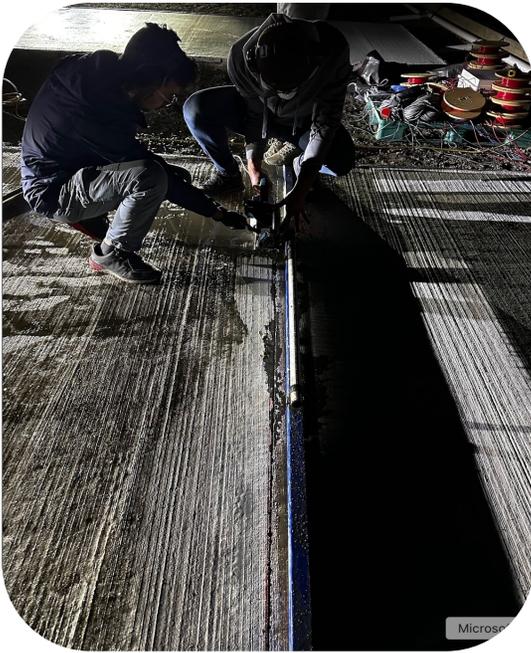
PHASE 2

Sample	Control 4/17	Purebase 4/17
Temperature (°C)	21.1	22.5
Slump (in)	4.5	5.25
Air Content (%)	1.6	1.9
Unit Weight (lb/ft ³)	145.76	146.64
Yield (%)	99	99
w/c by Phoenix	2.9	3.2
Initial Set Time (h:m)	5:55	5:40
Maturity (temp-time)	-7,653	-8,435
Initial Set Time (h:m)	Slab: 6:36	Slab: 5:59
Final Set Time (h:m)	7:12	6:54
Maturity (temp-time)	-10,295	-10,716
Initial Set Time (h:m)	Slab: 8:11	Slab: 7:44



Initial & Final Setting and Saw Cutting Times

PHASE 2



- Time of saw cutting:

Section	End of Placing Time	Start of Saw Cutting Time	Elapsed Time to Saw Cutting
CEL 1	9:57 AM	11:15 PM	13 hr & 18 mins
CEL 3	11:52 AM	11:35 PM	11 hr & 43 mins

Strength & Durability Testing

PHASE 2

- Cast cylinders and beams for quality control, strength, and durability testing.



Constructability – CEL 1 (Control)



- Batching started at 8:49 AM
- The truck arrived at the site at 9:25 AM
- Workability was verified visually, and discharge started at 9:34 AM

Constructability – CEL 1 (Control)



Constructability – CEL 1 (Control)



Constructability – CEL 1 (Control)



Constructability – CEL 1 (Control)



Finishability – CEL 1 (Control)



- Finishing started at 9:56 AM
- Finishing ended at 10:10 AM

Finishability – CEL 1 (Control)



Finishability – CEL 1 (Control)



Finishability – CEL 1 (Control)



4/17/2025 10:06 AM

Finishability – CEL 1 (Control)



4/17/2025 10:09 AM

Finishability – CEL 1 (Control)



4/17/2025 10:11 AM

Finishability – CEL 1 (Control)



Curing Application – CEL 1 (Control)



- Curing started at 11:58 AM
- Curing ended at 12:10 PM

Constructability – CEL 3 (Purebase)



- Batching started at 10:45 AM
- The truck arrived at the site at 11:15 AM
- To achieve the desired 4-6 in. slump:
 - 22 gal of water and 0.85 oz/cwt of HRWR were added
- Workability was verified visually, and discharge started at 11:34 AM

Constructability – CEL 3 (Purebase)



Diego M.
FABIAN PANIAGUA

4/17/2025 11:47 AM

Constructability – CEL 3 (Purebase)



Finishability – CEL 3 (Purebase)



- Finishing started at 11:50 AM
- Finishing ended at 12:00 PM

Finishability – CEL 3 (Purebase)



Finishability – CEL 3 (Purebase)



Finishability – CEL 3 (Purebase)



Finishability – CEL 3 (Purebase)



Curing Application – CEL 3 (Purebase)

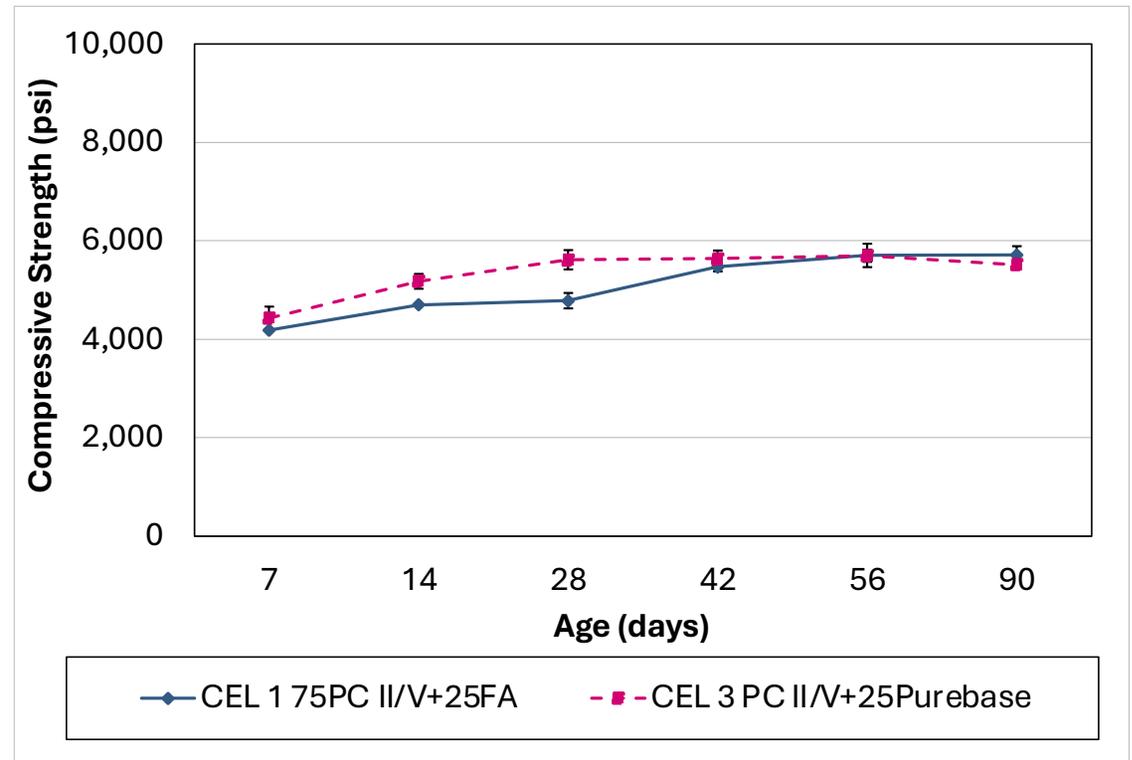


- Curing started at 1:20 PM
- Curing ended at 1:37 PM

Strength and Durability Test Results

PHASE 3

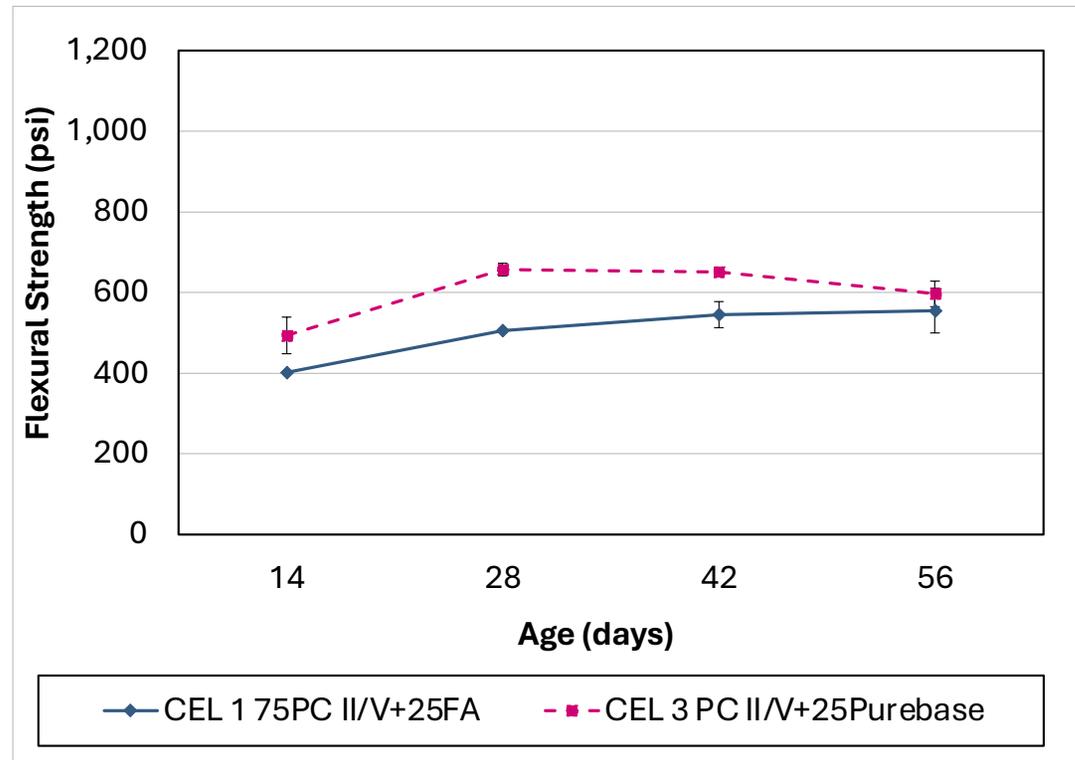
- CEL 1 showed a dip at 28 days, likely due to batch variability or curing inconsistency, before recovering by 42 days
- CEL 3 exhibited a statistically significant reduction from 5698 psi at 56 days to 5390 psi at 90 days ($p = 0.029$). This decline may be linked to the quality of cast cylinders and may not be mix related but cannot be isolated.
- Petrographic analysis of core specimens will be performed to further evaluate the quality of the mix.



Strength and Durability Test Results

PHASE 3

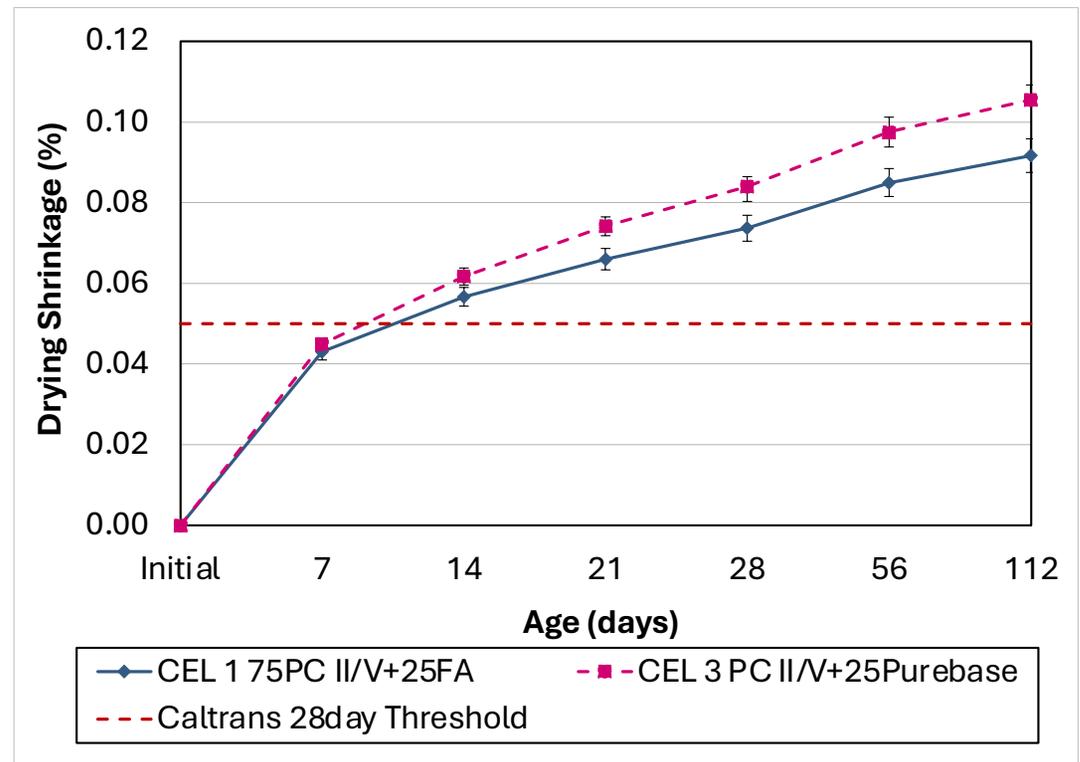
- CEL 3 had significantly higher flexural strength than CEL 1 at both 28 days ($p = 0.034$) and 42 days ($p = 0.048$)
- CEL 3 (Purebase) met the Caltrans acceptance criterion of 650 psi at 42 days, while CEL 1 did not (achieved ~550 psi)
- CEL 3 peaked at 28 days (657 psi) and slightly declined to 597 psi at 56 days. This reduction was not statistically significant ($p = 0.062$)



Strength and Durability Test Results

PHASE 3

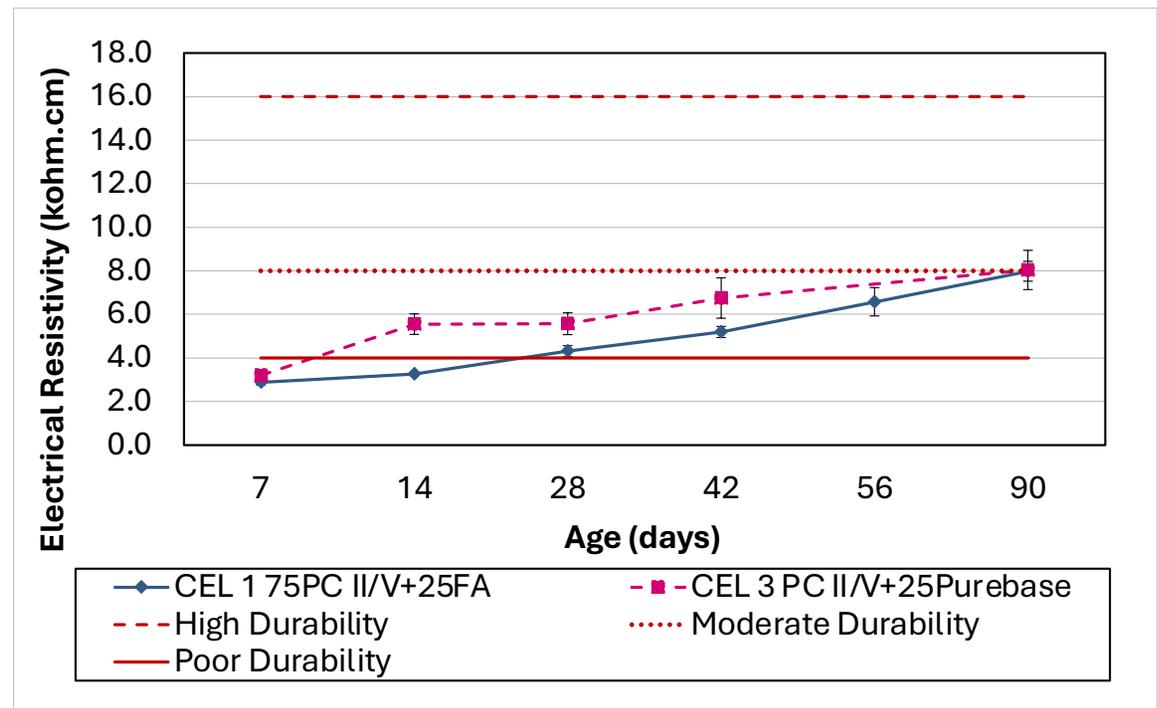
- Drying shrinkage for CEL 1 and CEL 3 was statistically similar at 7 days ($p > 0.05$), but CEL 3 became significantly higher than CEL 1 by 14 days and onward ($p < 0.05$)
- At 28 days, CEL 3 exceeded 0.085% while CEL 1 remained closer to 0.075%
- Neither CEL 1 nor CEL 3 met the Caltrans drying shrinkage limit of 0.05% at 28 days.
- Shrinkage-reducing admixture has been successful in mitigating drying shrinkage higher than the specification.



Strength and Durability Test Results

PHASE 3

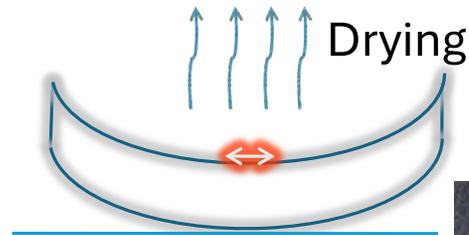
- By 90 days, both CEL 1 and CEL 3 reached the moderate chloride permeability risk range



Slab Scale – Long-Term Monitoring

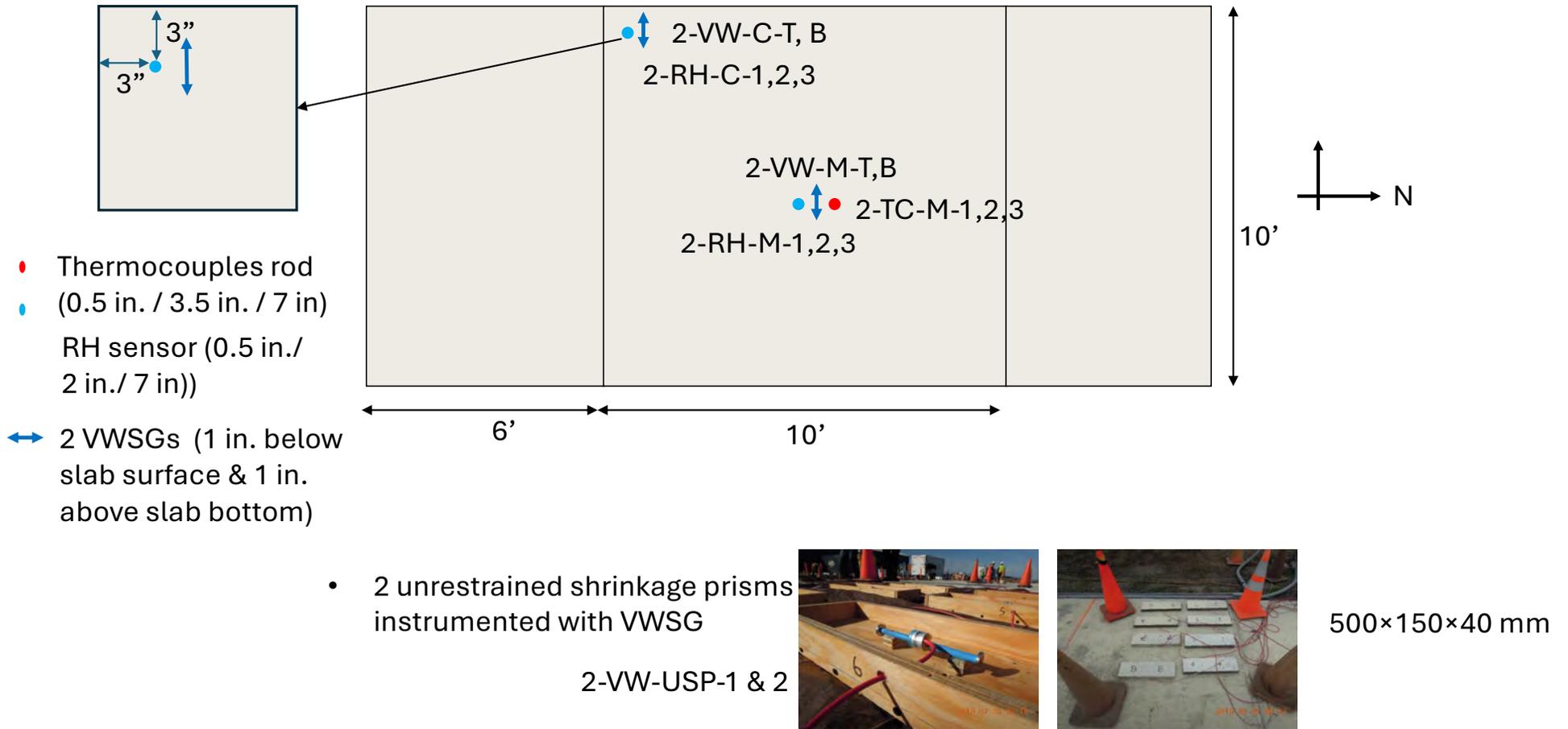
PHASE 2

- Slabs' curling and warping behavior due to temperature and moisture differential across the slab depth are being monitored using embedded sensors
 - Relative humidity, temperature and strain
- Data and analysis of slab behavior is available upon request



Unrestrained Shrinkage Prisms

Schematic Diagram of Instrumentation





THANK YOU

General information: <https://mdsc.ucdavis.edu/lab2slab/>

Questions or comments: nassiri@ucdavis.edu