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Concrete Construction Recap: Placement, Sampling, and Findings

Cells 2,4, and 6: Construction on June 05, 2025
(PLC2, LC4, LC3)

November 2025

Mix Proportions (Batch Size: 5 cy)

Item	Units	CEL 2 TR 1-PLC2	CEL 2 TR 2-PLC2	CEL 2 TR 3-PLC2
Batching date-time	-	06/05-5:55 AM	06/05-6:08 AM	06/05-10:20 AM
Ambient temperature	°F	50	52	65
Test material	-	70%PLC + 30%BCSA		
Cement	lb/batch (lb/cy)	2,950 (590)	2,950 (590)	2,950 (590)
Design water	gal/batch (gal/cy)	135 (27)	135 (27)	135 (27)
Batched Water	gal/batch (gal/cy)	132.5 (26.5)	142.3 (28.5)	141.3 (28.3)
Added extra water	gal/batch (gal/cy)	15 (3)	0	3 (0.6)
Total water	gal/batch (gal/cy)	147.5 (29.5)	142.3 (28.5)	144.3 (28.9)
Coarse Aggregate	lb/batch	5,780	5,660	5,880
Int. Aggregate	lb/batch	4,100	4,000	4,100
Fine Aggregate	lb/batch	6,900	6,800	6,940
Initial PCE Type A WR and Type F HRWR	oz/cwt	13	13	13
Extra PCE Type A WR and Type F HRWR	oz/cwt	7	0	13
Total PCE Type A WR and Type F HRWR	oz/cwt	20	13	26
Type B [retarding (RA)] and Type D RA&WR	oz/cwt	0.9	1.2	0.9

PLC: Portland limestone cement
 BCSA: Belitic Calcium sulfoaluminate
 RA: retarding admixture
 WR: water reducer
 HRWR: high-range water reducer

RA&WR: retarder and water reducer
 PCE: Polycarboxylate Ether-based
 admixture

Mix Proportions (Batch Size: 5 cy)

Item	Units	CEL 4 TR 1-LC4	CEL 4 TR 2-LC4	CEL 6 TR 1-LC3	CEL 6 TR 2-LC3
Batching date-time	-	06/05-8:11 AM	06/05-8:35 AM	06/05-12:00 PM	06/05-12:22 PM
Ambient temperature	°F	57	57	77	83.5
Test material	-	70%LC3+30%BCSA		100%LC3	
Cement	lb/batch (lb/cy)	2950 (590)	2950 (590)	2950 (590)	2950 (590)
Design water	gal/batch (gal/cy)	145 (29)	145 (29)	176.5 (35.3)	176.5 (35.3)
Batched Water	gal/batch (gal/cy)	141.3 (28.3)	140.4 (28.1)	153.8 (30.8)	146.9 (29.4)
Added extra water	gal/batch (gal/cy)	8 (1.6)	3 (0.6)	0	7.5 (1.5)
Total water	gal/batch (gal/cy)	149.3 (29.9)	143.4 (28.7)	153.8 (30.8)	154.4 (30.9)
Coarse Aggregate	lb/batch	5,620	5,640	7,860	7,880
Int. Aggregate	lb/batch	4,000	4,000	1,420	1,420
Fine Aggregate	lb/batch	6,760	6,800	6,400	6,400
Type A WR, Type B RA, and Type D RA&WR	oz/cwt	-	-	5.8	6.1
Initial PCE Type A WR and Type F HRWR	oz/cwt	13	13	7	7
Extra PCE Type A WR and Type F HRWR	oz/cwt	13	13	0	4.5
Total PCE Type A WR and Type F HRWR	oz/cwt	26	26	7	11.5
Type B RA and Type D RA&WR	oz/cwt	0.8	0.8	-	-

LC3: Limestone calcined clay cement
 PLC: Portland limestone cement
 BCSA: Belitic Calcium sulfoaluminate
 RA: retarding admixture
 WR: water reducer

HRWR: high-range water reducer
 RA&WR: retarder and water reducer
 PCE: Polycarboxylate Ether-based admixture

Constructability – CEL 2 (70%PLC+30%BCSA) TR 3



- Truck 3 arrival time: 10:51 AM
- Ambient temp: 79 °F
- Discharge started at 10:55 AM

Constructability – CEL 2 (70%PLC+30%BCSA) TR 3



Constructability – CEL 2 (70%PLC+30%BCSA) TR 3



6/5/2025 10:57 AM

Constructability – CEL 2 (70%PLC+30%BCSA) TR 3



6/5/2025 10:58 AM

Finishability – CEL 2 (70%PLC+30%BCSA) TR 3



- Finishing started at 11:03 AM

Finishability – CEL 2 (70%PLC+30%BCSA) TR 3



6/5/2025 11:06 AM

Finishability – CEL 2 (70%PLC+30%BCSA) TR 3



Finishability – CEL 2 (70%PLC+30%BCSA) TR 3



Finishability – CEL 2 (70%PLC+30%BCSA) TR 3



Finishability – CEL 2 (70%PLC+30%BCSA) TR 3



Curing – CEL 2 (70%PLC+30%BCSA) TR 3



Application of curing compound

- Started at 11:25 AM
- Finished at 11:36 AM

Saw Cutting – CEL 2 (70%PLC+30%BCSA) TR 3



Saw Cutting – CEL 2 (70%PLC+30%BCSA) TR 3



6/5/2025 1:56 PM

Constructability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



- Truck 1 arrival time: 8:43 AM
- Ambient temp: 75°F
- Discharge started at 8:50 AM

- Truck 2 arrival time: 9:03 AM
- Ambient temp: 74.4°F
- Discharge started at 9:05 AM

Constructability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Constructability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Constructability – CEL 4 (LC4) TR 1 and TR 2



6/5/2025 8:54 AM

Constructability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Constructability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Finishability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



- Finishing started at 9:02 AM

Finishability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Finishability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



6/5/2025 9:05 AM

Finishability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



6/5/2025 9:06 AM

Finishability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Finishability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Finishability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



6/5/2025 9:13 AM

Finishability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Finishability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Finishability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Finishability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Finishability – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Curing – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Application of curing compound

- Started at 9:43 AM
- Finished at 9:57 AM

Curing – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Curing – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Curing – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



6/5/2025 9:50 AM

Curing – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



6/5/2025 9:57 AM

Saw Cutting – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Saw Cutting – CEL 4 (70%LC3+30%BCSA) TR 1 and TR 2



Constructability – CEL 6 (LC3) TR 1 and TR 2



- Truck 1 arrival time: 12:00 PM
- Ambient temp: 80°F
- Discharge started at 12:45 PM

- Truck 2 arrival time: 12:52 PM
- Ambient temp: 83.5°F
- Discharge started at 1:03 PM

Constructability – CEL 6 (LC3) TR 1 and TR 2



Constructability – CEL 6 (LC3) TR 1 and TR 2



Constructability – CEL 6 (LC3) TR 1 and TR 2



Constructability – CEL 6 (LC3) TR 1 and TR 2



Constructability – CEL 6 (LC3) TR 1 and TR 2



6/5/2025 12:51 PM

Constructability – CEL 6 (LC3) TR 1 and TR 2



Constructability – CEL 6 (LC3) TR 1 and TR 2



6/5/2025 12:57 PM

Constructability – CEL 6 (LC3) TR 1 and TR 2



Constructability – CEL 6 (LC3) TR 1 and TR 2



Finishability – CEL 6 (LC3) TR 1 and TR 2



- Finishing started at 1:07 PM

Finishability – CEL 6 (LC3) TR 1 and TR 2



6/5/2025 1:08 PM

Finishability – CEL 6 (LC3) TR 1 and TR 2



6/5/2025 1:12 PM

Finishability – CEL 6 (LC3) TR 1 and TR 2



Finishability – CEL 6 (LC3) TR 1 and TR 2



Finishability – CEL 6 (LC3) TR 1 and TR 2



Plastic Concrete Properties Results

- Properties measured on samples taken from the truck

Fresh Properties	PLC2	LC4	LC4	LC3	LC3
	CEL 2 TR-3	CEL 4 TR-1	CEL 4 TR-2	CEL 6 TR-1	CEL 6 TR-2
Temperature (°C)	25.7	25.1	27.1	24.9	28.7
Slump (in)	7.5	2.5	2.25	9	4
Air Content (%)	2.3	2.7	2.4	3.1	2.3
Unit Weight (lb/ft ³)	149.7	149.5	149.7	145.5	149.1
Yield (%)	99	100	100	99	102

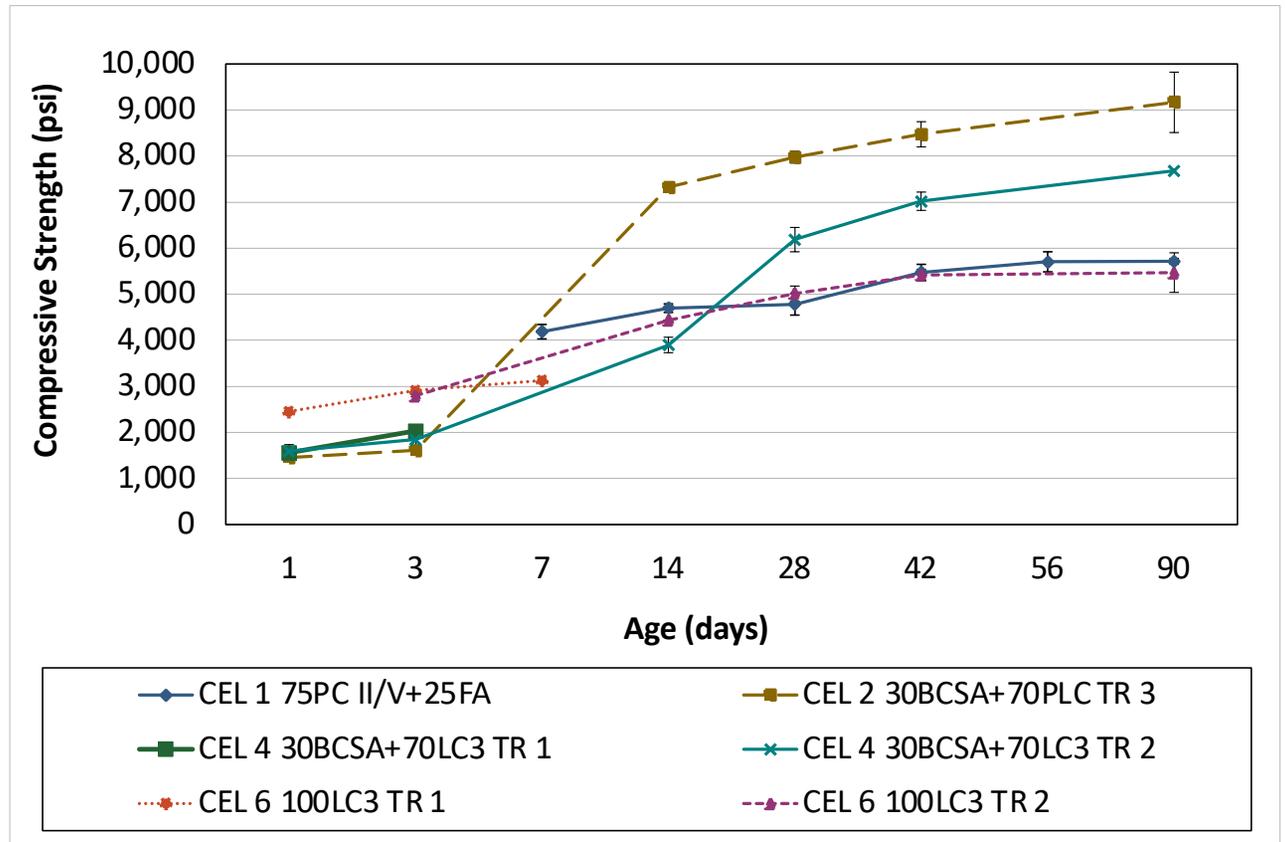
Plastic Concrete Properties Results

Setting Time & Maturity	Unit	PLC2 (CEL 2 TR-3)	LC4 (CEL 4 TR-1)	LC3 (CEL 6 TR-1)
Batching Time	h:m	10:20 AM	8:11 AM	12:00 PM
Initial Set Time of the sample	h:m (since batching time at plant)	1:20	1:14	4:45
Final Set Time of the sample	h:m	1:34	1:27	6:40
Maturity at Initial Set	°C-min	2,194	1,974	8,577
Maturity at Final Set	°C-min	2,671	2,433	12,543
Initial Set Time of the slab	h:m	1:22	1:19	4:06
Final Set Time of the slab	h:m	1:38	1:35	6:36
Start of Saw Cutting Window: 1.3 x final set time at target maturity + 30 min	h:m (since final set time)	2:37	2:06	7:06
End of Placing Time	h:m	11:03 AM	9:04 AM	1:06 PM
Saw Cutting Time	h:m	13:34 PM	1:10 AM*	9:00 AM*
Elapsed Time to Saw Cutting	h:m	2:31	16:52	19:54

*following day

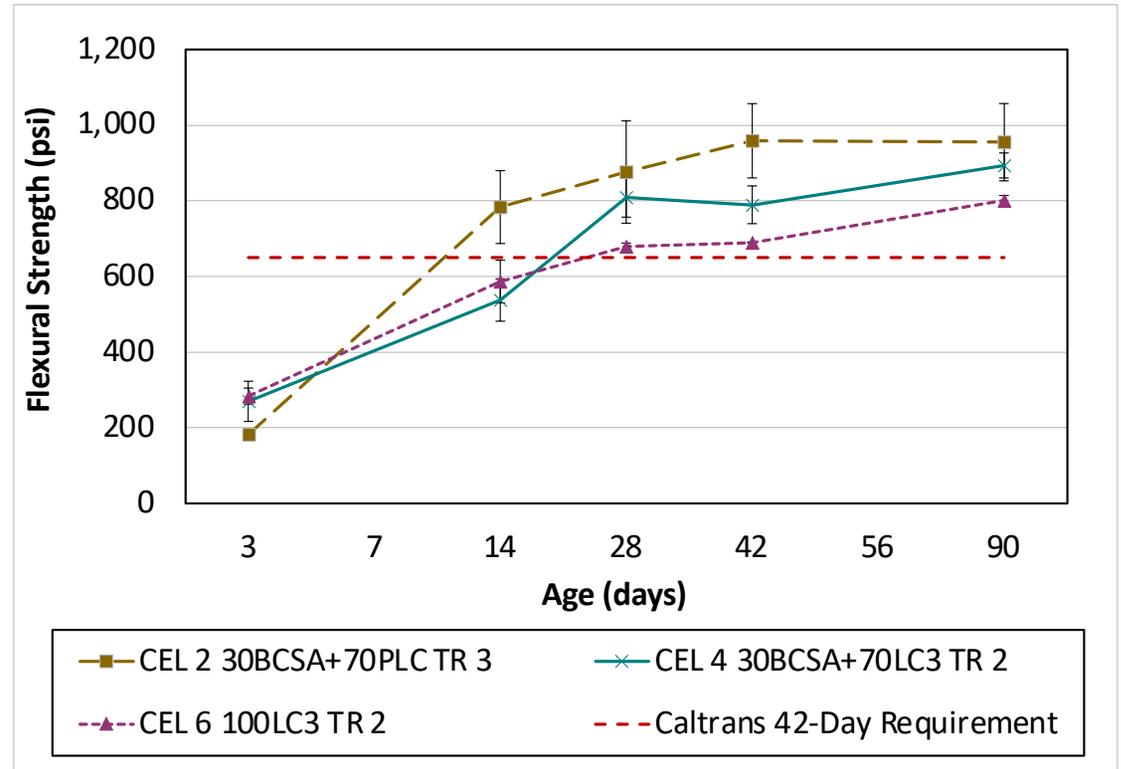
Compressive Strength Test Results (ASTM C39)

- Rapid set mixes (BCSA+PLC & BCSA+LC3) reach 1,500-psi strength on 1 day
- 30BCSA+70PLC reaches over 9,000 psi by 90 days followed by 30BCSA+70LC3 at over 7,600 psi
- 100LC3 reaches 5,400 psi on 90day



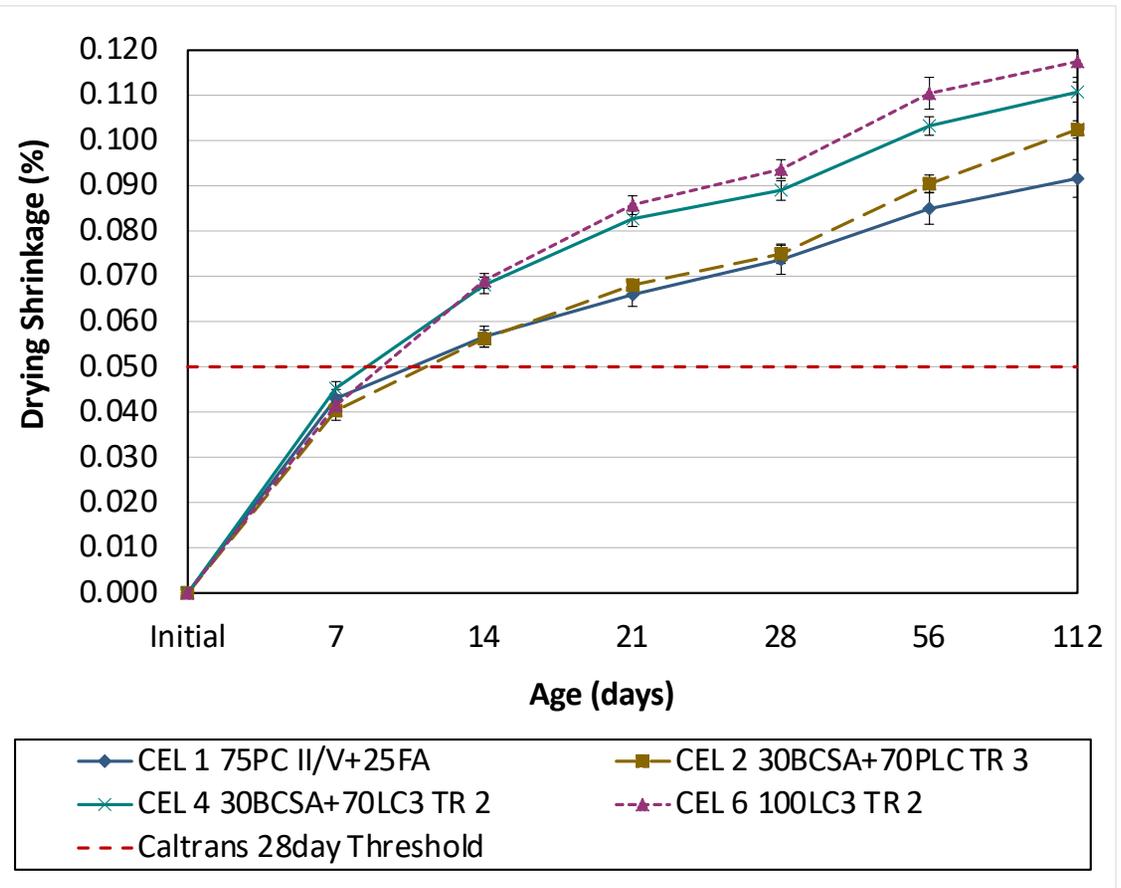
Flexural Strength Test Results (ASTM C78)

- All three mixes meet Caltrans's 650 psi requirement on 42 days
- 30BCSA+70PLC consistently shows the highest flexural strength, reaching nearly 1,000 psi by 90 day.
- 30BCSA+70LC3 also gains strength with age, showing around 900 psi by 90 day.
- 100LC3 showed strong early-age development but appears to plateau quickly, reaching 680 psi by 42 day, and gains 800 psi by 90 day.



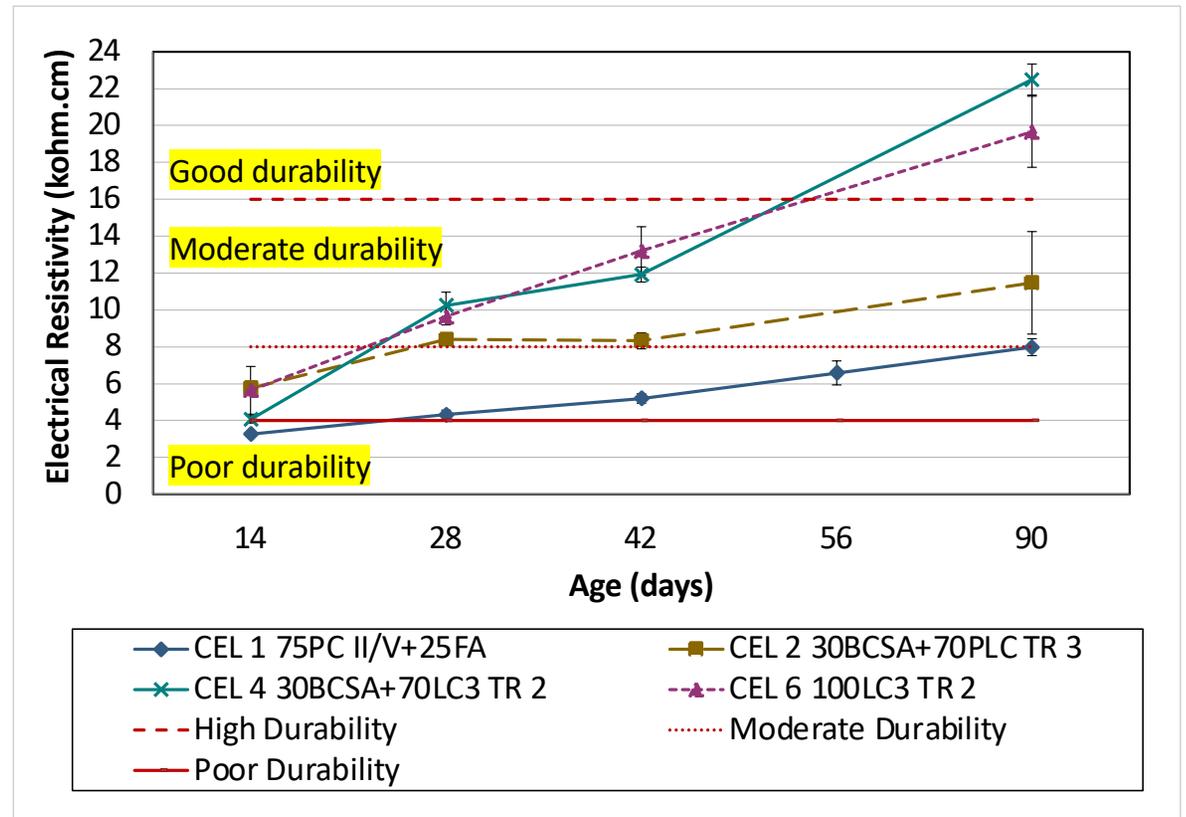
Drying Shrinkage Test Results (modified ASTM C157)

- Shrinkage-reducing admixture is commonly needed with PLC and mixes with pozzolans using this aggregate, and is required for these mixes also to meet the Caltrans requirement.



Electrical Resistivity Test Results (ASTM C1760)

- At 90-day age, 30BCSA+70LC3 followed by 100LC3 shows the highest resistivity and is in the high durability region
- All three mixes show good durability based on this test



Critical to Supervise Every Step of Operation

- Mixing test materials falls outside the normal operations for the concrete producer
- So, the process is more prone to operational error
- In this example:
 - The wrong mix design was used in the batching system, which had different water & admixture type and dose
- Lesson learned:
 - Supersack discharge and working with test materials is not regular and requires careful monitoring at every step
 - Have backup supersack of test material





THANK YOU

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