

# Caltrans Independent Assurance Reference Sample Program



## Portland Cement Concrete (PCC) Laboratory Proficiency Testing Report

2025 PROFICIENCY TEST RESULTS

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February 6, 2025

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## Table of Contents

1.0	Overview .....	4
2.0	Analysis of Test Results .....	5
2.1	Evaluation Criteria .....	5
2.2	Initial Round of Testing .....	5
2.3	Retests.....	7
2.4	I.A. Witness Tests .....	8
2.5	Late Participation .....	8
3.0	Observations .....	9
4.0	References .....	9
APPENDIX – A.....		11
APPENDIX – B.....		16
APPENDIX – C .....		17

## **ACKNOWLEDGEMENTS**

The contributions of the Caltrans Independent Assurance Staff were essential to the successful completion of this round of proficiency testing. Their technical support and coordination efforts are greatly appreciated. Special recognition is given to the Reference Sample Program (RSP) staff, particularly Mark Daniels, for the careful preparation and distribution of the samples used for proficiency tests. Their attention to detail and commitment to maintaining the quality and consistency of the samples were critical to the integrity of the testing process.

Appreciation is also extended to the participating Caltrans districts, local agencies, and private laboratories for providing test results and supporting the objectives of the proficiency testing program. Their continued participation and collaboration are vital to the program's success and ongoing improvement.

# **Caltrans Reference Sample Program (RSP)**

## **Laboratory Proficiency Testing on Portland Cement Concrete**

### **1.0 Overview**

In December 2024, Caltrans RSP sent a proficiency testing announcement letter to 184 laboratories that are Caltrans Independent Assurance (IA) accredited to perform CT 521: Method of Test for Compressive Strength of Cylindrical Concrete Specimens.

Those laboratories that were Caltrans IA accredited in CT 521 were also required to perform the following Portland Cement Concrete tests:

- CT 518: Method of Test for Unit Weight of Fresh Concrete
- CT 556: Method of Test for Slump of Fresh Portland Cement Concrete
- CT 557: Method of Test for Temperature of Freshly Mixed Portland Cement Concrete

The RSP aims to ensure that laboratories accredited under the Caltrans IA Program demonstrate proficiency in performing the selected test methods used for proficiency testing. The program validates the competence of accredited laboratories, verifying they strictly adhere to standardized procedures, utilize properly calibrated laboratory equipment, and produce consistent results compared to their peers.

The primary focus of this round of proficiency testing is assessing the 7-day compressive strength of cylindrical concrete specimens cast in 4"x8" molds. Concrete compressive strength laboratory proficiency testing is fundamental to ensuring the accuracy and reliability of this critical acceptance test. This process serves as an essential quality assurance measure, effectively distinguishing between genuine deficiencies in the concrete mix and operational errors introduced by a technician or laboratory equipment. Results from ancillary tests, including unit weight, slump, and temperature, will also be collected and utilized to investigate and explain any anomalies observed within the primary compression test data.

The test materials were prepared in the Caltrans RSP Laboratory in Sacramento, CA. Bulk samples of coarse aggregate, sand, and Portland cement (Type 1L) were sourced from local suppliers and met the requirements of Section 90-1.02B(2) of the Caltrans Standard Specifications (2022). Each laboratory received materials yielding approximately 0.85 cubic feet. Laboratories were provided

with instructions for oven-drying, weighing, mixing, and casting the concrete cylinders, followed by testing and reporting of CT 521, CT 518, CT 556, and CT 557. A total of 181 laboratories were evaluated.

## 2.0 Analysis of Test Results

### 2.1 Evaluation Criteria

Results were evaluated using a statistical evaluation system in which the mean ( $X$ ) and standard deviation ( $s$ ) were calculated. A rating score was then applied to the test results based on the criteria shown in Table 1. A test result with a score of 3 or greater was considered an acceptable result. A test result with a score of 2 or less was deemed to be unacceptable, and a retest was required.

**Table 1: Evaluation Criteria**

Test Result	Rating	Interpretation of Results	Acceptance
$X \pm 1.0s$	5	Very Good	Acceptable
$X \pm 1.5s$	4	Good	Acceptable
$X \pm 2.0s$	3	Fair	Acceptable
$X \pm 2.5s$	2	Poor	Unacceptable
$X \pm 3.0s$	1	Very Poor	Unacceptable

Data outliers were analyzed according to ASTM E 178 based on the initial data collected. A common method to identify potential outliers is using the "z-score," which measures how many standard deviations a data point is away from the mean. Values with a z-score exceeding 3 are often considered outliers.

### 2.2 Initial Round of Testing

A total of 179 laboratories participated in the initial round of tests. An outlier analysis, performed in accordance with ASTM E 178, was conducted for each sample set for the slump, unit weight, and compressive strength tests. Temperature measurements were recorded; however, individual laboratory ratings for concrete temperature were not evaluated because the measured temperature reflects the inherent condition of the material at the time of testing. As such, it does not provide a meaningful basis for assessing a laboratory's systematic or random error within a controlled interlaboratory testing program.

Following the outlier analysis, the resulting statistical summaries are presented in Tables 2A and 2B. The complete set of detailed test results for all participating laboratories is provided in Appendix A.

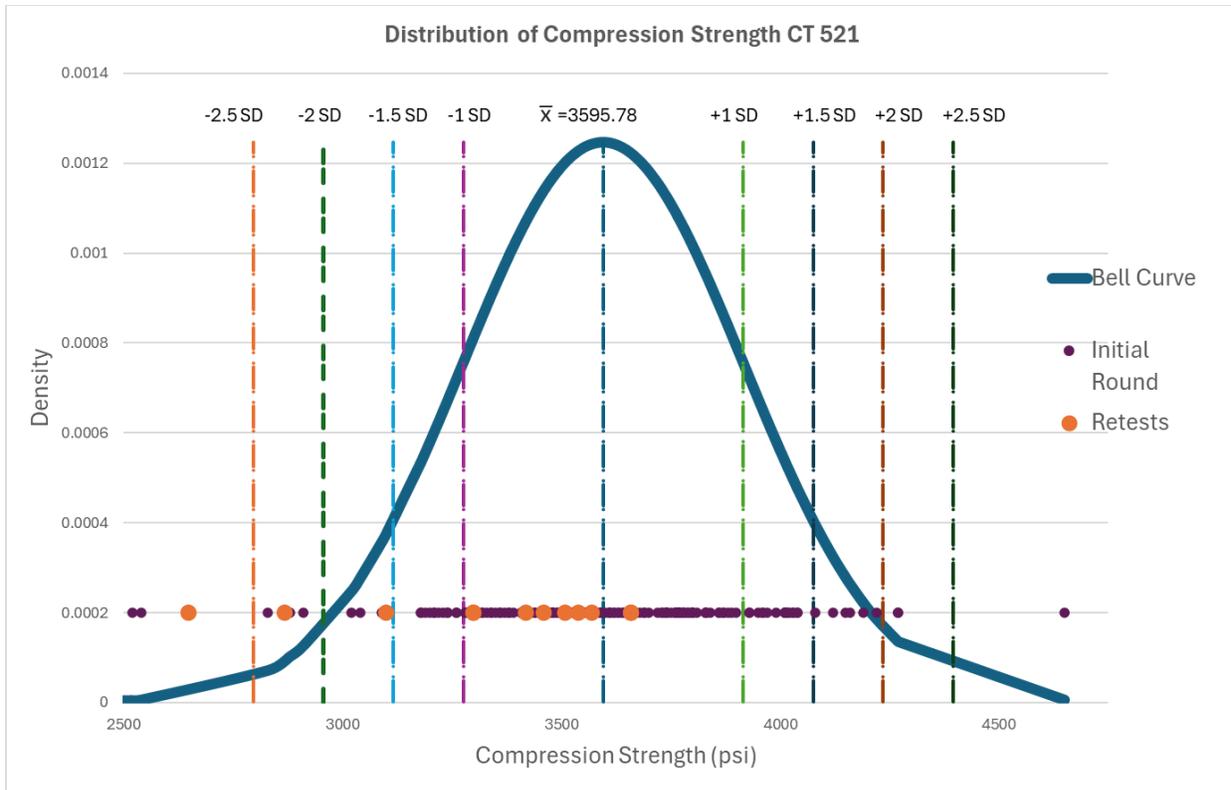
**Table 2A: Labs and Test Results Considered as Outliers**

Test Method	# of Outliers	Lab ID
CT 557	N/A	N/A
CT 556	1	266
CT 518	2	354, 636
CT 521	4	114, 244, 297, 310

**Table 2B: Summary Statistics and Score Distribution for 179 Labs (Initial Round)**

Test Method	Average	Standard Deviation	Number of Labs Achieved Score of				
			5	4	3	2	1
CT 557 Temperature, °F	71.41	7.148	N/A	N/A	N/A	N/A	N/A
CT 556 Slump (in)	2.94	1.044	121	39	8	8	3
CT 518 Unit Weight (lb/ft <sup>3</sup> )	152.02	1.732	147	12	7	3	10
CT 521 Compressive Strength (psi)	3595.78	279.586	121	33	12	7	6

Figure 1 below shows the normal distribution curve for the average data collected from each participating laboratory testing for compressive strength.



**Figure 1: CT 521 Compressive Strength Normal Distribution Curve with Data Points and Standard Deviation Lines**

**2.3 Retests**

Retest samples were sent to laboratories with test results that were either identified as outliers or received a rating of 2 or below for compressive strength (CT 521). 13 laboratories did not achieve acceptable ratings and were provided retest samples for re-evaluation. The retest results were assessed using the initial statistical analysis parameters.

The retest summary is presented in Table 3. The full retest results and scores are provided in Appendix B.

**Table 3: Summary of Retest Results**

Test Method	Item	# Lab	Number of Labs Achieved Score of				
			5	4	3	2	1
CT 521	Compressive Strength (psi)	13	7	2	1	0	3
% of Total			54	15	8	0	23

## **2.4 I.A. Witness Tests**

Witness testing is initiated when a laboratory's retest results remain unacceptable after the initial retest attempt or when initial results indicate procedural or operator-related issues. For laboratories that initially failed the slump test, the unit weight test, or both, witness testing was directly required to evaluate performance, as these tests are particularly sensitive to procedural errors and operator variability.

Of the 13 laboratories that performed retesting for compressive strength, 11 achieved acceptable results. The remaining two laboratories did not achieve a successful rating and were therefore required to undergo witness testing to evaluate their procedures and performance.

For slump and unit weight, IA witness testing was performed directly for 18 laboratories whose initial test results were either identified as outliers or received a rating of 2 or below. Witness testing confirmed laboratory proficiency by evaluating key procedures, including mixing, specimen preparation, and testing.

For compressive strength testing, IA witness testing was required for the three laboratories that received unsatisfactory retest results. Of these three laboratories, two successfully completed witness testing and were subsequently evaluated as proficient. One laboratory failed the witness evaluation.

In accordance with the 2024 IA Manual, three consecutive poor RSP test results constitute a second infraction. As a result, the laboratory is required to submit a Corrective Action Plan (CAP), serve a 90-calendar-day suspension beginning upon IA staff approval of the CAP, and complete IAP requalification at the conclusion of the suspension period.

## **2.5 Late Participation**

One laboratory submitted its initial test results after the deadline specified in the test data reporting instructions. The laboratory's results were evaluated using the initial-round mean and standard deviation calculated from the 179 laboratories that submitted their results on time. Based on this evaluation, the results were determined to be acceptable, and the laboratory successfully passed the proficiency test. The laboratory's results are included in Appendix C.

Another laboratory, which did not initially opt in to this round of proficiency testing but was required to participate, had its accreditation suspended. The laboratory subsequently paid the applicable late participation fee in

September 2025 and was then issued the required materials to perform the proficiency testing. The laboratory completed the testing and submitted results that received a satisfactory rating.

### **3.0 Observations**

A total of 181 laboratories participated in the 2025 Caltrans RSP laboratory proficiency testing on CT 521: Method of Test for Compressive Strength of Cylindrical Concrete Specimens. In addition to CT 521, laboratories that were Caltrans IA-accredited in CT 521 were also required to perform CT 557 (Temperature), CT 518 (Unit Weight) and CT 556 (Slump) tests.

In the initial testing round, 179 laboratories submitted their results on time for evaluation, while one laboratory submitted its results after the deadline.

Of the 179 initial round test results, 13 laboratories initially failed in compression strength, and 18 laboratories failed in the slump or unit weight test, or both in the initial round of testing. Failures were defined as either submitting results identified as outliers or obtaining a score below 3, as determined by the statistical evaluation method outlined in the Caltrans IA Manual for Reference Sample Program participants.

For compressive strength (CT 521), retest samples were issued to the 13 laboratories that initially failed. Of these, 10 laboratories achieved satisfactory results. The remaining three laboratories did not achieve a successful rating and were therefore required to undergo witness testing. Two of these laboratories completed the witness testing and were evaluated as proficient, while the other failed. Consequently, accreditation for CT 521 for that laboratory is suspended until corrective actions are completed, including full witness testing and submission of a laboratory evaluation to regain accreditation.

For slump (CT 556) and unit weight (CT 518), witness testing was directly required for the 18 laboratories that initially failed, as these tests are particularly sensitive to procedural errors and operator variability. IA staff conducted witness testing for all 18 laboratories, evaluating key procedures including mixing, specimen preparation, and testing techniques. All laboratories successfully demonstrated proficiency during these witness tests.

### **4.0 References**

1. ASTM E 178, "Standard Practice for Dealing with Outlying Observations."
2. Caltrans, "Independent Assurance Manual," Sacramento, April 2024.

3. CT 557, "Method of Test for Temperature of Freshly Mixed Portland Cement Concrete".
4. CT 556, "Method of Test for Slump of Fresh Portland Cement Concrete".
5. CT 518, "Method of Test for Unit Weight of Fresh Concrete".
6. CT 521, "Method of Test for Compressive Strength of Cylindrical Concrete Specimens".

## APPENDIX – A

### Test Results from Initial Round of Testing

Lab No.	CT 557	CT 556		CT 518		CT 521	
	Temperature (°F) (Score N/A)	Slump, in	Score	Unit Weight (lb/ft <sup>3</sup> )	Score	Compressive Strength (psi)	Score
1	68	4.25	4	153.2	5	3800	5
6	73	2.25	5	153.2	5	3420	5
8	74	3.75	5	150.6	5	3930	4
11	N/A	N/A	N/A	N/A	N/A	3760	5
12	81	1	3	151.2	5	3560	5
15	70	2.25	5	151.9	5	3690	5
18	73	2	5	152	5	3640	5
20	73	2.75	5	151.6	5	3780	5
22	60	2.25	5	152	5	3555	5
23	65	3.25	5	152	5	3870	5
24	73	3.25	5	151.3	5	3680	5
29	83	1.75	4	146.8	1	4040	3
31	74	2.25	5	159.7	1	4120	3
40	61	4	4	150.7	5	3430	5
43	68	4.25	4	151.6	5	3340	5
46	64	3	5	151.6	5	3780	5
49	85	3	5	153.2	5	3440	5
50	83	2.5	5	150.8	5	3330	5
52	58	4.25	4	153.7	5	3290	4
57	84	3.5	5	153.6	5	3310	4
58	78	3	5	151.6	5	3660	5
59	74	3.25	5	152	5	3210	4
63	80	3.5	5	150.9	5	3590	5
65	83	2.5	5	152.1	5	4010	4
66	80	3.5	5	152.8	5	3870	5
67	69	3.5	5	151.1	5	3800	5
70	79	2.5	5	152.3	5	4020	3
71	80	2	5	149.3	3	3760	5
74	55	3.75	5	152	5	3390	5
75	71	4.25	4	152.6	5	4010	4
76	73	3	5	152	5	4220	2
79	70	2.75	5	157.5	1	3490	5
80	62	2	5	151.1	5	3460	5

Lab No.	CT 557	CT 556		CT 518		CT 521	
	Temperature (°F) (Score N/A)	Slump, in	Score	Unit Weight (lb/ft³)	Score	Compressive Strength (psi)	Score
88	70	1.75	4	152.7	5	3860	5
91	73	1.5	4	153.3	5	4010	4
92	92	0.5	2	153.2	5	3750	5
94	60	3.5	5	150.2	4	3620	5
96	100	1.75	4	151	5	3020	2
110	69	5.25	2	153.5	5	4020	3
112	58	3	5	152.4	5	3560	5
114	70	3	5	150.6	5	2400	1
118	70	3.25	5	151.6	5	3470	5
125	72	3	5	151.4	5	3500	5
131	66	4	4	150.7	5	3630	5
137	83	0.75	2	158	1	4270	2
139	75	3.75	5	151.4	5	3510	5
144	77	2.5	5	149.3	3	3770	5
146	N/A	N/A	N/A	N/A	N/A	3840	5
149	65	3	5	152.4	5	3410	5
150	71	2.5	5	151.6	5	3320	5
153	73	4.5	4	151.6	5	3260	4
157	68	4.25	4	151.4	5	3690	5
161	75	3	5	151.7	5	3530	5
169	75	2.5	5	154	4	3190	4
171	68	4	4	153.1	5	3530	5
173	60	3.25	5	150.6	5	3530	5
177	62	5.25	2	150.8	5	3220	4
182	74	2.25	5	152.1	5	3480	5
197	66	2.5	5	152.4	5	3740	5
204	72	4.25	4	147.8	2	4040	3
206	60	3.5	5	150.8	5	3780	5
207	60	2.5	5	151.1	5	3880	4
209	60	3.75	5	152.5	5	3670	5
210	73	3.25	5	151.2	5	3770	5
213	70	3.75	5	151.2	5	3410	5
214	86	0.5	2	151.4	5	3760	5
216	62	1.5	4	155.3	3	3650	5
219	64	3	5	152.5	5	3470	5
220	64	3	5	152.5	5	3470	5
223	72	2.5	5	151.1	5	2910	2

Lab No.	CT 557	CT 556		CT 518		CT 521	
	Temperature (°F) (Score N/A)	Slump, in	Score	Unit Weight (lb/ft³)	Score	Compressive Strength (psi)	Score
225	78	3	5	151.3	5	3930	4
236	78	2.75	5	154	4	3570	5
237	61	5.75	1	149.5	4	3360	5
242	65	3.75	5	151.1	5	3580	5
244	71	3	5	154.2	4	2540	1
247	73	4.25	4	151.2	5	3240	4
248	71	3.75	5	151.6	5	3480	5
250	80	6	1	152.4	5	2880	1
251	69	3	5	152	5	3830	5
253	60	4.25	4	152	5	3310	4
254	79	2	5	152.4	5	3550	5
255	69	3	5	153.4	5	3770	5
258	73	3	5	150.3	5	3740	5
261	77	2	5	151.7	5	3550	5
262	79	2	5	152.4	5	3560	5
263	76	3.75	5	153.6	5	3460	5
266	89	7	1	151.4	5	2830	1
267	73	4	4	151.3	5	3550	5
268	70	5.5	2	151.6	5	3900	4
270	73	4	4	151.6	5	3230	4
273	72	3	5	151.9	5	3520	5
276	77	3.5	5	152.2	5	3460	5
277	70	2.5	5	150.1	4	3800	5
279	73	4	4	151.1	5	3380	5
284	74	2.75	5	154.2	4	3420	5
287	85	1.5	4	154	4	3860	5
295	72	2.5	5	151.9	5	3420	5
297	65	3.75	5	151.5	5	2520	1
303	71	2.5	5	152.3	5	3520	5
307	84	1	3	152.6	5	3590	5
310	64	2	5	152.4	5	4650	1
311	83	2	5	148.8	3	3950	4
315	67	4	4	152.1	5	3660	5
325	72	4	4	152	5	3300	4
326	77	1.75	4	156.1	2	3830	5
329	84	1	3	152.6	5	3590	5
331	84	3	5	151.8	5	3290	4

Lab No.	CT 557	CT 556		CT 518		CT 521	
	Temperature (°F) (Score N/A)	Slump, in	Score	Unit Weight (lb/ft³)	Score	Compressive Strength (psi)	Score
332	N/A	N/A	N/A	N/A	N/A	3640	5
334	67	1.25	3	N/A	N/A	3550	5
336	66	2	5	154	4	3490	5
338	77	1.5	4	152.4	5	3210	4
342	76	1.5	4	152.8	5	3790	5
347	64	4	4	152.6	5	3700	5
348	68	1.5	4	152.7	5	3790	5
353	73	2.75	5	151.6	5	3450	5
354	58	2	5	135.3	1	3100	3
356	73	3.75	5	151.5	5	3960	4
359	70	4.5	4	151.8	5	3180	4
361	79	2.75	5	152.3	5	3430	5
368	71	3	5	152.1	5	3350	5
374	73	3.5	5	151	5	3740	5
376	73	2	5	153.6	5	3550	5
381	69	1.75	4	152.5	5	4150	3
385	71	2.25	5	152.3	5	4270	2
395	69	1	3	153.6	5	3420	5
396	67	2.75	5	152.9	5	3530	5
399	73	2.75	5	152	5	3960	4
401	63	3.25	5	152.3	5	3280	4
415	63	3.25	5	151.9	5	3630	5
423	66	2.5	5	151.6	5	3360	5
428	64	2.25	5	155.3	3	3260	4
432	83	2	5	149.1	3	4030	3
441	74	3.5	5	152.5	5	3650	5
447	67	3	5	152.7	5	4160	2
448	72	3.25	5	152.4	5	3320	5
449	65	2.75	5	150	4	3620	5
464	79	3.25	5	151.1	5	3200	4
474	73	2.25	5	152.5	5	3530	5
492	68	2.5	5	153.6	5	3540	5
495	66	3	5	153.5	5	3090	3
496	63	4.5	4	152.2	5	4030	3
502	72	4.5	4	151.2	5	4190	2
508	78	0.75	2	145.9	1	3520	5
521	71	4.25	4	152	5	3670	5

Lab No.	CT 557	CT 556		CT 518		CT 521	
	Temperature (°F) (Score N/A)	Slump, in	Score	Unit Weight (lb/ft³)	Score	Compressive Strength (psi)	Score
533	78	2.25	5	151.8	5	3770	5
536	70	4.25	4	152	5	3240	4
538	72	2	5	152.9	5	3450	5
543	83	1.25	3	151.8	5	3730	5
550	65	5.5	2	151.8	5	3610	5
580	66	3.25	5	152.2	5	3380	5
589	64	3	5	152.9	5	3660	5
593	55	1	3	156.8	1	3370	5
595	55	2.5	5	153.3	5	3410	5
596	61	2	5	152.9	5	3180	4
600	63	4	4	151	5	3480	5
608	69	2	5	151.3	5	3280	4
636	76	3.5	5	130.5	1	4080	3
643	63	2.5	5	153.6	5	3340	5
644	73	4	4	151	5	3550	5
645	73	2	5	151.5	5	3740	5
648	82	2.25	5	148.6	3	3890	4
652	66	3.5	5	151.7	5	3970	4
1709	76	2	5	155.8	2	3720	5
1720	75	1.25	3	152.9	5	3440	5
1722	76	2.5	5	154	4	3770	5
1724	67	3	5	147.4	1	3520	5
1728	74	3.25	5	150.3	5	3550	5
1731	73	4.25	4	151.1	5	3040	3
1733	74	3.25	5	151.4	5	3730	5
1734	64	3.25	5	153	5	3410	5
1737	76	3.5	5	152.8	5	3540	5
1738	68	2.5	5	150.8	5	3610	5
1740	61	2.5	5	152.4	5	3831	5
1743	81	3.25	5	149.8	4	3800	5
1744	69	3.25	5	152.2	5	3600	5
1756	75	4.25	4	152.9	5	3810	5
1758	80	2.25	5	153.2	5	3990	4
1760	70	3.5	5	152.1	5	3480	5
1766	72	4	4	151.3	5	3280	4

## APPENDIX – B

### Retest Test Results

Laboratory ID	CT 521	CT 521 Overall Average	Lab Rating	Final Rating	Acceptable/Unacceptable
76	3300	3595.78	4	4	Acceptable
96	2870	3595.78	1	1	Witness Test Required
114	3100	3595.78	3	3	Acceptable
137	3420	3595.78	5	5	Acceptable
223	3570	3595.78	5	5	Acceptable
244	3660	3595.78	5	5	Acceptable
250	3540	3595.78	5	5	Acceptable
266	3300	3595.78	4	4	Acceptable
297	3460	3595.78	5	5	Acceptable
310	1210	3595.78	1	1	Witness Test Required
385	3510	3595.78	5	5	Acceptable
447	3660	3595.78	5	5	Acceptable
502	2650	3595.78	1	1	Witness Test Required

## APPENDIX – C

### Test Results from Late Labs

Lab No.	CT 557	CT 556		CT 518		CT 521	
	Temperature (°F) (Score N/A)	Slump, in	Score	Unit Weight (lb/ft <sup>3</sup> )	Score	Compressive Strength (psi)	Score
400	69	2	5	151.9	5	3260	4
420	91	2	5	152.4	5	3610	5