Concrete Subtask Group

WORK PRODUCT FINAL REPORT

4x8 Concrete Cylinders for Compressive Strength Testing

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Report to PMPC on 4x8-inch Concrete Cylinders

Abstract

This report to Pavement & Materials Partnering Committee (PMPC) addresses the concrete cylinder size allowed for compressive strength testing on Caltrans projects. Historically, Caltrans has required the use of 6x12-in. cylinders when verifying concrete's compressive strength for contract acceptance. To align the Department's practice with national and industry standards, a study was performed on the feasibility of implementing the use of 4x8-in. cylinders for verification testing. After performing a literature review, national survey of other State Departments of Transportation (DOT), and collecting comparison data, it is recommended to implement the use of 4x8-in. concrete cylinders for compressive strength acceptance testing under California Test (CT) 540. This change will reduce the space required to cure concrete specimens, allow the use of smaller, less expensive test equipment, and reduce physical strain on technicians incurred during fabrication and handling.

Introduction

As specified under the current CT 540, *Method for Making, Handling, and Storing Concrete Compressive Test Specimens in the Field,* 6x12-in. cylinders are the only sized specimens allowed when testing a concrete's compressive strength during production. However, with the increased use of higher strength concrete and the Department's transition to national testing standards, it was necessary to investigate the use of 4x8-in. cylinders. In addition to aligning the Departments practice with national standards, the use of 4x8-in. specimens will decrease the amount of storage space required for curing, reduced physical weight and volume of waste material by more than 50%, allow for easier handling during fabrication, transportation and testing, and permits the testing of high strength concrete using readily available testing equipment.

Although the use of smaller cylinders is a national and industry standard, there have been concerns from Department stakeholders related to the implementation of 4-in. cylinders. The main concerns that have been raised are the precision and accuracy of compressive strengths of 4-in. specimens. It is widely known within the industry that the 4-in. concrete specimens have increased variability and report back a higher compressive strength compared to the 6-in. specimens. However, it is also accepted that the increase in variability and compressive strengths are insignificant and can be ignored. The goal of this study was to analyze the effect that cylinder size has on variability and compressive strength.

This study aims to address the stakeholders concerns by performing a literature review of previous research, conducting a survey of other state DOTs current practice, and comparing compressive strengths of concrete cylinders. Additionally, an implementation plan was developed to identify the necessary steps to take to ensure a seamless rollout if the recommendations of this report are adopted by the Department.

Working Group

Table 1 displays the list of Caltrans and Industry Members that participated on this working group.

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Table 1. Working group members and contact information

Summary of Literature Review

There have been multiple efforts by researchers to analyze the effects that specimen size has on compressive strengths. A literature review was performed to analyze the conclusions and recommendations and to determine a consensus across multiple studies.

Working with Virginia DOT, Celik Ozylidirim had discovered that both 4-in. and 6-in. cylinders exhibit equal strengths in the strength range of 3,200 psi and 4,200 psi. Above this level, the smaller cylinders exhibited 2% higher strength than the larger cylinders. Ozylidiim concluded, "for bridge decks, the difference in strengths were small and can be disregarded."

In 1994, Carino et al. investigated the effect of multiple variables on the compressive strength of concrete. Specifically looking at 4x8 in. cylinders and their effect on the compressive strength, the study concluded the effect of size is on average 1.3% higher strength for 4-in. cylinders compared to 6-in. cylinders. In some cases, differences as high as 4% were observed. During this study, Carino also noted that data appeared to support the notion that the within-test variability of 4-in. cylinders is greater than that of 6-in. cylinders. To compensate for the increased variability, Carino recommends that three or four tests of 4-in. cylinders be required to obtain a mean strength value with the same precision as by using two 6-in. cylinders.

During a 2006 study by Dennis Vandergrift Jr. and Anton K. Schindler, their results showed that 4x8-in. cylinders were generally stronger than 6x12-in. cylinders in compression when strengths were less than 6,000 psi and 4x8-in. cylinders were generally weaker than 6x12-in. cylinders when strengths were greater than 6,000 psi. From their literature review, they discovered that Day (1994 a) had compiled data for over 8,000 specimen strengths and found that 4-in. cylinders were expected to be 5% higher than 6-in. specimens for a strength range of 2,900 psi and 14,500 psi. However, in the strength range of 2,900 psi to 8,700 psi, the compressive strengths can be assumed equal. Based on their own test results, Vandergrift and Schindler also conclude that strength range was the only significant factor affecting within-test variability, which is contradictory of the findings from Carino et al. (1994).

The notion that cylinder size is not significant in affecting within-test variability is supported by multiple studies. Kennedy et al. (1995) reported that within-laboratory and between laboratory standard deviations increased as the average compressive strength increased. With a 95% confidence level, Pistilli and Willems (1993) showed that the variations for 4-in. and 6-in. cylinders were the same when capped with sulfur and in the range of 2,000 psi and 15,000 psi. Lastly, based on Vandergrift and Schindler test results and a 99% confidence level, they conclude that cylinder size was not significant in affecting the within-test variability. Their results show that the percent difference of test results from 8,000 psi batches had far greater variability than from 6,000 psi and 4,000 psi batches, which is similar to results from Kennedy et al. and Pistilli and Willems (1993).

In 2015, Lee et al. concluded for normal strength concrete (≤40 MPa or 5800 psi), there are no significant differences in test results between the different cylinder sizes. However, the size effect became more substantial in high strength concrete greater than 40MPa. Their study shows the COV of test results from 4-in. cylinders were about 10% higher than those from 6-in. cylinders, however, the differences are insignificant. The results from Lee et al. (2015) are comparable to the data compiled by Day (1994 a), who stated that "the coefficient of variation of 4 x 8 in. cylinders is equivalent to that of 6 x 12 in. cylinders over a broad range that encompasses normal, high, and very high-strength concrete." However, Tucker (1945), Malhotra (1976) and Hestor (1980) all claim that more 4-in. cylinders should be tested compared to 6-in. cylinders. It should be noted that all three researchers based their conclusion using standard deviation as a control standard. Day (1994a), Cook (1989), and Lee et al. (2015) used coefficient of variation.

Utilizing coefficient of variation to estimate variability is a better control standard and this is supported by the American Concrete Institute (ACI) who has included standards of quality control in terms of COV on table 5.1.1 of ACI 363.2R-98. This is due to research by Cook (1989) and Anderson (1985) suggesting that the COV is a better estimate of variability. American Society for Testing and Materials (ASTM) also supports the overall idea that the effect smaller cylinder sizes have on compressive strengths is insignificant.

They state that when cylinders smaller than the standard sizes are used, within-test variability has been shown to be higher but not to a statistically significant degree (ASTM C31 2000).

It has been found that 4-in. cylinders break anywhere from 1% to 6% higher compared to 6-in. cylinders. However, multiple studies conclude that even though the compressive strengths of 4-in. cylinders are higher than 6-in. cylinders, the difference is considered insignificant and can be ignored. Both ASTM and ACI have adopted this idea. These organizations allow the use of 4x8-in. cylinders for compressive strength testing without the use of a correction factor.

Multiple studies reviewed mention an increase of variation when utilizing 4x8-in. cylinders. There are differing thoughts on whether this is due to the smaller cylinder size or if its related to the increase in compressive strengths. To increase the precision of test results, it is recommended to determine the average compressive strength by fabricating and testing three (3) 4x8 in. cylinders per test. This allows the laboratory to obtain a mean strength value with the same precision as by using two 6-in. cylinders

DOT Survey Summary

In 2009 and 2018, South Carolina and California DOT performed a national survey, respectively, to determine other state DOTs practice in utilizing 4x8-in. concrete cylinders on cast-in-place concrete. The compiled results show that 37 DOTs currently utilize 4x8-in. cylinders for acceptance testing, 8 DOTs still require 6x12-in. cylinders, and 7 DOTs did not respond to either survey.

According to the surveys, North Dakota is the only state that requires a correction factor when utilizing 4x8-in. cylinders for acceptance. They apply a correction factor of .92 which is multiplied by the compressive strength of 4-in. cylinders to account for the higher strengths of the 4-in. cylinders. Table 2 lists the compiled responses from the both surveys.

State	Do you allow 4x8-inch cylinders on CIP Concrete?	Do you apply a correction factor?	Number of 4x8-in. specimens per age break	Research Performed?
Alaska	YES	NO		NO
Arizona	YES	NO		YES
Colorado	YES	NO	3	ASTM
Connecticut	YES	NO		NO
Delaware	YES	NO		YES
Florida	YES	NO		YES
Georgia	NO			
Illinois	YES	NO	3	NO
Indiana	NO			
Iowa	YES	NO	3	
Kansas	YES	NO	3	

Maine	NO			YES, considering use
Massachusetts	YES	NO		YES
Michigan	YES	NO		NO
Minnesota	YES	NO	3	NO
Mississippi	YES	NO		NO
Missouri	YES	NO	3	YES
Montana	YES	NO	3	
Nebraska	YES	NO	2	YES
Nevada	YES	NO	3	
New Hampshire	YES	NO		YES
New Jersey	YES	NO		YES
New Mexico	YES	NO		YES
New York	YES	NO		
North Carolina	YES	NO	2	NO
North Dakota	YES	YES, CF=.92	3	
Ohio	YES	NO	3	
Oklahoma	YES	NO	3	NO
Oregon	YES	NO		YES
Pennsylvania	NO			NO
Rhode Island	YES			YES
South Carolina	YES	NO	3	YES
South Dakota	NO			
Tennessee	YES	NO	2	
Texas	YES	NO	2	YES
Utah	YES	NO	3	NO
Virginia	NO			YES
Washington	YES			YES
West Virginia	YES	NO		YES
Wisconsin	NO			
Wyoming	NO			NO

Table 2. Compiled results from 2009 and 2018 national survey

Comparison Data

It was discussed to utilize pilot projects to acquire comparison data for 4-in. and 6-in. cylinders. However, due to the time limitations of this Work Product, it was determined that the best course of action was for state staff to fabricate cylinders and testing to be performed by the Concrete Laboratory at the Transportation Laboratory in Sacramento or the Southern Regional Laboratory in Fontana, CA.

To assist with this effort, Office of Structures Construction (OSC) staff was requested to fabricate three (3) 4x8 in. cylinders alongside the standard two (2) 6x12 in. cylinders during quality assurance testing. OSC staff was directed to fabricate both sets of cylinders in accordance with ASTM C31. To fabricate cylinders for contract acceptance, OSC staff must be ACI certified, which provides certification to fabricate and test concrete specimens as specified in various ASTMs. Both sets of cylinders were fabricated, transported, and cured in the same environment to eliminate the addition of any potential variables that could lead to inaccurate results. All specimens were sulfur capped and cured in a moist room per California Test 540. During this effort, precision and bias was not tracked or documented on any of the specimens.

A total of 409 specimens were tested. This equates to 72 sets of data. Districts 3 and 4 supplied majority of the specimens, but specimens were also collected from District 5, 7, 8, 10 and 12. A minimum of 12 different mix designs were tested with a specified compressive strength of 4,000 psi to 8,500 psi. The results from this in-house effort are shown in Table 3. The average strength difference between the two cylinder sizes at 28 day was calculated to be 5.96%. This average was calculated from 40 sets of specimens. One set consists of two 6x12-in. cylinders and three 4x8-in. cylinders. A positive value represents 4x8-in. cylinders breaking higher than 6x12-in. cylinders.

During this data collection period, 3 sets of data returned results that were questionable. The strength difference from these 3 data points ranged from 19% to 56%, when the expected difference was about 6%. It is difficult to determine the cause of these erroneous results due to the lack of information on fabrication procedure followed and mix design specifications. These 3 points were omitted from the calculated average reported in Table 3. A table with additional information collected during this in-house effort is included in Appendix A.

Age at Time of Break (range of days included in average)	Average % Strength Difference (4-in. cylinder broke higher than 6-in. cylinders)	# of Sets
56 days (55 days-57 days)	9.31	1
42 days (41 days -43 days)	4.85	2
28 days (27 days-31 days)	5.96	40
21 days (20 days-22 days)	5.49	8
14 days (12 days-16 days)	5.93	8
7 days (5 days-9 days)	6.97	13

Table 3. Average strength difference of 4x8-in. and 6x12-in. concrete cylinders from Caltrans projects

In addition to in-house data, comparison data was also collected from Industry. Tables 4 through 6 lists the comparison data from 3 precast facilities, which include Harper Precast Concrete, KIE-CON Inc. and Confab Inc. For all data supplied by precast facilities, it is unknown as to what type of curing method was applied to the specimens. A positive value for the 'average strength difference' represents 4x8-in. cylinders breaking higher than 6x12-in. cylinders.

The data collected from Confab Inc. and Harper Precast Concrete were both from Self-Consolidating Concrete (SCC) mixes. ATSM C1758 specifies requirements for fabricating test specimens utilizing SCC. It should be noted that two different labs performed testing on the concrete specimens for Harper Precast Concrete.

Contractor/Vendor:		Confab Inc.		
Project:		Truckee River Bridges/CA Flap SR89		
Mix ID:		SCC-CL98-20AF		
Required Strength:		8500 psi @ 28 days		
Lab:		Confab QC Department		
Cylinder Size	Date	Age	Average PSI	% Difference
6 x 12	8/4/2017	28	10948	3.38
4 x 8		28	11317	
6 x 12	8/8/2017	28	11514	4.08
4 x 8		28	11984	
6 x 12	8/10/2017	28	11293	10.92
4 x 8		28	12526	
6 x 12	8/14/2017	28	11355	7.98
4 x 8		28	12261	
6 x 12	8/16/2017	28	11337	11.31
4 x 8		28	12619	
6 x 12	8/18/2017	28	10416	13.64
4 x 8		28	11836	
6 x 12	8/22/2017	28	9621	8.11
4 x 8		28	10401	
6 x 12	8/24/2017	28	11779	6.01
4 x 8		28	12486	
			Average Strength Difference	8.18

Table 4. Average strength difference of 4x8-in. and 6x12-in. concrete cylinders from Confab Inc.

Contractor/Vendor:		Harper Precast		
Project:		Inglewood Stadium		
Mix ID:		SCC 100		
Required Strength:		5000 psi @ 28 days		
Lab:		Harper Precast QC Department (6x12)		
		Western Technologies Inc. (4x8)		
Cylinder Size	Date	Age	Avergage PSI	% Difference
6 x 12	4/20/2018	28	7010	19.42
4 x 8		28	8371	
6 x 12	4/23/2018	28	6880	20.42
4 x 8		28	8285	
6 x 12	4/24/2018	28	7590	12.06
4 x 8		28	8505	
6 x 12	4/25/2018	28	7390	4.76

4 x 8		28	7742	
6 x 12	4/26/2018	28	7470	0.94
4 x 8		28	7540	
6 x 12	4/27/2018	28	7390	2.52
4 x 8		28	7576	
6 x 12	4/30/2018	28	6600	16.56
4 x 8		28	7693	
6 x 12	5/1/2018	28	7090	6.05
4 x 8		28	7519	
6 x 12	5/2/2018	28	7310	8.22
4 x 8		28	7911	
6 x 12	5/3/2018	28	6720	15.27
4 x 8		28	7746	
6 x 12	5/4/2018	28	7810	-6.11
4 x 8		28	7333	
6 x 12	5/7/2018	28	6740	17.48
4 x 8		28	7918	
6 x 12	5/8/2018	28	6340	8.69
4 x 8		28	6891	
6 x 12	5/9/2018	28	7300	-10.48
4 x 8		28	6535	
6 x 12	5/11/2018	28	7410	-11.81
4 x 8		28	6535	
6 x 12	7/30/2018	28	6580	23.42
4 x 8		28	8121	
6 x 12	7/31/2018	28	6830	7.77
4 x 8		28	7361	
		Average Strength Difference		7.95

Table 5. Average strength difference of 4x8-in. and 6x12-in. concrete cylinders from Harper Precast

Information on the type of concrete tested or specified strength was not available when data was collected from KIE-CON Inc. Nevertheless, Table 6 lists the average strength difference between the cylinder sizes, which was only -.22%. The negative represents 4x8-in. cylinders broke lower than 6x12-in. cylinders during this comparison.

Contractor/Vendor:		KIE-CON Inc.		
Project:		N/A		
Mix ID:		N/A		
Required Strength:		N/A		
Lab:		N/A		
Cylinder Size	Date	Age	Average PSI	% Difference
6 x 12	11/12/2015	28	7861	-5.67
4 x 8	11/12/2015		7415	
6 x 12	11/12/2015	28	7965	9.92
4 x 8	11/12/2015		8755	
6 x 12	11/17/2015	28	8810	-4.99
4 x 8	11/17/2015		8370	
6 x 12	11/17/2015	28	7119	-5.32

4 x 8	11/17/2015		6740	
6 x 12	11/18/2015	28	8725	-0.23
4 x 8	11/18/2015		8705	
6 x 12	11/18/2015	28	9100	-3.13
4 x 8	11/18/2015		8815	
6 x 12	11/18/2015	28	8575	-11.78
4 x 8	11/18/2015		7565	
6 x 12	11/18/2015	28	8540	-10.36
4 x 8	11/18/2015		7655	
6 x 12	11/19/2015	28	7165	11.58
4 x 8	11/19/2015		7995	
6 x 12	11/19/2015	28	7920	4.80
4 x 8	11/19/2015		8300	
6 x 12	11/19/2015	28	8485	0.24
4 x 8	11/19/2015		8505	
6 x 12	11/20/2015	28	7770	-5.02
4 x 8	11/20/2015		7380	
6 x 12	11/20/2015	28	8230	-3.10
4 x 8	11/20/2015		7975	
6 x 12	11/23/2015	28	7810	0.96
4 x 8	11/23/2015		7885	
6 x 12	11/23/2015	28	7730	5.63
4 x 8	11/23/2015		8165	
6 x 12	12/9/2015	28	6660	5.56
4 x 8	12/9/2015		7030	
6 x 12	12/10/2015	28	7645	0.85
4 x 8	12/10/2015		7710	
6 x 12	12/14/2015	28	6960	4.31
4 x 8	12/14/2015		7260	
6 x 12	12/14/2015	28	7530	-3.32
4 x 8	12/14/2015		7280	
6 x 12	12/14/2015	28	7360	-0.54
4 x 8	12/14/2015		7320	
6 x 12	12/14/2015	28	8120	0.37
4 x 8	12/14/2015		8150	
6 x 12	12/15/2015	28	6770	4.43
4 x 8	12/15/2015		7070	
		Average Strength Difference (%)		-0.22

Table 6. Average strength difference of 4x8-in. and 6x12-in. concrete cylinders from KIE-CON Inc.

The last set of data collected from Industry was from Graniterock. While performing trial batches of 5,000 psi concrete, 4-in and 6-in concrete specimens were fabricated and tested. The calculated average strength difference from their testing showed that 4x8-in. cylinders broke 2.77% higher than 6x12-in. cylinders as shown in Table 7. This average falls in line with studies determining the effects of cylinder size.

Contractor/Vendor:	Graniterock
Project:	Trial Batching
Required Strength:	5,000 psi @ 28 days

Lab:			Graniterock Internal Lab (Aromas, CA)	
Cylinder Size	Date	Age	Average PSI	% Difference
6 x 12	2/26/2019	28	6933	4.42
4 x 8	2/26/2019		7240	
6 x 12	2/26/2019	28	6920	4.00
4 x 8	2/26/2019		7197	
6 x 12	2/26/2019	28	8063	3.51
4 x 8			8347	
6 x 12	4/22/2019	28	7920	1.81
4 x 8			8063	
6 x 12	4/22/2019	28	7137	7.38
4 x 8			7663	
6 x 12	4/22/2019	28	6427	0.78
4 x 8			6477	
6 x 12	4/29/2019	28	7543	7.78
4 x 8			8130	
6 x 12	4/29/2019	28	7697	0.91
4 x 8			7767	
6 x 12	4/29/2019	28	8170	-1.31
4 x 8			8063	
6 x 12	4/29/2019	28	8253	-1.62
4 x 8			8120	
		Average Strength Difference (%)		2.77

Table 7. Average strength difference of 4x8-in. and 6x12-in. concrete cylinders from Graniterock

The average strength difference between the 4x8-in and 6x12-in cylinders from the KIE-CON Inc., Harper Precast, and Confab Inc. were -0.22%, 7.95%, and 8.18%, respectively. Although 7.95% and 8.18% fall outside the expected range of 1%-6%, a more detailed look shows that Confab Inc. was testing a concrete mix with a specified strength of 8,500 psi. This aligns with some studies that state the strength difference between cylinder sizes increases when concrete strength increases. The data from Harper Precast shows two individual tests that have a strength difference greater than 20%, far greater than the expected difference of 6%. Eliminating these two data points when calculating the average brings the average strength difference down from 7.95% to 6.09% which does fall within the expected range.

State DOT Research

Other State Departments had previously conducted their own research to determine the feasibility of implementing the use of 4x8-in. concrete cylinders. Information from Missouri and Nebraska was collected. Additionally, in 2011, Caltrans (Al-Manaseer et al. 2001) partnered with San Jose State University to investigate the long term compressive strength, modulus of elasticity, and density of the concrete to determine long term performance. During this study, both 4-in. and 6-in. cylinders were collected during construction. The concrete that was used for the Caltrans study was lightweight concrete from the Benicia-Martinez Bridge in the Bay Area.

From a collection of 1027 cylinders, the 2011 Caltrans study concluded, "that there is no significant difference between the compressive strengths determined from 4x8 in. and 6x12 in. cylinders at 5 years. Therefore, testing can be performed on 4x8 in. as an alternative to 6x12 in." The average compressive strength of 4x8-in. cylinders was 2% more than the 6x12-in. cylinders at 5 years. Although, compressive strengths between the two cylinder sizes were not compared at 28 days, this study shows that 4x8-in. cylinders can be used in place of 6-in. cylinders. Research notes from this study can be found in Appendix F.

During a research project from 2005 to 2010, Nebraska Department of Roads conducted a study to establish a strength correlation between 4-in. and 6-in. cylinders. Utilizing a mix design with a compressive strength between 3,000 psi and 3,5000 psi, they concluded that 4x8-in. cylinders had a compressive strength that was about 1% higher than the compressive strengths from 6x12-in. cylinders. They also mentioned that results were comparable for cylinders with f'c<5,000 psi. Due to results of their study, Nebraska Department of Roads began allowing the use of 4x8-in. cylinders in July 2010. 6x12-in. cylinder molds were discontinued in January 2011. The notes from this study can be found in Appendix G.

Missouri Department of Transportation conducted a research in 2004 to compare the compressive strengths of 4-in. and 6-in. concrete cylinders for prestress concrete. The recommendations of this research include allowing the use of 4x8-in. cylinders while applying a correction factor of .94. It should be noted that the 28-day breaks were in excess of 7,000 psi, which is in line with the general observation that as compressive strengths increase, so does the difference in strength values between the two cylinder sizes. Although the study recommended applying a correction factor to the compressive strength of 4x8-in concrete cylinders, Missouri DOT's current practice does not require a correction factor. Their current practice is in line with majority of other state DOTs as well as ASTM and ACI. Notes from Missouri DOT's investigation can be found in Appendix H.

Implementation

In addition to ensuring compressive strengths from 4x8-in. concrete cylinders are comparable to 6x12-in. cylinders, another effort of this working group was to identify and address any other issues to confidently transition to the use of 4x8-in. concrete specimens.

The current CT 540 (August 2010) only allows the use of 6x12-in. cylinder molds. When fabricating the specimen, CT 540 specifies the mold to be filled in 3 equal layers with each layer rodded 25 times using a 5/8 ± 1/16 in. tamping rod. These specifications mirror, the procedures listed in ASTM C31-19. For 4-in. molds, ASTM C31-19 specifies filling the mold in 2 equal layers with each layer rodded 25 times using a 3/8 ± 1/16 in tamping rod. If 4x8-in. concrete cylinders are adopted by the Department, this CT would need to be revised to specify new equipment/tools and procedures due to the smaller specimen size.

There is a current effort within Materials Engineering and Testing Services (METS) to revise CT 540. The revised test method will no longer specify the directions for fabrication, but instead, direct the reader to perform the test in accordance with ASTM C31-19. A draft version of the revised CT 540 is attached in Appendix I. Because ASTM C31-19 allows both 4-in. and 6-in. cylinder molds, the revised CT will list an exception to only allow 6x12-in molds. If the Department accepts the recommendations of this report, this exception will be removed to allow the use of either cylinder size.

An implementation plan has been developed to ensure a smooth rollout if the Department adopts the use of 4x8-in. cylinders. The implementation plan addresses notification needs, manual and specification updates, training and certification, and equipment needs. A draft of the implementation plan is attached in Appendix J. Furthermore, a flyer has been developed to distribute to state staff highlighting the changes due to the revised CT 540's reference to ASTM C31-19 and the possible adoption of 4x8-in. concrete specimens. See Appendix K for the flyer.

Recommendations

Based on the findings described within this report, it is recommended that the Department adopts the use of 4x8-in. cylinders for cast-in-place concrete. This change will result in lower equipment costs when replacing compressive machines, less strain on technicians, less required space for curing, and the ability to test higher strength concrete. This change will also align the Department's practice with national testing standards as directed by METS/GS Directive 05.

The items listed below are recommended for implementation:

- Allow the use of 4x8-in. concrete cylinders under California Test 540
- A correction factor should not be applied to the compressive strengths of 4x8-in. specimens
- Fabricate and test three (3) 4x8-in. cylinders to determine the average compressive strength
- Adoption of 4x8-in. concrete cylinders does not apply to Section 28-4, Lean Concrete Base Rapid Setting, of the Standard Specifications
- Test results for concrete prequalification, quality control testing, and quality assurance testing must all use the same sized concrete cylinder for the duration of a project for a specified mix design.

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Appendices

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Appendix A

California Department of Transportation Compressive Strength Comparison Data

DIME Test ID	DEA	Sampled Date	Tested Date	Test Submitted By	Material Identification	Cross sectional area of cylinder 1	Cross sectional area of cylinder 2	Average diameter of cylinder 1	Average diameter of cylinder 2	Number of specimens	Compressive strength (to nearest 10 psi)	Age of specimen	f'c @ 28 days	% difference
2019-04-04-1-1	030H26U4	2019-04-04	2019-04-11	CT HQ Concrete	1604381	28.37 in^2	28.46 in^2	6.01 in	6.02 in	2	3760 psi	7 days		
2019-04-04-5-1	030H26U4	2019-04-04	2019-04-11	CT HQ Concrete	1604381	12.69 in^2	12.63 in^2	4.02 in	4.01 in	3	3790 psi	7 days		0.80
2019-04-04-2-1	030H26U4	2019-04-04	2019-04-18	CT HQ Concrete	1604381	28.56 in^2	28.46 in^2	6.03 in	6.02 in	2	4930 psi	14 days		
2019-04-04-6-1	030H26U4	2019-04-04	2019-04-18	CT HQ Concrete	1604381	12.57 in^2	12.63 in^2	4.00 in	4.01 in	3	4850 psi	14 days		-1.62
2019-04-04-3-1	030H26U4	2019-04-04	2019-05-02	CT HQ Concrete	1604381	28.46 in^2	28.37 in^2	6.02 in	6.01 in	2	6340 psi	28 days		
2019-04-04-7-1	030H26U4	2019-04-04	2019-05-02	CT HQ Concrete	1604381	12.63 in^2	12.69 in^2	4.01 in	4.02 in	3	6800 psi	28 days		7.26
2019-04-16-16-1	030G8704	2019-04-16	2019-05-14	CT HQ Concrete	0000	28.27 in^2	28.37 in^2	6.00 in	6.01 in	2	7470 psi	28 days		
2019-04-16-17-1	030G8704	2019-04-16	2019-05-14	CT HQ Concrete	00000000000	12.57 in^2	12.57 in^2	4.00 in	4.00 in	3	7210 psi	28 days		-3.48
2019-04-04-4-1	030H26U4	2019-04-04	2019-05-16	CT HQ Concrete	1604381	28.46 in^2	28.56 in^2	6.02 in	6.03 in	2	6750 psi	42 days		
2019-04-04-8-1	030H26U4	2019-04-04	2019-05-16	CT HQ Concrete	1604381	12.87 in^2	12.56 in^2	4.05 in	4.00 in	3	6990 psi	42 days		3.56
2019-05-20-4-1	030H26U4	2019-05-20	2019-05-28	CT HQ Concrete	1605387	28.46 in^2	28.56 in^2	6.02 in	6.03 in	2	4060 psi	8 days		
2019-05-20-5-1	030H26U4	2019-05-20	2019-05-28	CT HQ Concrete	1605387	12.69 in^2	12.69 in^2	4.02 in	4.02 in	3	4300 psi	8 days		5.91
2019-05-20-9-1	030H26U4	2019-05-20	2019-06-17	CT HQ Concrete	1605387	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	5710 psi	28 days		
2019-05-20-7-1	030H26U4	2019-05-20	2019-06-17	CT HQ Concrete	1605387	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	6010 psi	28 days		5.25
2019-05-20-8-1	030H26U4	2019-05-20	2019-07-01	CT HQ Concrete	1605387	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	6340 psi	42 days		
2019-05-20-6-1	030H26U4	2019-05-20	2019-07-01	CT HQ Concrete	1605387	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	6730 psi	42 days		6.15
2019-07-15-7-1	042J5404	2019-07-15	2019-07-22	CT HQ Concrete	590CL2	28.54 in^2	28.45 in^2	6.03 in	6.02 in	2	3690 psi	7 days	4000	
2019-07-15-14-1	042J5404	2019-07-15	2019-07-22	CT HQ Concrete	590cl2	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	3930 psi	7 days	4000	6.50
2019-07-19-10-1	042640N4	2019-07-19	2019-07-26	CT HQ Concrete	4201	28.35 in^2	28.35 in^2	6.01 in	6.01 in	2	3700 psi	7 days	4000	
2019-07-19-9-1	042640N4	2019-07-19	2019-07-26	CT HQ Concrete	00000000	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	3890 psi	7 days	4000	5.14
2019-07-22-9-1	044G3804	2019-07-22	2019-07-29	CT HQ Concrete	4700	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	6300 psi	7 days	4000	
2019-07-22-13-1	044G3804	2019-07-22	2019-07-29	CT HQ Concrete	4700	12.56 in^2	12.62 in^2	4.00 in	4.01 in	3	6490 psi	7 days	4000	3.02
2019-07-24-11-1	042640N4	2019-07-24	2019-07-31	CT HQ Concrete	4201A	28.45 in^2	28.35 in^2	6.02 in	6.01 in	2	3390 psi	7 days	4000	
2019-07-24-7-1	042640N4	2019-07-24	2019-07-31	CT HQ Concrete	4201A	12.56 in^2	12.69 in^2	4.00 in	4.02 in	3	3810 psi	7 days	4000	12.39
2019-07-19-13-1	042640N4	2019-07-19	2019-08-02	CT HQ Concrete	4201	28.35 in^2	28.35 in^2	6.01 in	6.01 in	2	4520 psi	14 days	4000	
2019-07-19-6-1	042640N4	2019-07-19	2019-08-02	CT HQ Concrete	00000000	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	4720 psi	14 days	4000	4.42
2019-07-15-9-1	042J5404	2019-07-15	2019-08-05	CT HQ Concrete	590CL	28.35 in^2	28.45 in^2	6.01 in	6.02 in	2	4840 psi	21 days	4000	
2019-07-15-11-1	042J5404	2019-07-15	2019-08-05	CT HQ Concrete	590cl2	12.56 in^2	12.56 in^2	4.00 in	4.00 in	2	5160 psi	21 days	4000	6.61
2019-07-22-14-1	044G3804	2019-07-22	2019-08-05	CT HQ Concrete	4700	28.26 in^2	28.35 in^2	6.00 in	6.01 in	2	7350 psi	14 days	4000	
2019-07-22-15-1	044G3804	2019-07-22	2019-08-05	CT HQ Concrete	Unknown	12.56 in^2	12.56 in^2	4.00 in	4.00 in	3	7570 psi	14 days	4000	2.99
2019-07-24-13-1	042640N4	2019-07-24	2019-08-07	CT HQ Concrete	4201A	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	3980 psi	14 days	4000	
2019-07-24-8-1	042640N4	2019-07-24	2019-08-07	CT HQ Concrete	4201A	12.56 in^2	12.69 in^2	4.00 in	4.02 in	3	4600 psi	14 days	4000	15.58
2019-07-19-11-1	042640N4	2019-07-19	2019-08-09	CT HQ Concrete	4201	28.35 in^2	28.45 in^2	6.01 in	6.02 in	2	5210 psi	21 days	4000	
2019-07-19-7-1	042640N4	2019-07-19	2019-08-09	CT HQ Concrete	00000000	12.62 in^2	12.56 in^2	4.01 in	4.00 in	3	5430 psi	21 days	4000	4.22
2019-07-15-10-1	042J5404	2019-07-15	2019-08-12	CT HQ Concrete	590CL2	28.54 in^2	28.45 in^2	6.03 in	6.02 in	2	3780 psi	28 days	4000	
2019-07-15-13-1	042J5404	2019-07-15	2019-08-12	CT HQ Concrete	590cl2	12.69 in^2	12.62 in^2	4.02 in	4.01 in	3	5200 psi	28 days	4000	37.57
2019-07-22-10-1	044G3804	2019-07-22	2019-08-12	CT HQ Concrete	4700	28.45 in^2	28.54 in^2	6.02 in	6.03 in	2	7810 psi	21 days	4000	
2019-07-22-8-1	044G3804	2019-07-22	2019-08-12	CT HQ Concrete	4700	12.62 in^2	12.56 in^2	4.01 in	4.00 in	3	8060 psi	21 days	4000	0.80
2019-07-17-12-1	044G0564	2019-07-17	2019-08-14	CT HQ Concrete	D201C5E1	28.45 in^2	28.54 in^2	6.02 in	6.03 in	2	5280 psi	28 days	4000	
2019-07-17-13-1	044G0564	2019-07-17	2019-08-14	CT HQ Concrete	D201C5E1	12.62 in^2	12.56 in^2	4.01 in	4.00 in	3	5530 psi	28 days	4000	4.73
2019-07-24-14-1	042640N4	2019-07-24	2019-08-14	CT HQ Concrete	4201A	28.54 in^2	28.45 in^2	6.03 in	6.02 in	2	4690 psi	21 days	4000	
2019-07-24-9-1	042640N4	2019-07-24	2019-08-14	CT HQ Concrete	4201A	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	5080 psi	21 days	4000	8.32
2019-07-18-21-1	044G0564	2019-07-18	2019-08-15	CT HQ Concrete	D201C5E1	28.54 in^2	28.54 in^2	6.03 in	6.03 in	2	4950 psi	28 days	4000	
2019-07-18-22-1	044G0564	2019-07-18	2019-08-15	CT HQ Concrete	D201C5E1	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	5230 psi	28 days	4000	5.66
2019-07-19-12-1	042640N4	2019-07-19	2019-08-16	CT HQ Concrete	4201	28.45 in^2	28.35 in^2	6.02 in	6.01 in	2	5560 psi	28 days	4000	
2019-07-19-8-1	042640N4	2019-07-19	2019-08-16	CT HQ Concrete	00000000	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	5980 psi	28 days	4000	7.55
2019-07-22-12-1	044G3804	2019-07-22	2019-08-19	CT HQ Concrete	4700	28.45 in^2	28.35 in^2	6.02 in	6.01 in	2	8410 psi	28 days	4000	
2019-07-22-11-1	044G3804	2019-07-22	2019-08-19	CT HQ Concrete	4700	12.5 in^2	12.56 in^2	3.99 in	4.00 in	3	8780 psi	28 days	4000	4.40
2019-07-24-12-1	042640N4	2019-07-24	2019-08-21	CT HQ Concrete	4201A	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	5490 psi	28 days	4000	
2019-07-24-10-1	042640N4	2019-07-24	2019-08-21	CT HQ Concrete	4201A	12.56 in^2	12.62 in^2	4.00 in	4.01 in	3	5700 psi	28 days	4000	3.83
2019-09-13-6-1	072159U4	2019-09-13	2019-09-16	CT Southern Re	G3-STR-002	28.37 in^2	28.37 in^2	6.01 in	6.01 in	2	2890	3 days	5000	
2019-09-13-7-1	072159U4	2019-09-13	2019-09-16	CT Southern Re	G3-STR-002	12.63 in^2	12.57 in^2	4.01 in	4.00 in	3	3050 psi	3 days	5000	5.54
2019-09-13-6-2	072159U4	2019-09-13	2019-09-16	CT Southern Re	G3-STR-002	28.46 in^2	28.46 in^2	6.02 in	6.02 in	2	5100	28 days	5000	
2019-09-13-7-2	072159U4	2019-09-13	2019-09-16	CT Southern Re	G3-STR-002	12.57 in^2	12.63 in^2	4.00 in	4.01 in	3	5470 psi	28 days	5000	7.25
2019-08-20-3-1	042640N4	2019-08-20	2019-09-17	CT HQ Concrete	00000000	28.45 in^2	28.35 in^2	6.02 in	6.01 in	2	5210 psi	28 days		
2019-08-20-4-1	042640N4	2019-08-20	2019-09-17	CT HQ Concrete	00000000	12.56 in^2	12.56 in^2	4.00 in	4.00 in	3	5440 psi	28 days		4.41
2019-08-22-9-1	042640N4	2019-08-22	2019-09-19	CT HQ Concrete	na	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	5180 psi	28 days		
2019-08-22-10-1	042640N4	2019-08-22	2019-09-19	CT HQ Concrete	na	12.62 in^2	12.69 in^2	4.01 in	4.02 in	3	5580 psi	28 days		7.72
2019-09-09-9-1	042640N4	2019-09-09	2019-10-07	CT HQ Concrete	na	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	4750 psi	28 days	4000	
2019-09-09-10-1	042640N4	2019-09-09	2019-10-07	CT HQ Concrete	na	12.62 in^2	12.69 in^2	4.01 in	4.02 in	3	5130 psi	28 days	4000	8.00
2019-09-10-17-1	042640N4	2019-09-10	2019-10-08	CT HQ Concrete	na	28.35 in^2	28.35 in^2	6.01 in	6.01 in	2	5800 psi	28 days	4000	
2019-09-10-18-1	042640N4	2019-09-10	2019-10-08	CT HQ Concrete	na	12.56 in^2	12.56 in^2	4.00 in	4.00 in	3	6140 psi	28 days	4000	5.86
2019-09-11-15-1	042640N4	2019-09-11	2019-10-09	CT HQ Concrete	na	28.45 in^2	28.54 in^2	6.02 in	6.03 in	2	5240 psi	28 days	4000	
2019-09-11-16-1	042640N4	2019-09-11	2019-10-09	CT HQ Concrete	na	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	5510 psi	28 days	4000	5.15
2019-09-12-11-1	042640N4	2019-09-12	2019-10-10	CT HQ Concrete	00000000000	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	5040 psi	28 days	4000	
2019-09-12-10-1	042640N4	2019-09-12	2019-10-10	CT HQ Concrete	00000000000	12.62 in^2	12.56 in^2	4.01 in	4.00 in	3	5290 psi	28 days	4000	4.96
2019-09-13-6-2	072159U4	2019-09-13	2019-10-11	CT Southern Re	G3-STR-002	28.46 in^2	28.46 in^2	6.02 in	6.02 in	2	5100 psi	28 days	5000	
2019-09-13-7-2	072159U4	2019-09-13	2019-10-11	CT Southern Re	G3-STR-002	12.57 in^2	12.63 in^2	4.00 in	4.01 in	3	5470	28 days	5000	7.25
2019-09-15-1-1	080J0804	2019-09-15	2019-10-14	CT Southern Re	UV-301B2	28.46 in^2	28.46 in^2	6.02 in	6.02 in	2	10800 psi	29 days	8500	
2019-09-15-2-1	080J0804	2019-09-15	2019-10-14	CT Southern Re	UV-301B2	12.63 in^2	12.57 in^2	4.01 in	4.00 in	3	11070 psi	29 days	8500	2.50
2019-09-17-8-1	042640N4	2019-09-17	2019-10-15	CT HQ Concrete	00000000000	28.35 in^2	28.45 in^2	6.01 in	6.02 in	3	5520 psi	28 days	550 LB	
2019-09-17-9-1	042640N4	2019-09-17	2019-10-15	CT HQ Concrete	00000000000	12.56 in^2	12.56 in^2	4.00 in	4.00 in	2	6170 psi	28 days	550 LB	11.78
2019-09-18-3-1	080F0304	2019-09-18	2019-10-16	CT Southern Re	SCC 9-8-25F	28.46 in^2	28.46 in^2	6.02 in	6.02 in	3	9690 psi	28 days	7000	
2019-09-18-4-1	080F0304	2019-09-18	2019-10-16	CT Southern Re	SCC 9-8-25F	12.57 in^2	12.63 in^2	4.00 in	4.01 in	2	10470 psi	28 days	7000	8.05
2019-09-19-3-1	120H1004	2019-09-19	2019-10-17	CT Southern Re	284	28.46 in^2	28.46 in^2	6.02 in	6.02 in	3	11210 psi	28 days		
2019-09-19-4-1	120H1004	2019-09-19	2019-10-17	CT Southern Re	284	12.63 in^2	12.63 in^2	4.01 in	4.01 in	2	11420 psi	28 days		1.87
2019-09-20-3-1	051C8904	2019-09-20	2019-10-18	CT Southern Re	RRM14062	28.46 in^2	28.46 in^2	6.02 in	6.02 in	2	5810 psi	28 days	6000	
2019-09-20-4-1	051C8904	2019-09-20	2019-10-18	CT Southern Re	RRM14062	12.69 in^2	12.69 in^2	4.02 in	4.02 in	3	6230 psi	28 days	6000	7.23
2019-10-28-18-1	030F2824	2019-10-28	2019-11-01	CT HQ Concrete	00000000000	28.26 in^2	28.26 in^2	6.00 in	6.00 in	3	2520 psi	4 days		
2019-10-28-19-1	030F2824	2019-10-28	2019-11-01	CT HQ Concrete	00000000000	12.62 in^2	12.5 in^2	4.01 in	3.99 in	2	2600 psi	4 days		3.17
2019-10-08-26-1	042640N4	2019-10-08	2019-11-05	CT HQ Concrete	00000000000	28.45 in^2	28.54 in^2	6.02 in	6.03 in	3	6080 psi	28 days	550 LB	
2019-10-08-27-1	042640N4	2019-10-08	2019-11-05	CT HQ Concrete	00000000000	12.62 in^2	12.56 in^2	4.01 in	4.00 in	3	6430 psi	28 days	550 LB	5.76
2019-10-22-8-1	030F2824	2019-10-22	2019-11-05	CT HQ Concrete	00000000000	28.35 in^2	28.35 in^2	6.01 in	6.01 in	2	3990 psi	14 days		
2019-10-22-3-1	030F2824	2019-10-22	2019-11-05	CT HQ Concrete	00000000000	12.5 in^2	12.56 in^2	3.99 in	4.00 in	2	4240 psi	14 days		6.27
2019-10-09-17-1	042640N4	2019-10-09	2019-11-06	CT HQ Concrete	00000000000	28.45 in^2	28.35 in^2	6.02 in	6.01 in	3	5300 psi	28 days	550 LB	
2019-10-09-18-1	042640N4	2019-10-09	2019-11-06	CT HQ Concrete	00000000000	12.62 in^2	12.69 in^2	4.01 in	4.02 in	2	5740 psi	28 days	550 LB	8.30
2019-10-10-9-1	033F5304	2019-10-10	2019-11-07	CT HQ Concrete	0000000000	28.35 in^2	28.26 in^2	6.01 in	6.00 in	3	3950 psi	28 days		

Appendix A

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2019-10-10-10-1	033F5304	2019-10-10	2019-11-07	CT HQ Concrete	0000000000	12.5 in^2	12.56 in^2	3.99 in	4.00 in	2	4280 psi	28 days		8.35
2019-10-10-15-1	042640N4	2019-10-10	2019-11-07	CT HQ Concrete	0000000000(	28.54 in^2	28.54 in^2	6.03 in	6.03 in	3	4350 psi	28 days	550 LB	
2019-10-10-16-1	042640N4	2019-10-10	2019-11-07	CT HQ Concrete	0000000000(	12.56 in^2	12.56 in^2	4.00 in	4.00 in	2	6790 psi	28 days	550 LB	56.09
2019-10-31-8-1	030F2824	2019-10-31	2019-11-07	CT HQ Concrete	0000000000(	28.26 in^2	28.45 in^2	6.00 in	6.02 in	2	2880 psi	7 days		
2019-10-31-10-1	030F2824	2019-10-31	2019-11-07	CT HQ Concrete	0000000000(	12.56 in^2	12.5 in^2	4.00 in	3.99 in	2	3070 psi	7 days		6.60
2019-10-11-13-1	042640N4	2019-10-11	2019-11-08	CT HQ Concrete	0000000000(	28.45 in^2	28.54 in^2	6.02 in	6.03 in	3	4880 psi	28 days	550 LB	
2019-10-11-14-1	042640N4	2019-10-11	2019-11-08	CT HQ Concrete	0000000000(	12.69 in^2	12.69 in^2	4.02 in	4.02 in	2	5150 psi	28 days	550 LB	5.53
2019-10-11-2-1	043G6904	2019-10-11	2019-11-08	CT HQ Concrete	1416245	28.45 in^2	28.45 in^2	6.02 in	6.02 in	3	5620 psi	28 days	3600	
2019-10-11-3-1	043G6904	2019-10-11	2019-11-08	CT HQ Concrete	1416245	12.69 in^2	12.62 in^2	4.02 in	4.01 in	2	6060 psi	28 days	3600	7.83
2019-10-15-16-1	042640N4	2019-10-15	2019-11-12	CT HQ Concrete	0000000000(	28.35 in^2	28.35 in^2	6.01 in	6.01 in	3	6580 psi	28 days	550 LB	
2019-10-15-17-1	042640N4	2019-10-15	2019-11-12	CT HQ Concrete	0000000000(	12.56 in^2	12.62 in^2	4.00 in	4.01 in	2	6790 psi	28 days	550 LB	3.19
2019-10-18-1-1	033F5304	2019-10-18	2019-11-15	CT HQ Concrete	0000000000(	28.26 in^2	28.26 in^2	6.00 in	6.00 in	2	5990 psi	28 days		
2019-10-18-2-1	033F5304	2019-10-18	2019-11-15	CT HQ Concrete	0000000000(	12.43 in^2	12.5 in^2	3.98 in	3.99 in	2	6620 psi	28 days		10.52
2019-11-01-3-1	030F2824	2019-11-01	2019-11-15	CT HQ Concrete	0000000000(	28.26 in^2	28.35 in^2	6.00 in	6.01 in	3	3570 psi	14 days		
2019-11-01-5-1	030F2824	2019-11-01	2019-11-15	CT HQ Concrete	0000000000(	12.43 in^2	12.5 in^2	3.98 in	3.99 in	2	3940 psi	14 days		10.36
2019-10-22-9-1	033F5304	2019-10-22	2019-11-19	CT HQ Concrete	0000000000	28.35 in^2	28.35 in^2	6.01 in	6.01 in	3	4740 psi	28 days		
2019-10-22-10-1	033F5304	2019-10-22	2019-11-19	CT HQ Concrete	0000000000	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	4760 psi	28 days		0.42
2019-10-22-7-1	030F2824	2019-10-22	2019-11-19	CT HQ Concrete	0000000000(	28.35 in^2	28.26 in^2	6.01 in	6.00 in	2	4760 psi	28 days		
2019-10-22-4-1	030F2824	2019-10-22	2019-11-19	CT HQ Concrete	0000000000(	12.56 in^2	12.5 in^2	4.00 in	3.99 in	2	5010 psi	28 days		5.25
2019-10-31-9-1	030F2824	2019-10-31	2019-11-21	CT HQ Concrete	0000000000(	28.26 in^2	28.35 in^2	6.00 in	6.01 in	2	4120 psi	21 days		
2019-10-31-11-1	030F2824	2019-10-31	2019-11-21	CT HQ Concrete	0000000000(	12.62 in^2	12.62 in^2	4.01 in	4.01 in	2	4310 psi	21 days		4.61
2019-11-14-11-2	043Q0504	2019-11-14	2019-11-21	CT HQ Concrete	VER-85LV	28.35 in^2	28.54 in^2	6.01 in	6.03 in	3	6160 psi	7 days	6000	
2019-11-14-12-2	043Q0504	2019-11-14	2019-11-21	CT HQ Concrete	VER-85LV	12.62 in^2	12.56 in^2	4.01 in	4.00 in	2	6440 psi	7 days	6000	4.55
2019-11-15-24-1	030H10U4	2019-11-15	2019-11-25	CT HQ Concrete	1604795	28.35 in^2	28.26 in^2	6.01 in	6.00 in	3	5170 psi	10 days	4000	
2019-11-15-25-1	030H10U4	2019-11-15	2019-11-25	CT HQ Concrete	1604795	12.62 in^2	12.56 in^2	4.01 in	4.00 in	2	5900 psi	10 days	4000	14.12
2019-11-01-4-1	030F2824	2019-11-01	2019-12-02	CT HQ Concrete	0000000000(	28.54 in^2	28.45 in^2	6.03 in	6.02 in	3	4530 psi	31 days		
2019-11-01-6-1	030F2824	2019-11-01	2019-12-02	CT HQ Concrete	0000000000(	12.69 in^2	12.62 in^2	4.02 in	4.01 in	2	4820 psi	31 days		6.40
2019-11-04-1-1	120K0224	2019-11-04	2019-12-02	CT Southern Reg	1418596	28.37 in^2	28.37 in^2	6.01 in	6.01 in	2	3980 psi	28 days	4000	
2019-11-04-2-1	120K0224	2019-11-04	2019-12-02	CT Southern Reg	1418596	12.63 in^2	12.63 in^2	4.01 in	4.01 in	3	4740 psi	28 days	4000	19.10
2019-11-22-3-1	041G4304	2019-11-22	2019-12-02	CT HQ Concrete	CT 2	28.35 in^2	28.26 in^2	6.01 in	6.00 in	2	4510 psi	10 days	N/A	
2019-11-22-6-1	041G4304	2019-11-22	2019-12-02	CT HQ Concrete	CT 2	12.62 in^2	12.62 in^2	4.01 in	4.01 in	2	5030 psi	10 days	N/A	11.53
2019-11-23-1-1	030H10U4	2019-11-23	2019-12-02	CT HQ Concrete	1604795	28.54 in^2	28.54 in^2	6.03 in	6.03 in	3	4680 psi	9 days	4000	
2019-11-23-2-1	030H10U4	2019-11-23	2019-12-02	CT HQ Concrete	1604795	12.62 in^2	12.56 in^2	4.01 in	4.00 in	2	5020 psi	9 days	4000	7.26
2019-11-06-1-1	101L1504	2019-11-06	2019-12-04	CT HQ Concrete	1435 CTN	28.26 in^2	28.35 in^2	6.00 in	6.01 in	3	5160 psi	28 days		
2019-11-06-2-1	101L1504	2019-11-06	2019-12-04	CT HQ Concrete	1435 CTN	12.56 in^2	12.56 in^2	4.00 in	4.00 in	3	5400 psi	28 days		4.65
2019-11-15-27-1	030H10U4	2019-11-15	2019-12-06	CT HQ Concrete	1604795	28.35 in^2	28.35 in^2	6.01 in	6.01 in	2	6710 psi	21 days	4000	
2019-11-15-26-1	030H10U4	2019-11-15	2019-12-06	CT HQ Concrete	1604795	12.56 in^2	12.62 in^2	4.00 in	4.01 in	2	7200 psi	21 days	4000	7.30
2019-11-23-3-1	030H10U4	2019-11-23	2019-12-09	CT HQ Concrete	1604795	28.45 in^2	28.45 in^2	6.02 in	6.02 in	3	5910 psi	16 days	4000	
2019-11-23-4-1	030H10U4	2019-11-23	2019-12-09	CT HQ Concrete	1604795	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	6190 psi	16 days	4000	4.74
2019-11-12-17-1	042640N4	2019-11-12	2019-12-10	CT HQ Concrete	0000000000(	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	4680 psi	28 days	550 LB	
2019-11-12-16-1	042640N4	2019-11-12	2019-12-10	CT HQ Concrete	0000000000(	12.62 in^2	12.62 in^2	4.01 in	4.01 in	2	4910 psi	28 days	550 LB	4.91
2019-12-04-13-1	030H10U4	2019-12-04	2019-12-11	CT HQ Concrete	1604795	28.45 in^2	28.45 in^2	6.02 in	6.02 in	3	5130 psi	7 days	4000	
2019-12-04-15-1	030H10U4	2019-12-04	2019-12-11	CT HQ Concrete	1604795	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	5640 psi	7 days	4000	9.94
2019-11-14-18-1	042640N4	2019-11-14	2019-12-12	CT HQ Concrete	0000000000(	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	5510 psi	28 days	550 LB	
2019-11-14-17-1	042640N4	2019-11-14	2019-12-12	CT HQ Concrete	0000000000(	12.62 in^2	12.62 in^2	4.01 in	4.01 in	2	6010 psi	28 days	550 LB	9.07
2019-12-05-9-1	030H10U4	2019-12-05	2019-12-16	CT HQ Concrete	1519161	28.45 in^2	28.45 in^2	6.02 in	6.02 in	3	3330 psi	11 days	4000	
2019-12-05-8-1	030H10U4	2019-12-05	2019-12-16	CT HQ Concrete	1519161	12.62 in^2	12.62 in^2	4.01 in	4.01 in	2	3630 psi	11 days	4000	9.01
2019-10-22-6-1	030F2824	2019-10-22	2019-12-17	CT HQ Concrete	0000000000(	28.45 in^2	28.45 in^2	6.02 in	6.02 in		5480 psi	56 days		
2019-10-22-5-1	030F2824	2019-10-22	2019-12-17	CT HQ Concrete	0000000000(	12.62 in^2	12.62 in^2	4.01 in	4.01 in	2	5990 psi	56 days		9.31
2019-11-12-17-1	042640N4	2019-11-12	2019-12-10	CT HQ Concrete	0000000000(	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	4640 psi	28 days	550 LB	
2019-11-12-16-1	042640N4	2019-11-12	2019-12-10	CT HQ Concrete	0000000000(	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	4990 psi	28 days	550 LB	4.91
2019-11-14-18-1	042640N4	2019-11-14	2019-12-12	CT HQ Concrete	0000000000(	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	5510 psi	28 days	550 LB	
2019-11-14-17-1	042640N4	2019-11-14	2019-12-12	CT HQ Concrete	0000000000(	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	5760 psi	28 days	550 LB	9.07
2019-11-15-27-1	030H10U4	2019-11-15	2019-12-06	CT HQ Concrete	1604795	28.35 in^2	28.35 in^2	6.01 in	6.01 in	2	7000 psi	21 days		
2019-11-15-26-1	030H10U4	2019-11-15	2019-12-06	CT HQ Concrete	1604795	12.56 in^2	12.62 in^2	4.00 in	4.01 in	3	7300 psi	21 days		7.30
2019-11-23-1-1	030H10U4	2019-11-23	2019-12-02	CT HQ Concrete	1604795	28.54 in^2	28.54 in^2	6.03 in	6.03 in	2	4680 psi	9 days		
2019-11-23-2-1	030H10U4	2019-11-23	2019-12-02	CT HQ Concrete	1604795	12.62 in^2	12.56 in^2	4.01 in	4.00 in	3	4920 psi	9 days		7.26
2019-11-23-3-1	030H10U4	2019-11-23	2019-12-09	CT HQ Concrete	1604795	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	5840 psi	16 days		
2019-11-23-4-1	030H10U4	2019-11-23	2019-12-09	CT HQ Concrete	1604795	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	5990 psi	16 days		4.74
2019-11-23-5-1	030H10U4	2019-11-23	2019-12-23	CT HQ Concrete	1604795	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	7040 psi	30 days		
2019-11-23-6-1	030H10U4	2019-11-23	2019-12-23	CT HQ Concrete	1604795	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	7030 psi	30 days		4.31
2019-12-04-12-1	030H10U4	2019-12-04	2019-12-26	CT HQ Concrete	1604795	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	7580 psi	22 days		
2019-12-04-14-1	030H10U4	2019-12-04	2019-12-26	CT HQ Concrete	1604795	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	7620 psi	22 days		4.79
2019-12-04-13-1	030H10U4	2019-12-04	2019-12-11	CT HQ Concrete	1604795	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	5140 psi	7 days		
2019-12-04-15-1	030H10U4	2019-12-04	2019-12-11	CT HQ Concrete	1604795	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	5800 psi	7 days		9.94
2019-12-05-9-1	030H10U4	2019-12-05	2019-12-16	CT HQ Concrete	1519161	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	3370 psi	11 days		
2019-12-05-8-1	030H10U4	2019-12-05	2019-12-16	CT HQ Concrete	1519161	12.62 in^2	12.62 in^2	4.01 in	4.01 in	3	3640 psi	11 days		9.01
2019-12-12-14-1	030H10U4	2019-12-12	2019-12-19	CT HQ Concrete	1519161	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	3080 psi	7 days		
2019-12-12-15-1	030H10U4	2019-12-12	2019-12-19	CT HQ Concrete	1519161	12.56 in^2	12.56 in^2	4.00 in	4.00 in	3	3400 psi	7 days		11.36
2019-11-06-1-1	101L1504	2019-11-06	2019-12-04	CT HQ Concrete	1435 CTN	28.26 in^2	28.35 in^2	6.00 in	6.01 in	2	5220 psi	28 days		
2019-11-06-2-1	101L1504	2019-11-06	2019-12-04	CT HQ Concrete	1435 CTN	12.56 in^2	12.56 in^2	4.00 in	4.00 in	3	5330 psi	28 days		4.65
2019-11-01-4-1	030F2824	2019-11-01	2019-12-02	CT HQ Concrete	0000000000(	28.54 in^2	28.45 in^2	6.03 in	6.02 in	2	4540 psi	31 days		
2019-11-01-6-1	030F2824	2019-11-01	2019-12-02	CT HQ Concrete	0000000000(	12.69 in^2	12.62 in^2	4.02 in	4.01 in	3	4730 psi	31 days		6.40
2019-11-22-3-1	041G4304	2019-11-22	2019-12-02	CT HQ Concrete	CT 2	28.35 in^2	28.26 in^2	6.01 in	6.00 in	2	4550 psi	10 days		
2019-11-22-6-1	041G4304	2019-11-22	2019-12-02	CT HQ Concrete	CT 2	12.62 in^2	12.62 in^2	4.01 in	4.01 in	2	5040 psi	10 days		11.53
2019-11-22-4-1	041G4304	2019-11-22	2019-12-13	CT HQ Concrete	CT 2	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	5640 psi	21 days		
2019-11-22-7-1	041G4304	2019-11-22	2019-12-13	CT HQ Concrete	CT 2	12.62 in^2	12.62 in^2	4.01 in	4.01 in	2	5880 psi	21 days		5.70
2019-11-22-5-1	041G4304	2019-11-22	2019-12-20	CT HQ Concrete	CT 2	28.45 in^2	28.45 in^2	6.02 in	6.02 in	2	5690 psi	28 days		
2019-11-22-8-1	041G4304	2019-11-22	2019-12-20	CT HQ Concrete	CT 2	12.56 in^2	12.5 in^2	4.00 in	3.99 in	2	6110 psi	28 days		11.80

Appendix B - Confab Inc. Supplied Comparison Data

CONCRETE BREAK RESULTS										
Job Name:	Truckee River Bridge / CA Flap SR89(1)								MIX DESIGN	
									SCC-CL98-20AF	
Job No.:	L16-111		Cylinder Size:		6" x 12"				f'ci	6500 psi
Bed #	4A	Product Type:	3'-4 5/8" T Bulb Tee Girder						f'ci	8500 psi
Pour Date:	Pour #	Mark Number	Release		7 Days		28-Days		Remarks	
4-Aug-17	1	T1B	7091	7127	8984	9055	11036	10859		
8-Aug-17	2	T1D	7127	7268	9674	9446	11567	11461		
10-Aug-17	3	T1C	6791	7109	9356	9656	11213	11372		
14-Aug-17	4	T1B-2	7233	7144	9462	9515	11213	11496		
16-Aug-17	5	T1D2	7162	7198	9125	9267	11284	11390		
18-Aug-17	6	T1C	7286	7322	9143	8754	10380	10451		
22-Aug-17	7	T1A	6614	6650	7941	8135	9462	9780		
24-Aug-17	8	T1A-2	6544	6579	9266	9319	11567	11991		
END										
AVERAGE:			7015		9131		11033			

Appendix B - Confab Inc. Supplied Comparison Data

CONCRETE BREAK RESULTS												
Job Name:	Truckee River Bridge / CA Flap SR89(1)											MIX DESIGN SCC-CL98-20AF
Job No.:	L16-111		Cylinder Size:			4' x 8'						f'ci 6500 psi
Bed # 4A	Product Type:		3'-4 5/8" T Bulb Tee Girder									f'ci 8500 psi
Pour Date:	Pour #	Mark Number	Release			7 Days			28-Days			Remarks
4-Aug-17	1	T1B	7600	7600	7639	9032	9748	9589	11031	11859	11061	
8-Aug-17	2	T1D	7202	7281	7401	10350	10230	10270	10708	13136	12109	
10-Aug-17	3	T1C	7480	7242	7404	10027	10429	9656	12101	12579	12898	
14-Aug-17	4	T1B2	6605	7242	7172	9515	9914	9952	12141	12221	12420	
16-Aug-17	5	T1D2	6804	7563	7484	9952	9633	9708	12579	12659	12619	
18-Aug-17	6	T1C	7242	7321	7401	9788	9589	9311	11664	12221	11624	
22-Aug-17	7	T1A	6833	6724	6525	8757	8459	8634	10907	10027	10270	
24-Aug-17	8	T1A-2	6525	6525	6724	10310	10310	10310	12141	12659	12659	
END												
AVERAGE:			7147			9728			11929			

Appendix C Harper Precast Supplied Comparison Data

SCC2748

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

ENTERED

Y

Slump		Air	6.9	Unit Weight Lbs	34.8	Required Strength PSI
Spread	23	Ambient Temp	46	Density Volume Lbs/ft3	140.89	5000
		Concrete Temp	70	VSI		

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	3/24/2018	3/30/2018	4/20/2018	4/20/2018	4/20/2018	AVG
Strength PSI	4067	5697	8302	8318	8509	8371
Load (lbs)	51110	71590	104330	104530	106930	105263
Early Break Dates						

Western Tech Breaks

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
3/23/2018	16-1038	Inglewood Stadium	Mse	7	SCC2748
3/23/2018	17-488	Salt Lake City Airport Job-18407	Mse	10	SCC2748
3/23/2018	18-001	Inventory	Block	4	SCC2748
3/23/2018	18-001	Inventory	Box	2	SCC2748
3/23/2018	18-001	Inventory	Box - Knockout	7	SCC2748
3/23/2018	18-259	Irrigation Diversion Box	Box	1	SCC2748
				31	

QC Supervisor ______________ Date ______________ Inspector ______________

Created Date 3/26/2018

Appendix C Harper Precast Supplied Comparison Data

SCC2751

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

Y

Slump		Air	7.5	Unit Weight Lbs	34.65	Required Strength PSI
Spread	21	Ambient Temp	44	Density Volume Lbs/ft3	140.28	5000
		Concrete Temp	66	VSI		

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	3/27/2018	4/2/2018	4/23/2018	4/23/2018	4/23/2018	AVG
Strength PSI	2040	6586	8338	8493	8024	8285
Load (lbs)	25630	82760	104780	106720	100830	104113
Early Break Dates						

Western Tech Breaks

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
3/26/2018	16-1038	Inglewood Stadium	Mse	7	SCC2751
3/26/2018	17-488	Salt Lake City Airport Job-18407	Mse	8	SCC2751
				15	

QC Supervisor ____________________ Date ____________________ Inspector ____________________

Created Date 3/27/2018

Appendix C Harper Precast Supplied Comparison Data

SCC2755

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

Y

Slump		Air	6.4	Unit Weight Lbs	35.25	Required Strength PSI	
Spread	23	Ambient Temp	56	Density Volume Lbs/ft3	142.71		5000
		Concrete Temp	65	VSI			

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	3/28/2018	4/3/2018	4/24/2018	4/24/2018	4/24/2018	AVG
Strength PSI	2011	6886	8840	8241	8434	8505
Load (lbs)	25270	86530	111090	103560	105990	106880
Early Break Dates						

Western Tech Breaks

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
3/27/2018	16-1038	Inglewood Stadium	Mse	7	SCC2755
3/27/2018	18-001	Inventory	Block	5	SCC2755
3/27/2018	18-001	Inventory	Box - Knockout	6	SCC2755
3/27/2018	18-189	Penske Truck Leasing	Box	1	SCC2755
3/27/2018	18-174	Moab Food Truck Park	Box	1	SCC2755
3/27/2018	17-754	Camp Kearns Site Improvements	Box	8	SCC2755
3/27/2018	17-380	500 S. Diversion Ph 1 Pipeline	Box	2	SCC2755
				30	

QC Supervisor ____________ Date ____________ Inspector ____________

Created Date 3/28/2018

Appendix C Harper Precast Supplied Comparison Data

SCC2759

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

Y

Slump		Air	5.8	Unit Weight Lbs	35.5	Required Strength PSI	
Spread	23.5	Ambient Temp	53	Density Volume Lbs/ft3	143.72		5000
		Concrete Temp	67	VSI			

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	3/29/2018	4/4/2018	4/25/2018	4/25/2018	4/25/2018	AVG
Strength PSI	2664	6401	7517	7891	7820	7742
Load (lbs)	33480	80440	94460	99160	98270	97296
Early Break Dates						
Western Tech Breaks						

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
3/28/2018	16-1038	Inglewood Stadium	Mse	7	SCC2759
				7	

QC Supervisor ____________ Date ____________ Inspector ____________

Created Date 3/29/2018

Appendix C Harper Precast Supplied Comparison Data

SCC2762

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

Y

Slump		Air	5.6	Unit Weight Lbs	35.4	Required Strength PSI	
Spread	25	Ambient Temp	54	Density Volume Lbs/ft3	143.32		5000
		Concrete Temp	67	VSI	0		

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	3/30/2018	4/5/2018	4/26/2018	4/26/2018	4/26/2018	AVG
Strength PSI	2573	6068	7561	7520	7540	7540
Load (lbs)	32330	76250	95070	94500	94747	94755
Early Break Dates						

Western Tech Breaks

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
3/29/2018	16-1038	Inglewood Stadium	Mse	7	SCC2762
3/29/2018	17-488	Salt Lake City Airport Job-18407	Mse	5	SCC2762
				12	

QC Supervisor ______ Date ______ Inspector ______

Created Date 3/30/2018

Appendix C Harper Precast Supplied Comparison Data

SCC2766

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

Y

Slump		Air	6.3	Unit Weight Lbs	35.5	Required Strength PSI
Spread	21.5	Ambient Temp	66	Density Volume Lbs/ft3	143.72	5000
		Concrete Temp	65	VSI	1	

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	3/31/2018	4/6/2018	4/27/2018	4/27/2018	4/27/2018	AVG
Strength PSI	4758	6050	7395	7719	7614	7576
Load (lbs)	59790	76030	92930	97000	95680	95203
Early Break Dates						
Western Tech Breaks						

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
3/30/2018	16-1038	Inglewood Stadium	Mse	6	SCC2766
				6	

QC Supervisor ______ Date ______ Inspector ______

Created Date 4/2/2018

Appendix C Harper Precast Supplied Comparison Data

HARPER PRECAST

SCC2768

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

Y

Slump		Air	5.1	Unit Weight Lbs	35.25	Required Strength PSI
Spread	24	Ambient Temp	60	Density Volume Lbs/ft3	142.71	5000
		Concrete Temp	62	VSI	0	

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	4/3/2018	4/9/2018	4/30/2018	4/30/2018	4/30/2018	AVG
Strength PSI	1393	5444	7956	7589	7533	7693
Load (lbs)	17500	68410	99980	95370	94660	96670
Early Break Dates						

Western Tech Breaks

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
4/2/2018	16-1038	Inglewood Stadium	Mse	5	SCC2768
4/2/2018	17-488	Salt Lake City Airport Job-18407	Mse	5	SCC2768
4/2/2018	18-001	Inventory	Post	10	SCC2768
4/2/2018	18-328	Willow Creek Pet Center	Panel	5	SCC2768
4/2/2018	18-328	Willow Creek Pet Center	Post	5	SCC2768
				30	

QC Supervisor ______________ Date ______________ Inspector ______________

Created Date 4/3/2018

Appendix C Harper Precast Supplied Comparison Data

HARPER PRECAST

SCC2772

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

Y

Slump		Air	6.6	Unit Weight Lbs	35.15	Required Strength PSI
Spread	23	Ambient Temp	47	Density Volume Lbs/ft3	142.31	5000
		Concrete Temp	57	VSI	0	

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	4/4/2018	4/10/2018	5/1/2018	5/1/2018	5/1/2018	AVG
Strength PSI	969	6025	7511	7472	7574	7519
Load (lbs)	12180	75710	94390	93900	95180	94490
Early Break Dates						

Western Tech Breaks

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
4/3/2018	16-1038	Inglewood Stadium	Mse	4	SCC2772
4/3/2018	17-488	Salt Lake City Airport Job-18407	Mse	5	SCC2772
				9	

QC Supervisor ____________ Date ____________ Inspector ____________

Created Date 4/4/2018

Appendix C Harper Precast Supplied Comparison Data

SCC2774

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

Y

Slump		Air	6.4	Unit Weight Lbs	34.9	Required Strength PSI
Spread	21	Ambient Temp		Density Volume Lbs/ft3	141.30	5000
		Concrete Temp	60	VSI	1	

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	4/5/2018	4/11/2018	5/2/2018	5/2/2018	5/2/2018	AVG
Strength PSI	2446	5878	7670	7787	8275	7911
Load (lbs)	accident	73860	96380	97850	103990	99407
Early Break Dates						

Western Tech Breaks

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
4/4/2018	16-1038	Inglewood Stadium	Mse	4	SCC2774
4/4/2018	17-488	Salt Lake City Airport Job-18407	Mse	5	SCC2774
				9	

QC Supervisor ______ Date ______ Inspector ______

Created Date 4/5/2018

Appendix C Harper Precast Supplied Comparison Data

HARPER PRECAST

SCC2778

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

Y

Slump		Air	5.5	Unit Weight Lbs	35.2	Required Strength PSI
Spread	20	Ambient Temp	60	Density Volume Lbs/ft3	142.51	5000
		Concrete Temp	61	VSI	1	

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	4/6/2018	4/12/2018	5/3/2018	5/3/2018	5/3/2018	AVG
Strength PSI	2667	5356	7772	7970	7646	7796
Load (lbs)	33520	67300	97670	100160	96090	97973
Early Break Dates						

Western Tech Breaks

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
4/5/2018	16-1038	Inglewood Stadium	Mse	4	SCC2778
				4	

QC Supervisor ____________ Date ____________ Inspector ____________

Created Date 4/6/2018

Appendix C Harper Precast Supplied Comparison Data

HARPER PRECAST

SCC2780

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

Y

Slump		Air	5.6	Unit Weight Lbs	35.35	Required Strength PSI
Spread	25	Ambient Temp	51	Density Volume Lbs/ft3	143.12	5000
		Concrete Temp	60	VSI	0	

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	4/7/2018	4/13/2018	5/4/2018	5/4/2018	5/4/2018	AVG
Strength PSI	4436	5192	7429	7151	7419	7333
Load (lbs)	55750	65240	93350	89870	93230	95150
Early Break Dates						

Western Tech Breaks

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
4/6/2018	16-1038	Inglewood Stadium	Mse	4	SCC2780
4/6/2018	17-1074	Taylorsville 3200 W HPC 17620	Post	5	SCC2780
4/6/2018	18-328	Willow Creek Pet Center	Post	5	SCC2780
				14	

QC Supervisor ____________ Date ____________ Inspector ____________

Created Date 4/9/2018

Appendix C Harper Precast Supplied Comparison Data

HARPER PRECAST

SCC2783

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

Y

Slump		Air	5.8	Unit Weight Lbs	35.4	Required Strength PSI
Spread	22.5	Ambient Temp	56	Density Volume Lbs/ft3	143.32	5000
		Concrete Temp	64	VSI		

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	4/10/2018	4/16/2018	5/7/2018	5/7/2018	5/7/2018	AVG
Strength PSI	3053	5405	7848	7949	7956	7918
Load (lbs)	38360	67920	98620	99890	99980	99497
Early Break Dates						

Western Tech Breaks

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
4/9/2018	16-1038	Inglewood Stadium	Mse	4	SCC2783
				4	

QC Supervisor ____________ Date ____________ Inspector ____________

Created Date 4/10/2018

Appendix C Harper Precast Supplied Comparison Data

HARPER PRECAST

SCC2787

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

Y

Slump		Air	7.2	Unit Weight Lbs	34.45	Required Strength PSI
Spread	26	Ambient Temp	65	Density Volume Lbs/ft3	139.47	5000
		Concrete Temp	62	VSI	0	

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	4/11/2018	4/17/2018	5/8/2018	5/8/2018	5/8/2018	AVG
Strength PSI	2825	4791	7153	6714	6806	6891
Load (lbs)	35500	60210	89890	84370	85520	86593
Early Break Dates						
Western Tech Breaks						

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
4/10/2018	16-1038	Inglewood Stadium	Mse	4	SCC2787
				4	

QC Supervisor ____________________ Date ____________________ Inspector ____________________

Created Date 4/11/2018

Appendix C Harper Precast Supplied Comparison Data

HARPER PRECAST

SCC2790

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

Y

Slump		Air	7.2	Unit Weight Lbs	35.45	Required Strength PSI
Spread	26	Ambient Temp	66	Density Volume Lbs/ft3	143.52	5000
		Concrete Temp	62	VSI		

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	4/12/2018	4/18/2018	5/9/2018	5/9/2018	5/9/2018	AVG
Strength PSI	3468	5354	7447	7002	7040	7163
Load (lbs)	43580	67280	93580	87990	88470	90013
Early Break Dates						

Western Tech Breaks

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
4/11/2018	17-488	Salt Lake City Airport Job-18407	Mse	4	SCC2790
		IWS		4	

QC Supervisor ____________ Date ____________ Inspector ____________

Created Date 4/12/2018

Appendix C Harper Precast Supplied Comparison Data

HARPER PRECAST

SCC2791

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

Y

Slump		Air	7.4	Unit Weight Lbs	34.5	Required Strength PSI
Spread	26	Ambient Temp		Density Volume Lbs/ft3	139.68	5000
		Concrete Temp	68	VSI		

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	4/12/2018	4/18/2018	5/9/2018	5/9/2018	5/9/2018	AVG
Strength PSI	4690	4990	6513	6538	6554	6535
Load (lbs)	58930	62700	81840	82160	82360	82120
Early Break Dates						

Western Tech Breaks

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
4/13/2018	16-1038	Inglewood Stadium	Mse	1	SCC2791
4/13/2018	17-488	Salt Lake City Airport Job-18407	Mse	8	SCC2791
				9	

7 Day
4/20/18
5297
66570

QC Supervisor ____________ Date ____________ Inspector ____________

Created Date 4/16/2018

Appendix C Harper Precast Supplied Comparison Data

HARPER PRECAST

SCC2951

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

ENTERED

Y

Slump		Air	6.9	Unit Weight Lbs	34.5	Required Strength PSI
Spread	24	Ambient Temp		Density Volume Lbs/ft3	139.68	5000
		Concrete Temp	82	VSI	0	

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	7/3/2018	7/9/2018	7/30/2018	7/30/2018	7/30/2018	AVG
Strength PSI	3470	5791	8211	8175	7978	8121
Load (lbs)	43610	72770	103180	102727	100250	102052
Early Break Dates						

Western Tech Breaks

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
7/2/2018	16-1038	Inglewood Stadium	Mse	8	SCC2951
				8	

QC Supervisor ______________ Date ______________ Inspector ______________

Created Date 7/3/2018

Appendix C Harper Precast Supplied Comparison Data

HARPER PRECAST

SCC2953

SCC 100 G Mix

CONCRETE TESTING REPORT

QUALITY CONTROL DEPARTMENT

Y

Slump		Air	5	Unit Weight Lbs	36.05	Required Strength PSI
Spread	22.5	Ambient Temp		Density Volume Lbs/ft3	145.95	5000
		Concrete Temp	78	VSI	0	

Curing Time	Next Day	7 Day	28 Day	28 Day	28 Day	28 Day
Break Date	7/4/2018	7/10/2018	7/31/2018	7/31/2018	7/31/2018	AVG
Strength PSI	5520	6202	5882/7390	7565	7156	7361
Load (lbs)	69320	77930	~~7618~~	95070	89920	92495
Early Break Dates			7-6-18			

Western Tech Breaks

Products Produced

Cast Date	Job No	Project Name	Product	Qty	Mark No
7/3/2018	18-460	I-15 Tech Corridor MSE	Mse	27	SCC2953
7/3/2018	18-427	5600 West; 7800 South to 8600 South	Panel	14	SCC2953
		INGLEWOOD		41	

ENTERED

QC Supervisor ______ Date ______ Inspector ______

Created Date 7/5/2018

Appendix C - Harper Precast Supplied Comparison Data

Western Technologies Inc.
The Quality People
Since 1955

420 West Lawndale Drive
Salt Lake City, UT 84115-2971
(801) 972-3650

SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report **04-24-18**
Job No. **6148JD001**
Event/Invoice No. **L001-02** Lab No. **9163**
Authorized By **ROBERT WINTERS** Date **03-23-18**
Sampled By **CLIENT** Date **03-23-18**
Submitted By **WTI** Date **03-27-18**

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **IWS CAST DATE 3/23/18**
Architect/Engineer
Contractor
Supplier

Truck/Ticket No. — Mix Identification **SCC-100** — Maximum Size Aggregate inches
Batch Size cubic yards — Required Strength **5000** psi @ **28** days — Water Added Before Sampling **0** gallons
Time In Mixer hours minutes — Ambient Air Temperature °F — Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**

Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS

Unit Weight; lbf/cu.ft. — Temperature: **ASTM C1064** °F
Air Content; % — Slump; **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**

No. of Specimens Molded **4** — Diameter/Length **6.00** in.x **12** in. — Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	Compressive Strength: Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	03-30-18	7	12:07	132940	4700		TYPE 2	JM
	03-30-18	7	12:15	132620	4690		TYPE 5	JM
	04-20-18	28	08:20	208390	7370		2	LL
	04-20-18	28	08:25	188000	6650		5	JM
	AVERAGE	7			4700			
	AVERAGE	28			7010	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

REVIEWED BY **K PARKS**
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Appendix C - Harper Precast Supplied Comparison Data

Western Technologies Inc.
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420 West Lawndale Drive
Salt Lake City, UT 84115-2971
(801) 972-3650

SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report **04-25-18**
Job No. **6148JD001**
Event/Invoice No. **L001-03** Lab No. **9164**
Authorized By **ROBERT WINTERS** Date **03-23-18**
Sampled By **CLIENT** Date **03-26-18**
Submitted By **WTI** Date **04-04-18**

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **INGLEWOOD STADIUM CAST DATE 3/26/18**
Architect/Engineer
Contractor
Supplier

Truck/Ticket No. — Mix Identification **SCC100** — Maximum Size Aggregate inches
Batch Size cubic yards — Required Strength **5000** psi @**28** days — Water Added Before Sampling **0** gallons
Time In Mixer hours minutes — Ambient Air Temperature °F — Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**
Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS
Unit Weight; lbf/cu.ft. — Temperature: **ASTM C1064** °F
Air Content; % — Slump; **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**
No. of Specimens Molded **4** — Diameter/Length **6.00** in.x **12** in. — Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	Compressive Strength: Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	04-05-18	10	13:20	148090	5240		5	JM
	04-05-18	10	14:00	135880	4810		3	JM
	04-23-18	28	17:40	193640	6850		3	JM
	04-23-18	28	17:45	195420	6910		3	JM
	AVERAGE	10			5020			
	AVERAGE	28			6880	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

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Appendix C - Harper Precast Supplied Comparison Data

Western Technologies Inc.
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420 West Lawndale Drive
Salt Lake City, UT 84115-2971
(801) 972-3650

SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report **04-27-18**
Job No. **6148JD001**
Event/Invoice No. **L001-03** Lab No. **9165**
Authorized By **ROBERT WINTERS** Date **03-26-18**
Sampled By **CLIENT** Date **03-27-18**
Submitted By **WTI** Date **04-04-18**

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **INGLEWOOD STADIUM CAST DATE 3/27/18**
Architect/Engineer
Contractor
Supplier

Truck/Ticket No.
Batch Size cubic yards
Time In Mixer hours minutes

Mix Identification **SCC100**
Required Strength **5000** psi @**28** days
Ambient Air Temperature °F

Maximum Size Aggregate inches
Water Added Before Sampling **0** gallons
Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**

Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS

Unit Weight; lbf/cu.ft. Temperature: **ASTM C1064** °F
Air Content; % Slump; **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**

No. of Specimens Molded **4** Diameter/Length **6.00** in.x **12** in. Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	Compressive Strength: Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	04-05-18	9	14:15	158790	5620		1	JM
	04-05-18	9	13:45	165400	5850		3	JM
	04-24-18	28	15:40	216010	7640		3	JM
	04-24-18	28	15:45	213050	7540		5	JM
	AVERAGE	9			5730			
	AVERAGE	28			7590	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

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Appendix C - Harper Precast Supplied Comparison Data

Western Technologies Inc.
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420 West Lawndale Drive
Salt Lake City, UT 84115-2971
(801) 972-3650

SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report **05-01-18**
Job No. **6148JD001**
Event/Invoice No. **L001-03** Lab No. **9166**
Authorized By **ROBERT WINTERS** Date **03-27-18**
Sampled By **CLIENT** Date **03-28-18**
Submitted By **WTI** Date **04-04-18**

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **INGLEWOOD STADIUM CAST DATE 3/28/18**
Architect/Engineer
Contractor
Supplier

Truck/Ticket No. | Mix Identification **SCC100** | Maximum Size Aggregate inches
Batch Size cubic yards | Required Strength **5000** psi @ **28** days | Water Added Before Sampling **0** gallons
Time In Mixer hours minutes | Ambient Air Temperature °F | Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**
Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS
Unit Weight; lbf/cu.ft. | Temperature: **ASTM C1064** °F
Air Content; % | Slump; **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**
No. of Specimens Molded **4** | Diameter/Length **6.00** in.x **12** in. | Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	Compressive Strength: Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	04-05-18	8	13:50	147590	5220		5	JM
	04-05-18	8	14:10	156750	5550		5	JM
	04-25-18	28	13:20	208370	7370		3	JM
	04-25-18	28	13:28	209200	7400		3	JM
	AVERAGE	8			5380			
	AVERAGE	28			7390	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

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Western Technologies Inc.
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420 West Lawndale Drive
Salt Lake City, UT 84115-2971
(801) 972-3650

SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report **05-02-18**
Job No. **6148JD001**
Event/Invoice No. **L001-03** Lab No. **9167**
Authorized By **ROBERT WINTERS** Date **03-28-18**
Sampled By **CLIENT** Date **03-29-18**
Submitted By **WTI** Date **04-04-18**

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **INGLEWOOD STADIUM CAST DATE 3/29/18**
Architect/Engineer
Contractor
Supplier

Truck/Ticket No. | Mix Identification **SCC100** | Maximum Size Aggregate inches
Batch Size cubic yards | Required Strength **5000** psi @ **28** days | Water Added Before Sampling **0** gallons
Time In Mixer hours minutes | Ambient Air Temperature °F | Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**
Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS
Unit Weight; lbf/cu.ft. | Temperature: **ASTM C1064** °F
Air Content; % | Slump; **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**
No. of Specimens Molded **4** | Diameter/Length **6.00** in.x **12** in. | Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	Compressive Strength: Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	04-05-18	7	13:20	136800	4840		5	JM
	04-05-18	7	13:25	135360	4790		5	JM
	04-26-18	28	16:45	209520	7410		3	JM
	04-26-18	28	16:50	212520	7520		2	JM
	AVERAGE	7			4810			
	AVERAGE	28			7470	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

REVIEWED BY **R WENZEL**
(SIGNED COPY ON FILE)

Appendix C - Harper Precast Supplied Comparison Data

Western Technologies Inc.
The Quality People
Since 1955

420 West Lawndale Drive
Salt Lake City, UT 84115-2971
(801) 972-3650

SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report **05-02-18**
Job No. **6148JD001**
Event/Invoice No. **L001-03** Lab No. **9168**
Authorized By **ROBERT WINTERS** Date **03-30-18**
Sampled By **CLIENT** Date **03-30-18**
Submitted By **WTI** Date **04-04-18**

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **INGLEWOOD STADIUM CAST DATE 3/30/18**
Architect/Engineer
Contractor
Supplier
Truck/Ticket No.
Batch Size cubic yards
Time In Mixer hours minutes

Mix Identification **SCC100**
Required Strength **5000** psi @ **28** days
Ambient Air Temperature °F

Maximum Size Aggregate inches
Water Added Before Sampling **0** gallons
Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**

Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS

Unit Weight; lbf/cu.ft. Temperature: **ASTM C1064** °F
Air Content; % Slump; **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**

No. of Specimens Molded **4** Diameter/Length **6.00** in.x **12** in. Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	Compressive Strength: Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	04-06-18	7	17:01	144450	5110		2	JH
	04-06-18	7	17:05	143380	5070		2	JH
	04-27-18	28	18:04	206570	7310		2	JH
	04-27-18	28	18:10	210950	7460		2	JH
	AVERAGE	7			5090			
	AVERAGE	28			7390	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

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SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Date of Report **05-03-18**
Job No. **6148JD001**
Event/Invoice No. **L001-04** Lab No. **9214**
Authorized By **ROBERT WINTERS** Date **04-02-18**
Sampled By **CLIENT** Date **04-02-18**
Submitted By **WTI** Date **04-04-18**

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **INGELWOOD STADIUM CAST DATE 4/2/18**
Architect/Engineer
Contractor
Supplier

Truck/Ticket No. | Mix Identification **SCC100** | Maximum Size Aggregate inches
Batch Size cubic yards | Required Strength **5000** psi @**28** days | Water Added Before Sampling **0** gallons
Time In Mixer hours minutes | Ambient Air Temperature °F | Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**

Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS

Unit Weight; lbf/cu.ft. Temperature: **ASTM C1064** °F
Air Content; % Slump; **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**

No. of Specimens Molded **4** Diameter/Length **6.00** in.x **12** in. Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	Compressive Strength: Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	04-09-18	7	11:05	133180	4710		5	JM
	04-09-18	7	11:10	144320	5110		5	JM
	04-30-18	28	09:15	189800	6710		2	JM
	04-30-18	28	09:25	183570	6490		2	JM
	AVERAGE	7			4910			
	AVERAGE	28			6600	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

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SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report **05-04-18**
Job No. **6148JD001**
Event/Invoice No. **L001-04** Lab No. **9215**
Authorized By **ROBERT WINTERS** Date **04-03-18**
Sampled By **CLIENT** Date **04-03-18**
Submitted By **WTI** Date **04-04-18**

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **INGLEWOOD STADIUM CAST DATE 4/3/18**
Architect/Engineer
Contractor
Supplier

Truck/Ticket No. | Mix Identification **SCC100** | Maximum Size Aggregate inches
Batch Size cubic yards | Required Strength **5000** psi @ **28** days | Water Added Before Sampling **0** gallons
Time In Mixer hours minutes | Ambient Air Temperature °F | Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**

Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS

Unit Weight; lbf/cu.ft. Temperature: **ASTM C1064** °F
Air Content; % Slump: **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**

No. of Specimens Molded **4** Diameter/Length **6.00** in.x **12** in. Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	Compressive Strength: Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	04-10-18	7	17:00	138140	4890		2	KP
	04-10-18	7	17:05	136360	4820		5	KP
	05-01-18	28	06:00	194660	6890		3	JM
	05-01-18	28	06:05	205940	7290		3	JM
	AVERAGE	7			4860			
	AVERAGE	28			7090	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

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SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report **05-03-18**
Job No. **6148JD001**
Event/Invoice No. **L001-04** Lab No. **9263**
Authorized By **ROBERT WINTERS** Date **04-16-18**
Sampled By **CLIENT** Date **04-04-18**
Submitted By **WTI** Date **04-16-18**

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **IWS CAST DATE 4/4/18**
Architect/Engineer
Contractor
Supplier
Truck/Ticket No.
Batch Size cubic yards
Time In Mixer hours minutes

Mix Identification **SCC-100**
Required Strength **5000** psi @ **28** days
Ambient Air Temperature °F

Maximum Size Aggregate inches
Water Added Before Sampling **0** gallons
Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**
Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS
Unit Weight; lbf/cu.ft. Temperature: **ASTM C1064** °F
Air Content; % Slump: **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**
No. of Specimens Molded **4** Diameter/Length **6.00** in.x **12** in. Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	Compressive Strength: Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	04-16-18	12	07:41	168030	5940		TYPE 2	JH
	04-16-18	12	07:46	162600	5750		TYPE 2	JH
	05-02-18	28	12:00	202810	7170		2	JM
	05-02-18	28	12:10	210180	7440		2	JM
	AVERAGE	12			5850			
	AVERAGE	28			7310	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

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SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Date of Report **05-07-18**
Job No. **6148JD001**
Event/Invoice No. **L001-04** Lab No. **9264**
Authorized By **ROBERT WINTERS** Date **04-16-18**
Sampled By **CLIENT** Date **04-05-18**
Submitted By **WTI** Date **04-16-18**

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **IWS CAST DATE 4/5/18**
Architect/Engineer
Contractor
Supplier
Truck/Ticket No.
Batch Size cubic yards
Time In Mixer hours minutes

Mix Identification **SCC-100**
Required Strength **5000** psi @ **28** days
Ambient Air Temperature °F

Maximum Size Aggregate inches
Water Added Before Sampling **0** gallons
Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**
Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS
Unit Weight; lbf/cu.ft. Temperature: **ASTM C1064** °F
Air Content; % Slump; **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**
No. of Specimens Molded **4** Diameter/Length **6.00** in.x **12** in. Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength – Maximum Load lbf	Compressive Strength – Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	04-16-18	11	07:52	154230	5460		TYPE 2	JH
	04-16-18	11	07:55	147720	5230		TYPE 2	JH
	05-03-18	28	12:40	197640	6990		5	JM
	05-03-18	28	12:45	182150	6440		2	JM
	AVERAGE	11			5340			
	AVERAGE	28			6720	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

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SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report **05-07-18**
Job No. **6148JD001**
Event/Invoice No. **L001-04** Lab No. **9265**
Authorized By **ROBERT WINTERS** Date **04-16-18**
Sampled By **CLINET** Date **04-06-18**
Submitted By **WTI** Date **04-16-18**

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **IWS CAST DATE 4/6/18**
Architect/Engineer
Contractor
Supplier
Truck/Ticket No.
Batch Size cubic yards
Time In Mixer hours minutes

Mix Identification **SCC-100**
Required Strength **5000** psi @ **28** days
Ambient Air Temperature °F

Maximum Size Aggregate inches
Water Added Before Sampling **0** gallons
Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**

Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS

Unit Weight; lbf/cu.ft. Temperature: **ASTM C1064** °F
Air Content; % Slump; **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**

No. of Specimens Molded **4** Diameter/Length **6.00** in.x **12** in. Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	Compressive Strength: Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	04-16-18	10	08:00	163460	5780		TYPE 2	JH
	04-16-18	10	08:05	170730	6040		TYPE 2	JH
	05-04-18	28	08:30	217700	7700		5	JM
	05-04-18	28	08:40	224010	7920		5	JM
	AVERAGE	10			5910			
	AVERAGE	28			7810	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

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420 West Lawndale Drive
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SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report 05-09-18
Job No. 6148JD001
Event/Invoice No. L001-04 Lab No. 9266
Authorized By ROBERT WINTERS Date 04-16-18
Sampled By CLIENT Date 04-09-18
Submitted By WTI Date 04-16-18

Client HARPER PRECAST
P.O BOX 16007
SALT LAKE CITY, UT 84116

Client HARPER PRECAST
Project VARIOUS ON-CALL LAB TESTING
Location WT LAB
Source of Sample IWS CAST DATE 4/9/18
Architect/Engineer
Contractor
Supplier
Truck/Ticket No.
Batch Size cubic yards
Time In Mixer hours minutes

Mix Identification SCC-100
Required Strength 5000 psi @28 days
Ambient Air Temperature ˚F

Maximum Size Aggregate inches
Water Added Before Sampling 0 gallons
Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH ASTM C172

Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS

Unit Weight; lbf/cu.ft. Temperature: ASTM C1064 ˚F
Air Content; % Slump; ASTM C143 inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH ASTM C31

No. of Specimens Molded 4 Diameter/Length 6.00 in.x 12 in. Cross Sectional Area 28.27 sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH ASTM C31 & C39

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	Compressive Strength: Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	04-16-18	7	08:09	156570	5540		2	JH
	04-16-18	7	08:14	151050	5340		3	JH
	05-07-18	28	12:30	185860	6570		6	JM
	05-07-18	28	12:50	195410	6910		5	JM
	AVERAGE	7			5440			
	AVERAGE	28			6740	YES		

Comments:

Distribution : HARPER PRECAST (1)

REVIEWED BY M FRAME
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420 West Lawndale Drive
Salt Lake City, UT 84115-2971
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SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report **05-09-18**
Job No. **6148JD001**
Event/Invoice No. **L001-04** Lab No. **9267**
Authorized By **ROBERT WINTERS** Date **04-16-18**
Sampled By **CLIENT** Date **04-10-18**
Submitted By **WTI** Date **04-16-18**

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **IWS CAST DATE 4/10/18**
Architect/Engineer
Contractor
Supplier
Truck/Ticket No.
Batch Size cubic yards
Time In Mixer hours minutes

Mix Identification **SCC-100**
Required Strength **5000** psi @ **28** days
Ambient Air Temperature °F

Maximum Size Aggregate inches
Water Added Before Sampling **0** gallons
Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**
Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS
Unit Weight; lbf/cu.ft. Temperature: **ASTM C1064** °F
Air Content; % Slump; **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**
No. of Specimens Molded **4** Diameter/Length **6.00** in.x **12** in. Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	Compressive Strength: Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	04-17-18	7	11:20	139080	4920		5	JM
	04-17-18	7	11:25	126820	4490		3	JM
	05-08-18	28	10:20	186710	6610		6	JM
	05-08-18	28	10:25	171440	6060		5	JM
	AVERAGE	7			4700			
	AVERAGE	28			6340	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

REVIEWED BY **M FRAME**
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SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report **05-11-18**
Job No. **6148JD001**
Event/Invoice No. **L001-04** Lab No. **9268**
Authorized By **ROBERT WINTERS** Date **04-16-18**
Sampled By **CLIENT** Date **04-11-18**
Submitted By **WTI** Date **04-16-18**

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **IWS CAST DATE 4/11/18**
Architect/Engineer
Contractor
Supplier
Truck/Ticket No.
Batch Size cubic yards
Time In Mixer hours minutes

Mix Identification **SCC-100**
Required Strength **5000** psi @ **28** days
Ambient Air Temperature °F

Maximum Size Aggregate inches
Water Added Before Sampling **0** gallons
Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**
Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS
Unit Weight; lbf/cu.ft. Temperature: **ASTM C1064** °F
Air Content; % Slump; **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**
No. of Specimens Molded **4** Diameter/Length **6.00** in.x **12** in. Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	Compressive Strength: Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	04-18-18	7	19:00	147250	5210		2	JH
	04-18-18	7	19:03	148370	5250		3	JH
	05-09-18	28	13:50	202660	7170		5	JM
	05-09-18	28	14:00	209750	7420		5	JM
	AVERAGE	7			5230			
	AVERAGE	28			7300	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

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Salt Lake City, UT 84115-2971
(801) 972-3650

SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report **05-15-18**
Job No. **6148JD001**
Event/Invoice No. **L001-04** Lab No. **9269**
Authorized By **ROBERT WINTERS** Date **04-16-18**
Sampled By **CLIENT** Date **04-13-18**
Submitted By **WTI** Date **04-16-18**

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **IWS CAST DATE 4/13/18**
Architect/Engineer
Contractor
Supplier

Truck/Ticket No. Mix Identification **SCC-100** Maximum Size Aggregate inches
Batch Size cubic yards Required Strength **5000** psi @ **28** days Water Added Before Sampling **0** gallons
Time In Mixer hours minutes Ambient Air Temperature °F Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**
Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS
Unit Weight; lbf/cu.ft. Temperature: **ASTM C1064** °F
Air Content; % Slump; **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**
No. of Specimens Molded **4** Diameter/Length **6.00** in.x **12** in. Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	04-20-18	7	08:15	154240	5460		TYPE 5	JM
	04-20-18	7	08:20	149250	5280		TYPE 3	JM
	05-11-18	28	09:05	217000	7680		3	JM
	05-11-18	28	09:10	201940	7140		5	JM
	AVERAGE	7			5370			
	AVERAGE	28			7410	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

REVIEWED BY **K PARKS**
(SIGNED COPY ON FILE)

Appendix C - Harper Precast Supplied Comparison Data

Western Technologies Inc.
The Quality People
Since 1955

420 West Lawndale Drive
Salt Lake City, UT 84115-2971
(801) 972-3650

SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report **07-31-18**
Job No. **6148JD001**
Event/Invoice No. **L001-07** Lab No. **9649**
Authorized By **ROBERT WINTERS** Date **07-02-18**
Sampled By **CLIENT** Date **07-02-18**
Submitted By **WTI** Date **07-10-18**

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **INGLEWOOD STADIUM CAST DATE 7/2/18**
Architect/Engineer
Contractor
Supplier **HARPER**

Truck/Ticket No. | Mix Identification **SCC100** | Maximum Size Aggregate inches
Batch Size cubic yards | Required Strength **5000** psi @ **28** days | Water Added Before Sampling **0** gallons
Time In Mixer hours minutes | Ambient Air Temperature °F | Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**
Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS
Unit Weight; lbf/cu.ft. Temperature: **ASTM C1064** °F
Air Content; % Slump; **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**
No. of Specimens Molded **4** Diameter/Length **6.00** in.x **12** in. Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength: Maximum Load lbf	Compressive Strength: Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	07-10-18	8	15:00	167810	5940		5	JM
	07-10-18	8	15:10	175120	6200		5	JM
	07-30-18	28	14:30	187830	6640		3	JM
	07-30-18	28	14:40	184040	6510		5	JM
	AVERAGE	8			6070			
	AVERAGE	28			6580	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

REVIEWED BY **M FRAME**
(SIGNED COPY ON FILE)

Appendix C - Harper Precast Supplied Comparison Data

Western Technologies Inc.
The Quality People
Since 1955

420 West Lawndale Drive
Salt Lake City, UT 84115-2971
(801) 972-3650

SAMPLING / TESTING OF PORTLAND CEMENT CONCRETE

Date of Report **08-01-18**
Job No. **6148JD001**
Event/Invoice No. **L001-07** Lab No. **9650**
Authorized By **ROBERT WINTERS** Date **07-03-18**
Sampled By **CLIENT** Date **07-03-18**
Submitted By **WTI** Date **07-10-18**

Client **HARPER PRECAST**
P.O BOX 16007
SALT LAKE CITY, UT 84116

Client **HARPER PRECAST**
Project **VARIOUS ON-CALL LAB TESTING**
Location **WT LAB**
Source of Sample **INGLEWOOD STADIUM CAST DATE 7/3/18**
Architect/Engineer
Contractor
Supplier **HARPER**
Truck/Ticket No.
Batch Size cubic yards
Time In Mixer hours minutes

Mix Identification **SCC100**
Required Strength **5000** psi @**28** days
Ambient Air Temperature °F

Maximum Size Aggregate inches
Water Added Before Sampling **0** gallons
Time Sampled

FRESHLY MIXED CONCRETE SAMPLED IN ACCORDANCE WITH **ASTM C172**

Deviations:

FRESHLY MIXED CONCRETE TESTED IN ACCORDANCE WITH DESIGNATED SPECIFICATIONS

Unit Weight; lbf/cu.ft. Temperature: **ASTM C1064** °F
Air Content; % Slump; **ASTM C143** inches
Deviations:

CYLINDRICAL CONCRETE SPECIMENS MOLDED & CURED IN THE FIELD IN ACCORDANCE WITH **ASTM C31**

No. of Specimens Molded **4** Diameter/Length **6.00** in.x **12** in. Cross Sectional Area **28.27** sq. in.
Deviations:

CYLINDRICAL CONCRETE SPECIMENS CURED & TESTED IN THE LABORATORY IN ACCORDANCE WITH **ASTM C31 & C39**

Specimen Marking If Any	Date Tested	Age In Days	Time Tested	Compressive Strength – Maximum Load lbf	Compressive Strength – Maximum Load lbf per sq.in.	Conformance Indicated?	Type of Fracture & Defects Noted	Tested By
	07-10-18	7		173210	6130		5	JM
	07-10-18	7		173230	6130		5	JM
	07-31-18	28	14:00	204090	7220		3	JM
	07-31-18	28	14:10	182100	6440		5	JM
	AVERAGE	7			6130			
	AVERAGE	28			6830	YES		

Comments:

Distribution : **HARPER PRECAST (1)**

REVIEWED BY **K PARKS**
(SIGNED COPY ON FILE)

Appendix D - KIE-CON Inc. supplied comparison data

Date	Job#	Material	6x12		Average	Average	4x8	
11/12/2015	428	14"	7,702	8,020	**7,861**	**7,415**	7,380	7,450
11/12/2015	428	14"	8,030	7,900	**7,965**	**8,755**	8,800	8,710
11/17/2015	454-C	14"	8,660	8,960	**8,810**	**8,370**	9,010	7,730
11/17/2015	454-C	14"	6,958	7,280	**7,119**	**6,740**	6,320	7,160
11/18/2015	435	14"	8,890	8,560	**8,725**	**8,705**	8,740	8,670
11/18/2015	435	14"	8,960	9,240	**9,100**	**8,815**	9,350	8,280
11/18/2015	454-C	14"	8,480	8,670	**8,575**	**7,565**	7,200	7,930
11/18/2015	454-C	14"	8,760	8,320	**8,540**	**7,655**	8,000	7,310
11/19/2015	454-C	14"	7,090	7,240	**7,165**	**7,995**	8,150	7,840
11/19/2015	454-C	14"	8,150	7,690	**7,920**	**8,300**	8,270	8,330
11/19/2015	454-C	14"	8,780	8,190	**8,485**	**8,505**	7,800	9,210
11/20/2015	454-C	14"	7,620	7,920	**7,770**	**7,380**	7,630	7,130
11/20/2015	454-C	14"	8,460	8,000	**8,230**	**7,975**	8,140	7,810
11/23/2015	454-C	14"	7,760	7,860	**7,810**	**7,885**	7,440	8,330
11/23/2015	456	14"	8,040	7,420	**7,730**	**8,165**	7,770	8,560
12/9/2015	454-C	14"	6,940	6,380	**6,660**	**7,030**	6,970	7,090
12/10/2015	454-C	14"	7,900	7,390	**7,645**	**7,710**	7,940	7,480
12/14/2015	436-T	14"	6,960		**6,960**	**7,260**	7,260	
12/14/2015	436-T	14"	7,530		**7,530**	**7,280**	7,280	
12/14/2015	436-C	14"	7,360		**7,360**	**7,320**	7,320	
12/14/2015	436-C	14"	8,120		**8,120**	**8,150**	8,150	
12/15/2015	436-T/C	14"	6,770		**6,770**	**7,070**	7,070	
Average					**7,857**	**7,820**		

Appendix E - Graniterock Supplied Comparison Data

INDUSTRY COMPARISON STRENGTH RESULTS

4x8 Cylinder Strength Results versus 6x12 Cylinder Strength Results

Submitted By: Katha Redmon

Batch Date	Batch ID	Sack Eq	Design f'c	Slump	Air	7-day 4x8	7-day 4x8	7-day 4x8	7-day 6x12	7-day 6x12	7-day 6x12	28-day 4x8	28-day 4x8	28-day 4x8	28-day 6x12	28-day 6x12	28-day 6x12
02/26/19	190226-1	7.2	5000	4.25	4.1%	5130	4700	4720	4590	4530		7010	7540	7170	7070	6730	7000
02/26/19	190226-2	7.5	5000	5.25	4.6%	4780	4460	4740	4500	4380		7230	7110	7250	6790	6860	7110
02/26/19	190226-3	7.5	5000	4.50	4.3%	5510	5290	5200	5390	5250		8460	8410	8170	7800	8210	8180
04/22/19	190422-1	7.5	5000	4.50	1.2%	4710	4940	4750	4400	4420	4570	8080	8140	8040	7970	7910	7880
04/22/19	190422-2	7.2	5000	4.25	5.0%	5160	5220	4720	4940	4440	4610	7590	7830	7570	7170	7230	7010
04/22/19	190422-3	6.0	4000	4.25	4.1%	4370	4190	4230	3800	4180	4220	6180	6530	6720	6290	6550	6440
04/29/19	190429-1	7.5	5000	4.00	3.8%	5210	5140	5170	4950	4610	4650	8220	8300	7870	7610	7420	7600
04/29/19	190429-2	7.5	5000	4.50	3.6%	5370	5600	5420	5340	5090	5230	8170	7570	7560	7760	7700	7630
04/29/19	190429-3	7.5	5000	4.00	3.5%	5450	5420	5650	5410	5280	5340	8090	8160	7940	7990	8160	8360
04/29/19	190429-4	7.5	5000	4.50	3.1%	5680	5250	5370	5460	5460	5250	8130	8370	7860	8280	8240	8240

RESEARCH NOTES

Contract: 59A0682
Task Order: 1862
May 2011

Caltrans

Strength, Unit Weight and Elasticity of Concrete Cylinders from Benicia-Martinez Bridge

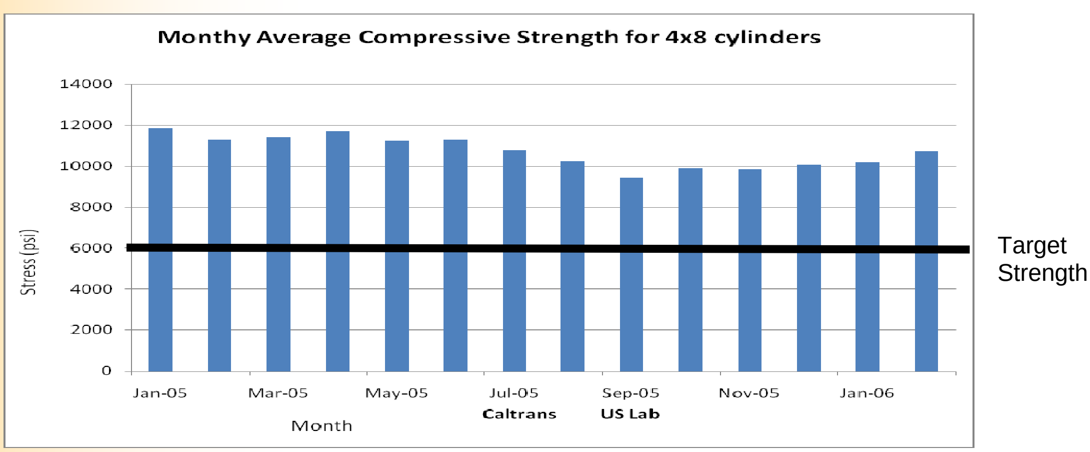
RESULTS: ***In testing 1027 cylinders, it was confirmed that the strength of lightweight concrete performed closely to what was expected and predicted. The confidence and performance of using lightweight concrete on the Benicia-Martinez is validated.***

Background

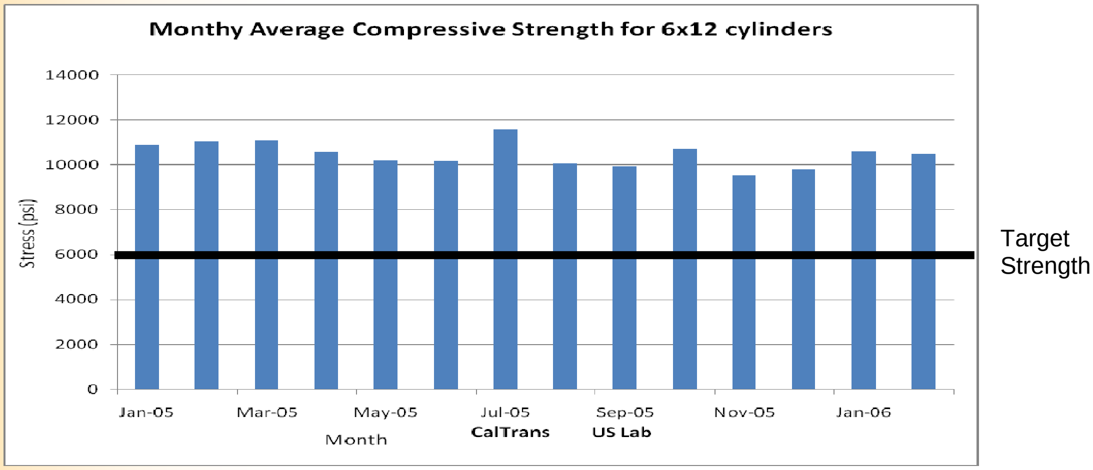
In 2005, lightweight aggregate concrete was placed on the Benicia-Martinez Bridge during construction. The purpose of using lightweight aggregate concrete instead of regular weight concrete is to keep the bridge weight low so it can carry the required capacity. Concrete cylinders were collected during construction and sent to San Jose State University to determine the compressive strength, modulus of elasticity and density over 5 years.

Why We Pursued This Research

Lightweight aggregate was used in the concrete of the Benicia-Martinez Bridge. Lightweight concrete is less dense than normal weight concrete and therefore, weighs less. Although concrete was tested at the age of 35 days to determine its strength, it was necessary to validate the long term compressive strength, modulus of elasticity and density of the concrete on this bridge to determine the long term performance. Both 4x8 inch and 6x12 inch concrete cylinder samples were collected during construction. This study seeks to determine if the smaller 4x8 in. cylinders can be utilized as an alternative to the 6x12 in. cylinders.



Appendix F - Caltrans Study Research Notes



What We Did

Office of Earthquake Engineering from Engineering Service Center contracted with San Jose State University to test lightweight aggregate concrete cylinders collected during Benicia-Martinez Bridge construction. Specimens were transported to San Jose State University and tested at the age of 5 years. The results were statistically analyzed to compare it with the results obtained at 35 days. The test included comparing 4x8 in. and 6x12 in. cylinder sizes on compressive strength.

Research Results

The compressive strength of the Benicia-Martinez Bridge concrete has good long-term performance. The statistical analysis showed that the bridge will never fall below its target compressive strength during its lifetime.

The following other conclusions are also drawn from the results:

- The average compressive strength increased by 3.6% at the age of 5 years from those observed at 35 days.
- The average compressive strength of the 4x8 in. cylinders was 2% more than the 6x12 in. cylinders at 5 years.
- At 5 years, the maximum strength has increased by 9% and the minimum strength has increased by 6.6% for the 4x8 in. cylinders when compared to those at 35 days.
- The production test average was 10,500 psi (72 MPa) at the age of 35 days and it has not dropped in 5 years.
- The probability of any single strength falling below the minimum observed strength decreased at 5 years.
- The probability of falling below the target compressive strength essentially approached zero at 5 years.
- The modulus of elasticity computed from the 6x12 in. cylinder was $3.79x10^3$ ksi (2.6 MPa) at 5 years.
- The concrete has maintained its dry density of 125 lb/ft^3 (2,002 kg/m^3) at 5 years.

Recommendations

From the study, it is observed that there is no significant difference between the compressive strengths determined from 4x8 in. and 6x12 in. cylinders at 5 years. Therefore, testing can be performed on 4x8 in. as an alternative to 6x12 in. Using smaller concrete cylinders to test for long-term compressive strength will save material and be easier to handle and transport during construction.

Reference

Akthem Al-Manaseer, Saad Nadeem, Ric Maggenti, Peter Lee: “Strength Unit Weight and Elasticity of Concrete Cylinders for the Benicia Martinez Bridge”, Final Report, March 2011, 55 pp.

Principal Investigator:

Prof. Akthem Al-Manaseer
Department of Civil and Environmental Engineering
San Jose State University
One Washington Square
San Jose, CA 95192-0083
Tel.: (408) 924-3860; Fax: (408) 924-4004
Email Address: akthem.al-manaseer@sjsu.edu

In House Research
NDOR Research Section

Starting Date: 09/1/2005

Evaluation of Cylinder Strength Correlation

Nebraska Department of Roads

Research Project Title:

Evaluation of Cylinder Strength Correlation

Research Project Number:

R-2005-07

Starting Date: 09/01/2005

Completion Date: 07/01/2010

Principle Investigators:

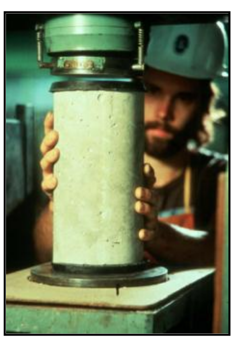
Robert Rea
Assistant Materials & Research Engineer

Wally Heyen
PCC Engineer

Lieska Halsey
NDOR Research

P.C.C Laboratory:

Gary Mangen
Highway Quality Assurance Manager



PURPOSE OF THE INVESTIGATION:

Currently, NDOR is using 6x12-inch cylinder mold for compressive strength field performance testing. In 2005, due to the increase of research on the strength comparison between 4x8-inch cylinders vs. 6x12-inch cylinders, NDOR started an evaluation for strength comparison in four NDOR's mixes to establish a strength correlation.

DESCRIPTION OF THE INVESTIGATION:

1. Evaluate NDOR's paving and structural mixes according to AASHTO T-126 and ASTM C-1231 specifications.
2. Evaluate compressive strength data for 7, 28 and 56 days to establish an average of two specimens per age per mix tested.
3. Evaluate and establish a percent different between the 4x8-inch and the 6x12-inch cylinders and compare results with other studies.

LABORATORY INVESTIGATION:

The cylinders were made in the field and were brought to the central lab the next day. The fabrication and curing of all cylinders was conducted according to specifications previously mentioned. The 47B mix design was used in all applications shown in Table 1. The compressive strengths were between 3000 and 3500 psi.

Each mix was composed of six specimens for each 4x8 inch and 6x12 inch cylinders. The concrete plastic characteristics used in the study are shown in Table 1.

Table 1. Concrete Mix Plastic Characteristics

Mix Number (#)	Concrete Type	W/C Ratio	Air Percentage (%)	Compressive Strength (psi)	Cementitious Contents lbs per cy
1	47B	0.412	6.5	3500	564
2	47B	0.423	6.8	3000	564
3	47B	0.436	4.5	3000	564
4	47B	0.414	7.0	3500	564

Compressive strength was collected from the results of 7, 28 & 56 days; respectively, as it is shown graphically in Figure 1.

Figure 1. Compressive strength results

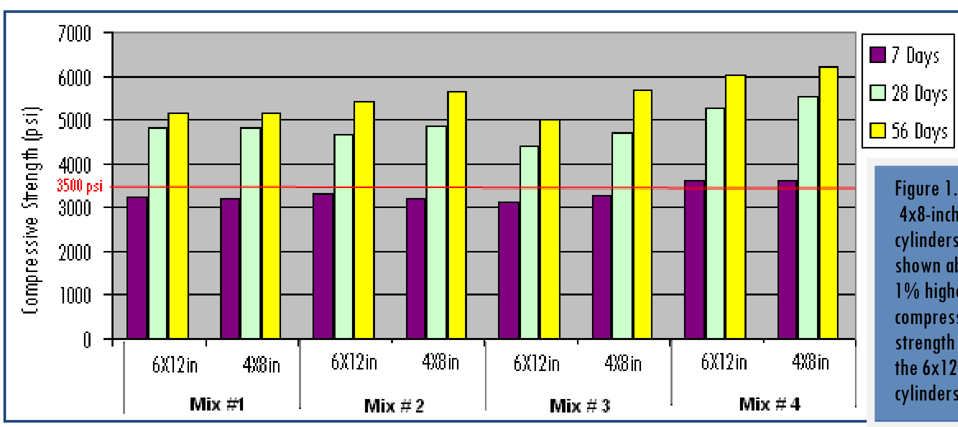


Figure 1. 4x8-inch cylinders have shown about a 1% higher compressive strength than the 6x12-inch cylinders.

TO DATE INVESTIGATION PROGRESS:

In 2005, 20 laboratories documented to ASTM the close correlation between the 4x8 and 6x12 inch cylinders in compressive strength.

In 2006, ASTM C 31 allowed the use of 4x8 inch cylinders in lieu of 6x12 inch cylinders when job specifications permitted their use.

In 2007 through 2009, NDOR followed up with the 2007 ASTM C 31 which stated, "The cylinder diameter shall be at least 3 times the nominal maximum size of the coarse aggregate"; therefore, the largest aggregate size allowed would be $1^{5}/_{16}$ inch. NDOR's spec. specifies the coarse aggregate to be used in paving and structures will have a target value of 100% passing with a tolerance of -8% on the 1 inch sieve. NDOR is currently investigating what percent is passing the $1^{1}/_{4}$ sieve. Two projects will be selected in the next construction season, to collect more compressive strength data for comparing the 4x8inch and 6x12 inch cylinders. Depending on these results, NDOR may require the 4x8 inch cylinder in lieu of the 6x12 inch cylinder for compressive strength in the future. After an in depth testing and correlation NDOR with several projects was performed and compressive strength data was analyzed. The results were within the 1% deference on the 4x8 inch cylinders.

The Table 2. Shown the evaluation performed in different highways type of projects.

SAMPLE ID#	PROJECT NUMBER	AGE DAYS	COMPRESSIVE STRENGTH LBS /SQ IN CYLINDER SIZE		Percent Average %
			6X12	4X8	
083714170019	STPD-BR-89-3(104)	7	3892	4281	1.10
083714170020	STPD-BR-89-3(104)	7	3565	3697	1.04
083714170029	STPD-BR-89-3(104)	7	3986	3857	0.97
083714170019	STPD-BR-89-3(104)	28	5485	5559	1.01
083714170020	STPD-BR-89-3(104)	28	4878	5483	1.12
083714170029	STPD-BR-89-3(104)	28	4959	5204	1.05
083410540052	NH-30-4(103)	7	3352	3623	1.08
083410540052	NH-30-4(103)	28	4861	5415	1.11
N/A	NH-80-9(837) SCC concrete	7	5060	5620	1.11
N/A	NH-80-9(837) SCC concrete	28	6870	6920	1.01
Average					1.06

Results were comparable for cylinders with $f'_c < 5000$ psi within Nebraska Department of Roads Class of Concrete. Also, these results correlated with National Studies performed on the subject. Due to the results found Nebraska Department of Roads starting July 1, 2010 4x8 cylinders will be allow to be used on all NDOR & Federally Funded Projects. This change will be reflected in the sampling guide and in Site Manager on July 1, 2010. Therefore, when using 4x8 molds, concrete should be place in the molds in two lifts and rodded 25 times using a 3/8 by 12 inch rod. Also, when testing the 4X8 specimens, 2 cylinders will be made and averaged for one test result. The 6X12 cylinder molds will be discontinued January 1, 2011 for NDOR Staff. For LPA Projects, consultants will still have the option of using 6X12 cylinders.
Starting July 1, 2010 4x8 cylinders will be allow to be used on all NDOR & Federally Funded Projects.

RDT

Brief

Research Investigation 03-038
Research Report 04-005

February, 2004

Comparison of Compressive Strengths Using 4x8 vs. 6x12 Cylinders for Prestress Concrete

Description:

Recently, prestress/precast companies are requesting to use smaller cylinder specimens, in particular 4 by 8-in. cylinders, for concrete compressive strength tests. The Missouri Department of Transportation (MoDOT) currently allows only the standard 6 by 12-in. cylinders in prestress fabrication. With smaller cylinders a person can handle them easier, spend less time and effort preparing them, and use less material. However, there is a debate over the strengths of the 4 by 8-in. cylinders compared to 6 by 12-in. cylinders. Typically, strengths of 4 by 8-in. cylinders are known to be higher than strengths of 6 by 12-in. cylinders for the same mix at the same age. Therefore, a laboratory research project was conducted to determine if there could be a comparison between 4 by 8-in. cylinders and 6 by 12-in. cylinders and then a correlation established.

Three mix designs were used representing MoDOT's Class A-1 concrete used in prestress production. Each mix composed of three batches to make 24 specimens, consisting of twelve 6 by 12-in. cylinders and twelve 4 by 8-in. cylinders. Fresh concrete characteristics are listed in Table 1.

Table 1 - Fresh Concrete Characteristics

Mix No.	Batch	w/c ratio	Slump (in)	Air (%)	Cementitious Content (sacks/yd^3)
	A	0.385	2.00	5.6	6.40
1	B	0.385	3.50	7.8	6.40
	C	0.385	2.50	6.0	6.40
Average		**0.385**	**2.67**	**6.5**	**6.40**
	A	0.345	3.00	6.6	7.20
2	B	0.345	2.25	5.7	7.20
	C	0.350	1.50	5.3	7.20
Average		**0.347**	**2.25**	**5.9**	**7.20**
	A	0.315	1.00	4.9	8.00
3	B	0.315	2.00	4.6	8.00
	C	0.315	0.75	3.9	8.00
Average		**0.315**	**1.25**	**4.5**	**8.00**

Research Development and Technology

Missouri Department of Transportation

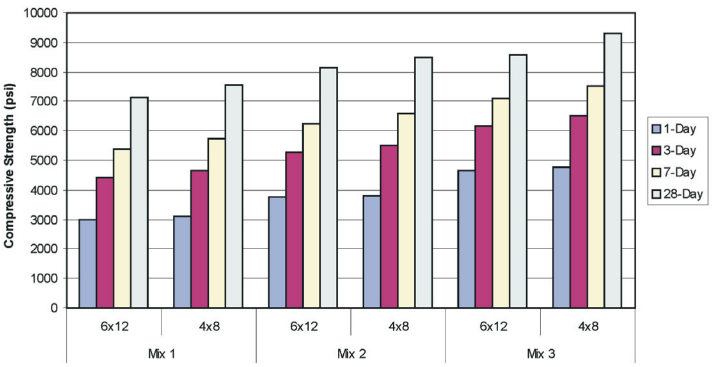
1617 Missouri Blvd.
P.O. Box 270
Jefferson City,
Missouri 65101

Appendix H - MoDOT Study Research Notes

Laboratory Results and Findings:

Compressive strength data was collected from 1, 3, 7 and 28 days concrete test specimens from both the 4 by 8-in. cylinders and 6 by 12-in. cylinders. Three specimens per age per mix were tested. Figure 1 graphically illustrates the average compressive strengths of each mix design.

Figure 1 - Average Compressive Strength



The slump and air tests were conducted on all mixes according to AASHTO T119 and AASHTO T152, respectfully. The laboratory specimen fabrication and curing was performed in accordance with AASHTO T126. The compressive strength test for the 4 by 8-in. cylinders and the 6 by 12-in. cylinders was done according to ASTM C1231 and AASHTO T22, respectfully.

The percent differences between the 4 by 8-in. and the 6 by 12-in. cylinders were calculated for the three mixes and are listed in Table 2. The calculations assumed that the 4 by 8-in. cylinders would break higher than the 6 by 12-in. cylinders and are indicated by positive values.

Table 2 - Percent Difference

Mix No.	Percent Difference			
	1-Day	3-Day	7-Day	28-Day
1	+4%	+5%	+6%	+6%
2	+1%	+4%	+5%	+4%
3	+2%	+5%	+6%	+8%
Avg.	+2%	+5%	+6%	+6%

Consistently, the 4 by 8-in. cylinders broke higher that the 6 by 12-in. cylinders. In only two individual cases the 4 by 8-in. cylinder broke lower (less than 30 psi) than the 6 by 12-in. cylinder. The maximum percent difference between an individual 4 by 8-in. cylinder and an individual 6 by 12-in. cylinder was +10%. Generally, the difference in compressive strengths between the 4 by 8-in. cylinders and the 6 by 12-in. cylinders increased over time.

Based on the compressive strength differences observed in this study, a multiplier of 0.94 applied to the results of the 4 by 8-in. cylinders should provide reliable compressive strength acceptance data, which can be used in lieu of 6 by 12-in. cylinder strength data. This would enable the use of 4 by 8-in. cylinders on a routine basis resulting in easier handling and saving in time, effort and material.

Recommendations:

Based on the laboratory results from this study, the following recommendations were made:

- Allow the use of 4 by 8-in. cylinders with a correction factor of 0.94 when determining compressive strength acceptance of MoDOT Class A-1, prestress, concrete at the plant with a semi-controlled environment.
- When fabricating the 4 by 8-in. cylinders, AASHTO T 23 requirements shall be followed, which specifies a "small rod" and two equal depth layers, rodded 25 times per layer.
- The retainer used with neoprene pads when testing for compressive strength of the 4 by 8-in. cylinders should be constructed according to ASTM C 1231.

Implementation:

MoDOT's Construction and Materials Functional Unit has recently revised Field Section 705, Prestressed Concrete Members for Bridges, in the Materials Manual to incorporate the results of this study. When finalized, this section will be found in the Materials Manual, Field Section 705.3.8.1, Concrete Testing.

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METHOD OF TEST FOR MAKING AND CURING CONCRETE TEST SPECIMENS IN THE FIELD

A. SCOPE

This test method describes the procedure for making, handling, and curing concrete specimens from representative samples of fresh concrete in the field.

B. PROCEDURE

Conduct the test in accordance with ASTM C31/C31M-19 except for the following:

1. Add to the end of Section 4.1:

   4.1.1 _Where referenced in the Standard Specifications, "Method 1" will be understood as Standard Curing in ASTM C31-19. "Method 2" and "Method 3" will be understood as Field Curing in ASTM C31-19.

2. Replace the 1st paragraph of Section 5.2 with:

   Cylinder Molds – 6 in. x 12 in. cylinder molds with lids conforming to the requirements of ASTM C470-15 must be used.

3. Replace *Practice C172/C172M* in the 1st paragraph of Section 7.1 with:

   Practice C172/C172M-17.

4. Replace Section 8 with:

   8. RESERVED

5. Replace the 2nd sentence in the 1st paragraph of Section 9.5.1 with:

   The top surface of freshly made cylinders must not be capped using neat portland cement paste.

6. Add to end of Section 12:

12.2 Section 12.2 applies to concrete cylinders.

12.2.1 Form TL-0502 sample identification card must be complete. There should not be any blank spaces. Designation of concrete strength must be included in Remarks field of TL-0502.

12.2.2 Source of aggregates should indicate the deposit from which the aggregates were obtained, such as "Kaiser-Radum" or "Chevreaux-Bear River" and not the batch plant.

12.2.3 A uniform system of marking cylinders is used. This system consists of the contract number, the sample number, and the date cast. The sample number consists of a series of digits separated by dashes to indicate: method of storage for curing, age at which cylinder(s) are to be tested, and the cylinder number of the pair, or the group of 5, which is to be tested. Use a flow pen to mark each sample can.

Example: Contact No. 09-100844
Sample No. 1-28-1/5
Date Cast ________________

Where: In the sample number shown above, the first digit indicates Method 1 storage for curing (use only one digit for this designation). The second group of digits indicates that the cylinder is to be tested at 28 days (use 2 digits for the test age). The third symbol (1/5) indicates that it is the No. 1 cylinder of the 5-cylinder trial batch sample (the No. 2 cylinder would be marked 2/5, etc.).

C. REPORTING OF RESULTS

RESERVED

D. HEALTH AND SAFETY

It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Prior to handling, testing, or disposing of any materials, testers must be knowledgeable about safe laboratory practices, hazards and exposure, chemical procurement and storage, and personal protective apparel and equipment.

Refer to the Safety Manual for your Laboratory.

End of Text
(California Test 540 contains 3 pages)

4x8 Cylinder Implementation Plan

Implementation plan to ensure a successful statewide roll out of the upcoming change to 4x8 cylinders for concrete strength testing.

Objectives

Develop an action plan for implementation that includes notification to stakeholders, manual updates, and additional equipment needs.

Summary of Action Item

Notification

- Develop a 1-page flyer documenting changes to fabrication and testing procedures. Flyer will include a comparison between the requirements of 6x12 and 4x8 cylinders, including fabrication/testing procedures and acceptance requirements.

  Target December 2019 – Tom Collins
  Status: Flyer is being developed

- Construction Policy Directive
  Draft CPD notifying Deputies, Construction Managers, Construction Engineers, and Resident Engineers. Roll out dependent on CTG's acceptance of Working Group recommendation.

  Target April 2020 – Samir Ead
  Status: On hold until PMPC work product is completed

- Perform outreach to notify stakeholders of upcoming changes.
  - Industry Outreach
    Develop PowerPoint to present upcoming changes at CalCIMA conference on November 19, 2019 in Napa, CA

    Target November 2019 – Patrick Lo
    Status: PPT has been created and reviewed by members of PMPC CTG. PPT submitted to CalCIMA

  - Office of Structures Construction
    1-page flyer distributed to OSC staff during Winter Training 2020.

    Target December 2019 – Tom Collins
    Status: Flyer under development. Distribution on hold until Winter Training begins

  - IA/JTCP
    Notify lab managers, technicians, and all labs performing concrete testing (See 'Training and Certification' for more information). Utilize SIAD to identify and notify stakeholders.

    Notification will include:
    - Email memorandum
    - 1-page flyer

Target April 2020 – JeremyPeterson-Self and Veer Nanugonda
Status: On hold until PMPC work product is completed

- RE Meetings
  Present changes during RE Meetings. Held the first quarter of the calendar year. Topics presented by METS Representatives. PowerPoint developed by Cortney Vanhook.

  Target February 2020 – Cortney Vanhook
  Status: Draft PPT is being developed

- DME Meetings
  Notify DMEs of upcoming changes during quarterly DME meeting.

  Target October 2019 – Various
  Status: Presented changes during October 2019 DME meeting. Next DME meeting: January 2020

Manual and Specification Updates (Construction, Design, OSC)

- Standard Specifications/Revised Standard Specification
  - Draft RSS specifying use of 4x8-in. cylinder for acceptance testing
  - Collaborate with Structure Specification Research and Development Branch and Structures IQA to ensure RSS language coincides with other Department manuals and guides

  Target April 2020 – Patrick Lo and METS Concrete Committee
  Status: On hold until PMPC work product is completed

- Construction Manual
  Revise testing requirements and documentation in Construction Manual including:
  Add Example 6-1.3 Sample Cylinder Label
  Add additional sample label for three-cylinder sample (page 6-1.12)
  Add (3)-4x8 cylinders
  Table 6-1.17 Materials Acceptance Sampling and Testing Requirements (pg. 6.1-45 and 6.1-47)
  Concrete > 3600 psi
  Concrete < 3600 psi
  Minor Concrete - tested when concrete quality is questionable
  Add 2 cylinders – 4x8 inches to:
  Table 6-1.18 Materials Acceptance Sampling and Testing Requirements (pg. 6-1.49)
  Prestressed Tendon Grout
  Add 3 – 4x8 cylinders = one test
  6-305D (1) Number of Cylinders Required for a "Test" (pg. 6-3.5)

  Target April 2020 – Samir Ead
  Status: On hold until PMPC work product is completed

- Concrete Technology Manual
  Revise fabrication and testing requirements in the Concrete Technology Manual

Target April 2020 –Tom Collins
Status: On hold until PMPC work product is completed

Training and Certification (JTCP/IA)

- Determine certification requirements to fabricate and test concrete cylinders
    - Technicians performing testing of concrete cylinders are required to be certified under CT 521 by Independent Assurance
    - Technicians performing fabrication of concrete cylinder specimens are required to be ACI Field Tech Level 1 certified.

  Target March 2020 – Jeremy Peterson-Self and Veera Nanugonda
  Status: Ongoing. On hold until PMPC work product is completed

- Identify demand on JTCP and IA to certify technicians for ACI Field Tech Level 1 and CT 521
    - Perform analysis of current technicians certified under current CT 521. Determine if recertification is necessary for 4x8-in. cylinders.
    - Technicians who currently fabricate specimens per CT 540 must be ACI Field Tech Level 1 certified. No additional training/certification required to fabricate 4x8-in. cylinders

  Target March 2020 – Jeremy Peterson-Self and Veera Nanugonda
  Status: Ongoing. On hold until PMPC work product is completed

Equipment Needs

- Materials and equipment for fabrication and testing of specimens
    - Perform statewide survey of equipment needs to perform fabrication and testing of 4x8-in. concrete cylinders. Distribute survey to DMEs statewide.
      Equipment required by laboratory to perform fabrication and testing of 4x8-in. cylinders:
        - 3/8" diameter tamping rod
        - Sulfur Capping Jig for 4x8-in. cylinders
        - Spacer for compression testing machine

      Target December 2019 – Patrick Lo
      Status: Survey has been distributed. Currently collecting responses

    - Calculate cost for equipment
      Analyze survey results and calculate estimated cost to procure equipment

      Estimated equipment costs:
        - 3/8" rods – Estimated total cost $3k
          Estimated: 25 rods per district
        - Capping Jig – Estimated total cost $10k
          Estimated: 2-3 jigs per district
        - 4" spacer for compression testing – Estimated total cost $10k
        - Estimated: 2-3 spacers per district

      Target December 2019 – Patrick Lo
      Status: Ongoing. Contingent on survey results

- Capping jig fabricated by METS Machine Shop
  - Fabricate capping jig for 4x8-in. cylinders to ASTM specifications.
  - Machine Shop will custom make jigs with spring-loaded release mechanism and removeable plates to aid in resurfacing.
  - Calculate estimated cost to fabricate jig in house. Compare with cost to purchase from vendor

  Target November 2019 – Machine Shop/Larry McCrum
  Status: Prototype is being developed

- Purchase equipment
  Equipment purchasing performed by METS and distributed to labs statewide

  Target March 2020 – Patrick Lo
  Status: Ongoing. Contingent on survey results

Changes to CT 540:
Making, Handling, and Storing Concrete Compressive Test Specimens in the Field

	Current CT 540 (Issued August 2010)	**Proposed CT 540 (Goal: Fall 2020)**
Temperature, Air Content, and Slump of fresh Concrete	Not mentioned	Measure and record
No. of Specimens per test	Two (2) 6 in. x 12 in. cylindrical specimens per test	Three (3) 4 in. x 8 in. or Two (2) 6 in. x 12 in. cylindrical specimens per test
Cylinder Specimen Size and Tamping Rod Size	• Cylinder Molds: **6 in. x 12 in.** conforming to ASTM C470 and ASTM C192 • Tamping Rod: round, straight steel rod with a diameter of **5/8 in. ± 1/16 in**. Length of at least 4 in. greater than the depth of the measure, but not more than 24 in. One or both ends of rod must be rounded to a hemispherical tip	• Cylinder Molds: **4 in. x 8 in.** conforming to ASTM C470 • Tamping Rod: A round, smooth, straight, steel rod with diameter **3/8 in. ± 1/16 in**. Length of at least 4 in. greater than the depth of the measure, but not more than 24 in. One or both ends of rod must be rounded to a hemispherical tip
Sieving fresh concrete	If the maximum size of the coarse aggregate exceeds 2 in., screen the concrete sample through a 2 in. sieve, discard the oversized aggregate, and remix the sample before molding the specimen.	If the nominal maximum size of the coarse aggregate exceeds 1 in., screen the concrete sample through a 1 in. sieve, discard the oversized aggregate, and remix the sample before molding the specimen. • Optional: In lieu of screening, 6 in. x 12 in. cylinders may be used if the nominal maximum aggregate size exceeds 1 in.
Consolidation	• Rodding only (5/8 in. diameter) • Place concrete in the molds in **three approximately equal layers**. • Rod each layer 25 times with the rounded end of the tamping rod	• Rodding only (3/8 in. diameter) • Place concrete in the molds in **two approximately equal layers** • Rod each layer 25 times with the rounded end of the tamping rod

Changes to CT 540:
Making, Handling, and Storing Concrete Compressive Test Specimens in the Field

	Current CT 540 (Issued August 2010)	**Proposed CT 540 (Goal: Fall 2020)**
Standard Curing (Method 1) Initial Curing Use: Acceptance testing	• **Initial** • Once the concrete has begun to set do not disturb the specimens for 20hr ± 4hr • Cylinders must be stored under conditions that maintain a temperature of 60°F to 80°F immediately adjacent to the specimens for a period of 1 day. At the end of 20hr ± 4hr, remove the lids from the molds and store the specimens in a water bath at a temperature of 60°F to 80°F	• **Initial** • Store standard cure specimens for a period of up to 48 hrs after molding • For concrete mixtures with f'c<6,000 psi, maintain the initial curing temperature between 60°F to 80°F • For concrete mixtures with f'c≥6,000 psi, maintain the initial curing temperature between 68°F to 78°F • Shield Specimens from direct exposure to sunlight. • Store specimens in an environment that controls the loss of moisture • Record the minimum temperature and maximum temperatures achieved for each set of specimens during the initial curing period
Standard Curing (Method 1) Final Curing Use: Acceptance testing	• **Final** • At an age of 2 days and no later than 5 days, replace lids. Reseal with masking tape and ship directly to the laboratory • At the laboratory, specimens must be stored at 73°F ±3°F	• **Final** • Cure specimens with free water maintained on their surfaces at all times at a temperature of 73.5°F ±3.5°F using water storage tanks or moist rooms • For a period not to exceed 3 hrs prior to test, standard curing temperature is not required provided free moisture is maintained on the cylinders and ambient temperature is between 68°F to 86°F

Changes to CT 540:
Making, Handling, and Storing Concrete Compressive Test Specimens in the Field

	Current CT 540 (Issued August 2010)	**Proposed CT 540 (Goal: Fall 2020)**
Field Curing (Method 2) Use: Determining in-place strength prior to applying loads or stresses	• Once the concrete has begun to set do not disturb the specimens for 20hr ± 4hr • Store specimens at or near the structure in a semi-sheltered location where the temperature of the test specimens will be approximately that of the concrete in the structure • Leave the specimens at the structure for as long a period of time as possible before shipping to the laboratory • During storage time at the structure, keep specimens in a plywood box (w/o insulation) or other suitable shelter but in a shaded location. • Avoid conditions of extreme exposure to wind and sun	• Store cylinder in or on the structure near to the point of deposit of the concrete represented as possible • Protect all surfaces of the cylinders from the elements in as near as possible the same way as the formed work • Provide the cylinders with the same temperature and moisture environment as the structural work • Test the specimens in the moisture condition resulting from the specified curing treatment • Specimens shall be removed from the molds at the time of removal of form work
Field Curing (Method 3) Use: Evaluating steam cured concrete for compliance with strength specifications	• Cylinders for determining time of prestressing loading must be cured in the same manner as the concrete in the member • Cylinders for determining compliance with 28-day strength requirements must be cured in the same manner as the member until completion of the steam curing process and then transferred to a water bath or moist room at 60°F to 80°F until tested • Testing may be done using the producer's equipment, provided the laboratory and tester meet the requirements of the Department's Independent Assurance Program	• See Field Curing (Method 2)