Low Embodied Carbon Concrete – Tilt-Up Panels Pilot Study

Laboratory and Field-Testing Report

FINAL REPORT

June 10, 2024

WJE No. 2023.4830.0

PREPARED FOR:

Breakthrough Energy Foundation

PREPARED BY:

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Laboratory and Field-Testing Report

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EXECUTIVE SUMMARY

Breakthrough Energy Foundation and ClimateWorks Foundation supported a collaboration effort between Clayco, Concrete Strategies Inc., Amazon Web Services (AWS), Ozinga, Kienstra Ready Mix, Davies-Crooks Associates, Sutter Engineering, Al Innis Consulting, Concrete Durability Associates, Nichols Consulting Engineers (NCE), and Wiss Janney Elstner (WJE) that constructed three mock-up tilt-up wall panels utilizing three concrete mixes with varying degrees of embodied carbon. The tilt-up wall design and construction were like typical tilt-up wall panels at AWS data centers. The three concrete mixes, included as part of this field pilot, are described as follows:

Mix 1 – Control was an ASTM C595 Type IL blended cement mix with proportions commonly used in tilt-up wall construction in AWS Data Centers. The embodied carbon of this mix is 209 kg CO_2 e/yd^3, which is 25% lower than the NMRCA regional benchmark.

Mix 2 – 25% Slag Cement was identical to Mix 1, but 25% of the ASTM C595 Type IL cement was replaced with ASTM C989 slag cement. The estimated carbon reduction is 19% as compared to control based on EPDs produced by Ozinga, and 39% lower than NMRCA regional benchmark.

Mix 3 – C1157. This mix contained a proprietary blend of cementitious materials which conforms to ASTM C1157, *Standard Performance Specification for Hydraulic Cement*. The estimated carbon reduction is 52% as compared to control based on EPDs produced by Ozinga, and 64% lower than NMRCA regional benchmark. The goal of this field pilot was to understand the performance of these three mixes and potential challenges encountered when using concrete mixtures with reduced embodied carbon. The field pilot included a rigorous laboratory evaluation program; field instrumentation with strain gages, thermocouples, and tilt meters; field observations of the construction of the panels; and field quality control testing.

Summary of Laboratory Evaluation Program

The laboratory evaluation program included assessment of plastic and hardened properties to evaluate performance of each mix and to make comparisons between the mixes. In the laboratory, all three mixes met the project requirements for plastic concrete properties (less than 3% air and a slump range from 6 to 9 inches), and all three mixes easily achieved the minimum 28-day design strength of 5,000 psi.

In general, Mix 1 and Mix 2 were comparable in plastic and hardened properties. Mix 3 differed from the other two mixes. Mix 3 was thixotropic; being easily flowable when energy is applied (during mixing) but stiff in appearance at rest and requiring more energy to initiate and maintain movement. This observation in the laboratory had implications during field demonstration related to the placement and finishing of the concrete. Additional efforts were needed to place, consolidate, and finish Mix 3 compared to Mix 1 and Mix 2.

Mix 3 also had a slightly faster initial set but significantly longer final set, with the heat of hydration of Mix 3 being much lower. In addition, Mix 3 had no observable or measurable bleed water as compared to Mix 1 and Mix 2. The setting time and bleeding characteristics of Mix 3 suggests adjustments to early age curing and finishing operations may be required, and the low heat of hydration would make Mix 3 susceptible to slower early age strength in colder temperatures.

The hardened concrete properties were comparable for Mix 1 and Mix 2. Compared to Mix 1 and Mix 2, Mix 3 had slower gain in properties (compressive strength, splitting tensile strength, and modulus of elasticity) at very early ages (less than 3 days) but had comparable or higher strength at later ages (greater than 7 days). Mix 3 had the lowest shrinkage potential and the highest bulk resistivity of the three mixes, both of which are desirable for limiting restrained shrinkage cracking and enhancing durability. Mix 3 did have a measured coefficient of thermal (CTE) of approximately 25% greater than Mix 1, the significance of this measurement needs to be further research and significance assessed.

Summary of Field Demonstration

Concrete was placed for the three tilt-up panels incorporating the three mixes on November 27, 2023, at Clayco's storage yard in St. Louis, Missouri. All three mixes were pumped, placed and finished successfully. The placement was done in cold ambient temperatures ranging from 26 to 45 °F, and ice had to be removed from the forms prior to concrete placement.

The finishing process for all three mixes included screeding using a vibratory screed or manually (for areas not accessible to vibratory screed), bull floating, and light power trowel finish after cessation of bleeding. Mix 1 and Mix 2 were easily finished. The thixotropic behavior of Mix 3 required the use of additional finishing aid to help close the surface during hand finishing.

All three panels were also successfully tilted into place. Panels made with Mix 1 and Mix 2 were tilted at 3 days as planned while Mix 3 was titled at 7 days due to slower strength gain associated with colder temperatures and low heat of hydration. In addition, the field cured cylinders for Mix 3 (which were used for the basis of tilting of the panels) were exposed to much colder temperatures due to not being insulated adequately. The lower heat of hydration of Mix 3 makes it susceptible to low temperatures where it cannot support the hydration reaction and can result in slower strength gain at low temperatures.

INTRODUCTION

Breakthrough Energy Foundation and ClimateWorks Foundation supported a collaboration effort between Clayco, Concrete Strategies Inc., Amazon Web Services (AWS), Ozinga, Kienstra Ready Mix, Davies-Crooks Associates, Sutter Engineering, Al Innis Consulting, Concrete Durability Associates, Nichols Consulting Engineers (NCE), and Wiss Janney Elstner (WJE) that included the development and implementation of a field pilot program to construct three mock-up tilt-up wall panels utilizing three separate concrete mixes with varying degrees of embodied carbon. The tilt-up wall design and construction were like typical tilt-up wall panels at AWS data centers. The three concrete mixes included as part of this field pilot are detailed in **Table 2** and described as follows:

Mix 1 – Control. A straight ASTM C595 Type IL blended cement mix with proportions commonly used in tilt-up wall construction in AWS Data Centers. This mix consisted of an ASTM C595 Type IL cement, no supplementary cementitious materials, a cement content of 564 pounds per cubic yard (lb./yd^3), and a water to cementitious materials ratio (w/cm) ratio of 0.48. This mix contained coarse and fine aggregate locally available to the field pilot location in St. Louis, Missouri.

Mix 2 – 25% Slag Cement (SC). Identical mix to Mix 1, but 25% of the ASTM C595 Type IL cement was replaced with ASTM C989 slag cement with the same w/cm (0.48) and cementitious content of 564 lb./yd^3. The estimated carbon reduction was 39% lower than NMRCA regional benchmark.

Mix 3 – C1157. This mix contained a proprietary blend of cementitious materials which conforms to ASTM C1157, *Standard Performance Specification for Hydraulic Cement*. The total cementitious content was 750 lb./yd^3, and the w/cm was 0.34. The estimated carbon reduction was 64% lower than NMRCA regional benchmark.

Based on the location of the field pilot program and the raw materials being used, the global warming potential of the three mixes were calculated to be 209, 169 and 100 kg CO_2 equivalents per cubic yard of concrete, respectively. The environmental product declarations (EPD) for these mixes are provided in the **Appendix A**.

Table 1. Embodied Carbon

Parameter	Mix 1 - Control	Mix 2 – 25% Slag Cement	Mix 3 – ASTM C1157 Cement
Embodied Carbon (kg CO_2 e/yd^3)	209	169	100
Percent Reduction from Control	-	19%	52%
Percent Reduction from NRMCA Benchmark*	25%	39%	64%

*277 kg COE2/yd^3 - NRMCA Regional Benchmark, 2021 for Great Lakes Region, 5,000 psi

The goal of this field pilot was to understand the performance of these three mixes and potential challenges encountered when using concrete mixtures with reduced embodied carbon. The field pilot included a rigorous laboratory evaluation program of the three mixes; instrumentation of the three wall panels with strain gages, thermocouples, and tilt meters; field observations of the construction of the panels, and field quality control testing. The following report summarizes these activities.

Table 2. Concrete Mix Designs[1]

Constituent	Description or Source	Units	Mix 1 - Control	Mix 2 - 25% SC	Mix 3 - C1157
Type IL Cement	St. Gen, MO	lbs/yd^3	564	423	--
Slag Cement	Holcim, Chicago, IL	lbs/yd^3	--	141	--
C1157 cement	Ozinga, Chicago, IL	lbs/yd^3	--	--	750
Coarse aggregate	Bluff City Materials, Alton, IL	lbs/yd^3	1775	1780	1740
Fine aggregate	Madison County Sand, Collinsville, IL	lbs/yd^3	1420	1400	1240
Water	n/a	lbs/yd^3	271	271	237
High-Range Water Reducer	ADVACAST 600, GCP	fl. oz.	26	26	30
Workability Enhancing admixture	ADVA XT, GCP	fl. oz.	--	--	22
Rheology modifying admixture	V-MAR F100, GCP	fl. oz.	--	--	45
Accelerating Admixture	OZ set	fl. oz.	--	--	262.5
W/C (not incl. admixtures)	--	--	0.48	0.48	0.32
W/C (incl. admixtures)	--	--	0.48	0.48	0.34
Target Air Content	--	%	1.5	1.5	1.5

Note: [1]Aggregate quantities presented in SSD condition, A "--" indicates that the material was not used in the mix.

LABORATORY TESTING PROGRAM

The raw materials for each mix were shipped from the concrete supplier, Kienstra in St. Louis, Missouri, with the ASTM C595 Type IL cement, ASTM C989 slag cement, and the proprietary ASTM C1157 cement being provided by Ozinga to WJE's laboratories in Northbrook, Illinois. Each mix was tested in the laboratory for plastic and hardened properties to assess performance and to make comparisons between the mixes. The following describes the raw material characterization and laboratory testing performed on each mix.

Raw Material Characterization

WJE characterized the properties of the raw materials by the following methods:

- **Absorption and Density.** The relative density and absorption of the coarse aggregate was measured in accordance with ASTM C127, *Standard Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate*, and the relative density and absorption of the fine aggregate was measured in accordance with ASTM C128, *Standard Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate*. This testing was performed to allow for appropriate moisture content adjustments during laboratory batching and for the mixture proportions to yield appropriately.

- **Aggregate Gradation.** The gradations of the coarse and fine aggregate were determined in accordance with ASTM C136, *Standard Test Method for sieve Analysis of Fine and Coarse Aggregates*.
- **Fineness and Density.** The Blaine fineness of the ASTM C595 Type IL cement, ASTM C989 slag cement, and the ASTM C1157 cement was measured per ASTM C204, *Standard Test Methods for Fineness of Hydraulic Cement by Air-Permeability Apparatus*, and the density was determined per ASTM C188, *Standard Test Method for Density of Hydraulic Cement*.
- **Particle Size Distribution.** A sample of each cement was sent to Particle Technology Labs (PTL) for particle size distribution (PSD) testing. The PSD was determined by liquid dispersed laser diffraction using a Malvern Mastersizer 3000.
- **Chemical Analysis.** The chemical composition of the cements was determined in accordance with ASTM C114 *Standard Test Methods for Chemical Analysis of Hydraulic Cement*.

Concrete Physical Testing

Each mix was batched and tested to characterize plastic properties, workability, setting characteristics, bleeding potential, concrete strength (compressive and split tensile), modulus of elasticity, drying shrinkage, coefficient of thermal expansion, and bulk resistivity. The goal of the testing was to determine if the proposed concrete mixes were applicable for field use prior to placement of the field pilot panels and to test the physical properties for comparison of the mixes and to make informed decisions regarding the lifting of the field cast mock-up panels. WJE batched each of the three concrete mixes and evaluated the following concrete properties:

- **Plastic Properties.**
  - Concrete slump, per ASTM C143, *Standard Test Method for Slump of Hydraulic-Cement Concrete*.
  - Air content, per ASTM C231, *Standard Test Method for air Content of Freshly Mixed Concrete by the Pressure Method*.
  - Unit weight, per ASTM C138, *Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete*.
  - Temperature, per ASTM C1064, *Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete*.
- **Setting Time.** Setting time was assessed according to ASTM C403, *Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance*. Measurement of the setting characteristics of the mixes were used to assess the impact on timing of finishing processes and construction schedule. Extended setting times would delay the finishing processes and associated construction schedule.
- **Heat of Hydration.** The total heat of hydration was measured in general according to ASTM C1702 *Standard Test Method for Measurement of Heat of Hydration of Hydraulic Cementitious Materials Using Isothermal Conduction Calorimetry*. The cementitious material was obtained from each mix by sifting the concrete through a No. 4 sieve. The mortar passing the sieve was collected and placed in an

isothermal calorimeter to measure the total heat generated by the cementitious material during the first 7-days.

- **Bleed Potential.** The bleed rate and total concrete bleed water was measured according to ASTM C232, *Standard Test Method for Bleeding of Concrete*. Understanding the bleed rate and total bleed potential is important from an early age curing and finishing standpoint. With less bleed water and lower bleeding rates, early age curing (preventing moisture loss) becomes more important to prevent plastic cracking. In addition, judgement on when to initiate the finishing process is affected with less bleed water.
- **Compressive Strength.** Compressive strength testing was performed at 1, 2, 3, 7, 14, 28, and 56 days per ASTM C39, *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*.
- **Splitting Tensile Strength.** Splitting tensile strength testing was performed at 1, 2, 3, 7, 14, 28, and 56 days per ASTM C496, *Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens*.
- **Modulus of Elasticity.** Modulus of Elasticity testing was performed at 1, 2, 3, 7, 14, 28, and 56 days per ASTM C469, *Standard Test Method Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression*. The modulus of elasticity of the mixes were compared to assess the effect of the changes to the mix design on this property of concrete. The modulus of elasticity gives an indication of the deflection (strain) of the tilt-up panels to applied stress.
- **Maturity.** Maturity curves and equations were developed for each mix for compressive and splitting tensile strength and modulus of elasticity in general accordance with ASTM C1074, *Standard Practice for Estimating Concrete Strength by the Maturity Method.* Maturity curves were developed through laboratory testing to help estimate the in-situ physical properties of the test panels based on ambient curing conditions at the field test site.
- **Drying Shrinkage.** Drying shrinkage was tested per ASTM C157, *Standard Test Method for Length Change of Hardened Cement Mortar and Concrete*, modified per current Amazon specifications for a 7-day moist cure in lieu of 28 days. The initial comparator reading was made at 24 hours after fabrication consistent with ASTM C157. The drying shrinkage potential of the mixes were compared to understand the mix changes effect on the drying shrinkage and ultimately cracking potential.
- **Coefficient of Thermal Expansion.** The coefficient of thermal expansion (CTE) was measured at 28 and 77 days per AASHTO T 336, *Standard Method of Test for Coefficient of Thermal Expansion of Hydraulic Cement Concrete*. The CTE is a measure of the change in concrete dimension due to changes in temperature.
- **Bulk Resistivity.** The bulk resistivity of the mixes at 28 days (moisture saturated), 35, 56, and 90 days (saturated in simulated pore solution (SPS)) was measured per AASHTO T 402, *Standard Method of Test for Electrical Resistivity of a Concrete Cylinder Tested in a Uniaxial Resistance Test*. This test method can provide an indication of the concrete's resistance to penetration of chloride ions and other fluids.

Raw Material Characterizations Results

The following paragraphs summarize the results of the material characterization portion with the details of the testing presented in **Appendix B**. The relative density and absorption values of the aggregates are provided in **Table 3**. Concrete batches were appropriately adjusted based on these absorption and specific gravity measurements.

Table 3. Aggregate Characterization Results

Aggregate	Source	Relative Density (SSD)	Absorption (%)
Fine Aggregate	Madison County Sand, Collinsville, IL	2.61	0.5
Coarse Aggregate	Bluff City Materials, Alton, IL	2.67	1.1

The Blaine fineness, density, and particle size distribution of the cementitious materials were measured and are provided in **Table 4**, with the particle distribution curves presented in **Figure 1**.

Table 4. Cementitious Material Characterization Results

Sample	Source	Blaine Specific Surface Area (m^2/kg)	Density (g/cm^3)	Particle Size Distribution (cum. vol. % less than indicated size (μm)		
				10%	50%	90%
Type IL	St. Gen, MO (Holcim)	438	3.15	1.82	10.7	32.1
Slag Cement	Chicago, IL (Holcim)	227	2.45	1.42	8.58	45.8
ASTM C1157 cement	CarbonSense (Ozinga)	329	2.90	2.31	12.0	33.9

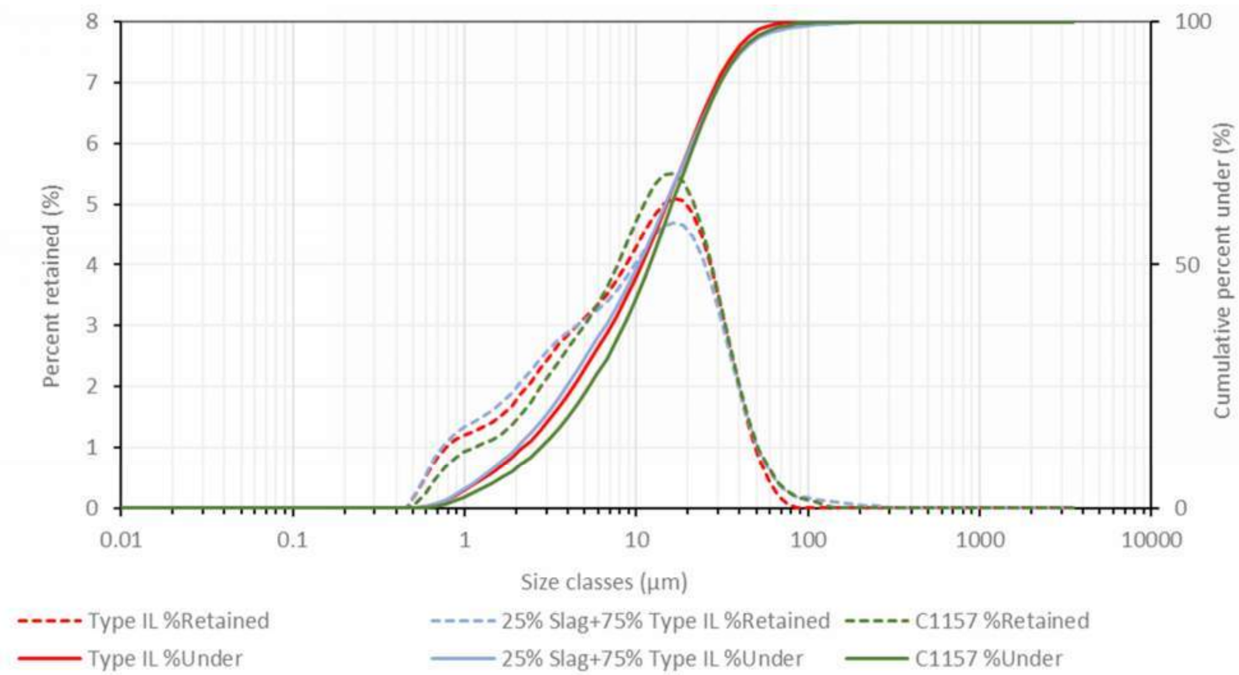

Figure 1. Particle size distribution curves for the cementitious materials used in the three mixes.

Table 5. Chemical analysis results (% by mass)

Oxide	Chemical Formula	Type 1L	Slag
Silicon dioxide, %	SiO_2	20.3	30.7
Aluminum oxide, %	Al_2O_3	5.2	8.8
Ferric oxide, %	Fe_2O_3	3.24	1.79
Calcium oxide, %	CaO	60.4	46.2
Magnesium oxide, %	MgO	2.3	8.3
Sulfur trioxide, %	SO_3	3.24	1.21
Loss on ignition, %	NA	4.8	2.1
Sodium oxide, %	Na_2O	0.24	0.26
Potassium oxide, %	K_2O	0.64	0.48
Equivalent alkalis, %	$Na_2O + 0.658K_2O$	0.66	0.58
Strontium oxide, %	SrO	0.06	0.05
Titanium dioxide, %	TiO_2	0.28	0.49
Phosphorus pentoxide, %	P_2O_5	0.15	0.06
Zinc oxide, %	ZnO	0.01	0.01
Manganic oxide, %	Mn_2O_3	0.042	0.163
Chromium oxide, %	Cr_2O_3	0.006	0.008
Sulfide Sulfur, %	S	NA	0.63
Chloride, %	Cl	0.028	0.067
Carbon dioxide, %	CO_2	3.9	1.7

Concrete Physical Testing Results

Plastic Properties

For each of the mixes, the laboratory measured plastic properties (concrete slump, air content, unit weight and temperature) are shown in **Table 6**. Consistent with typical pumpable concrete supplied for tilt-up walls, the target was to have a slump from 6 to 8 inches with an air content less of 2.5%. Another goal of the laboratory batching was to achieve a cohesive and finishable mix; this was accomplished in all mixes and was assessed subjectively during the batching, and placement and finishing of subsequent test samples.

It was observed that Mix 3 had a thixotropic behavior. When at rest, the mix lost workability and required significant energy to move around. However, the concrete regained its workability with application of external energy (restarting the mixer or using external vibration). This has implications for placement and finishing in the field.

The setting characteristics of each mix were measured in accordance with ASTM C403, with the results presented in **Table 7**. The initial and final setting characteristics of the mixes did not vary significantly for Mix 1 and 2. Mix 3 had slightly faster initial set, but significantly longer final setting time compared to the control – Mix 1. This may suggest adjustment to timing of finishing operations of Mix 3, compared to Mix 1 and Mix 2, which was further assessed during the field placement as noted in Section 3 of this report.

Table 6. Plastic Properties

Test		Unit	Mix 1 - Control	Mix 2 - 25% SC	Mix 3 - C1157
Slump	ASTM C143	in.	7	8	9
Temperature	ASTM C1064	°F	74	74	77
Unit weight	ASTM C138	lb/ft^3	148.7	149.4	150.5
Air content	ASTM C231	%	2.0	2.0	2.1

Table 7. Setting Times

Test		Unit	Mix 1 - Control	Mix 2 - 25% SC	Mix 3 - C1157
Setting time, Initial	ASTM C403	h:mm	3:20	3:15	2:55
Setting time, Final	ASTM C403	h:mm	4:40	4:40	7:10

The total heat of hydration for the three mixes was calculated and is presented in **Table 8**. Mix 2 generated 15% less heat than the control (Mix 1) while Mix 3 generated 61% less heat than control during the first 24 hours. However, over the first 7 days (168 hours), the total heat of hydration for Mix 2 was only 8% lower than Mix 1, while Mix 3 was 62% lower. Heat of hydration is the heat generated during the chemical reaction between the cementitious materials and water. This heat dissipates from the surface of concrete elements causing a temperature differential to occur between the interior regions and the surface. This non-uniform cooling causes thermal stress to develop, which can lead to cracking. In addition, during cold weather placements, it is the heat of hydration that is retained by insulating blankets and maintains the chemical reactions and strength gain. Having a lower heat of hydration means less potential to retain heat and can result in slower strength gain during cooler temperatures. Similar to the total heat released, the rate at which the heat is released is also important to prevent thermal stress. The rate of heat release was 65% lower with Mix 3 compared to the control mix.

Table 8. Total Heat Generated (in J/g)

Sample ID	24 Hours	48 Hours	72 Hours	168 Hours
Mix 1 - Control	195	239	262	292
Mix 2 - 25% SC	165	207	232	269
Mix 3 - C1157	76	92	98	110

The bleeding rate and total bleed of each mix was performed in accordance with ASTM C232, with the results from these tests shown in **Figure 2**. As can be seen from this plot, the bleeding rate and total bleed is comparable for Mixes 1 and 2, with Mix 3 having no observable or measurable bleed.

It was observed that the bleeding finished at about the same time for mixes 1 and 2. However, no bleeding was observed with Mix 3. Because of this, early age curing of Mix 3 becomes more important to prevent moisture loss from the surface and associated plastic shrinkage cracking. Further details of the setting time and bleed testing are presented in **Appendix C.**

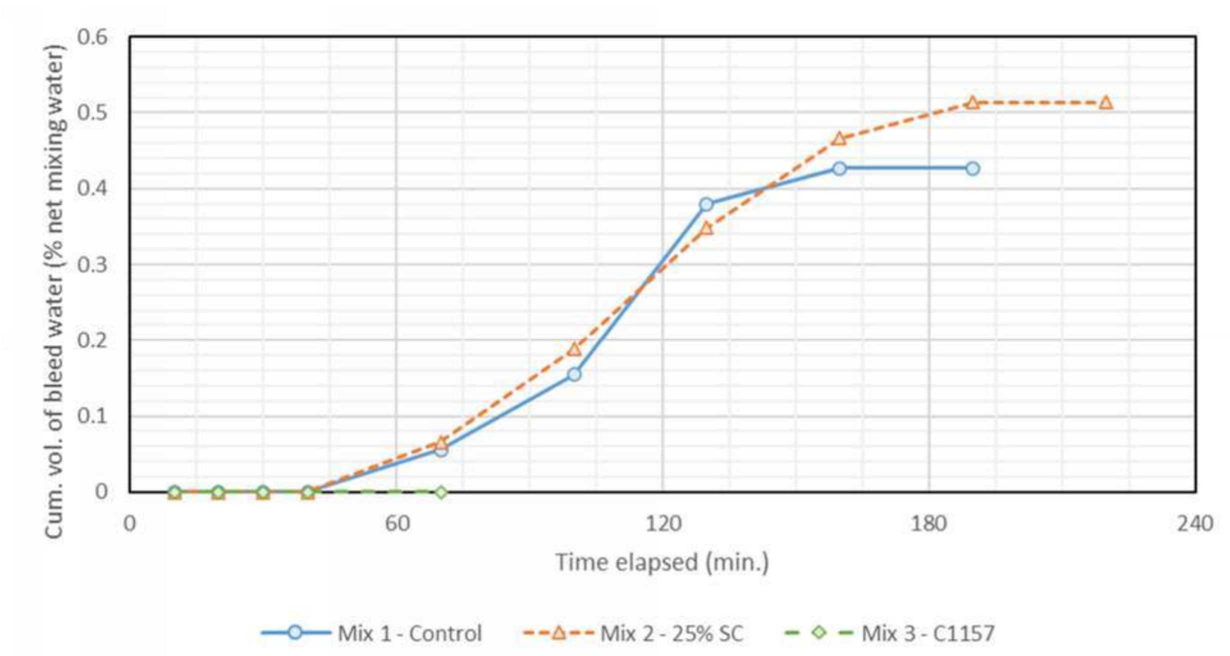

Figure 2. Bleed Test Results.

Hardened Concrete Testing Results

The hardened concrete testing results of the three mixes are summarized in the following paragraphs and detailed in **Appendix D**.

Compressive Strength

The compressive strength of each mix was tested on three 4x8 cylinders at 1, 2, 3, 7, 14, 28, and 56 days, with results presented in **Table 9** and plotted in **Figure 3**. Mix 3 had slower strength gain at very early ages up to 3 days but by 28 and 56 days had the highest compressive strength.

Table 9. Compressive Strength Testing Results (psi)

Age (days)	Mix 1 - Control	Mix 2 - 25% SC	Mix 3 - C1157
1	3,040	2,670	1,860
2	3,950	3,790	3,490
3	4,740	4,460	4,210
7	5,390	5,540	5,464
14	5,650	6,140	6,100
28	6,420	6,620	6,960
56	6,860	7,210	7,620

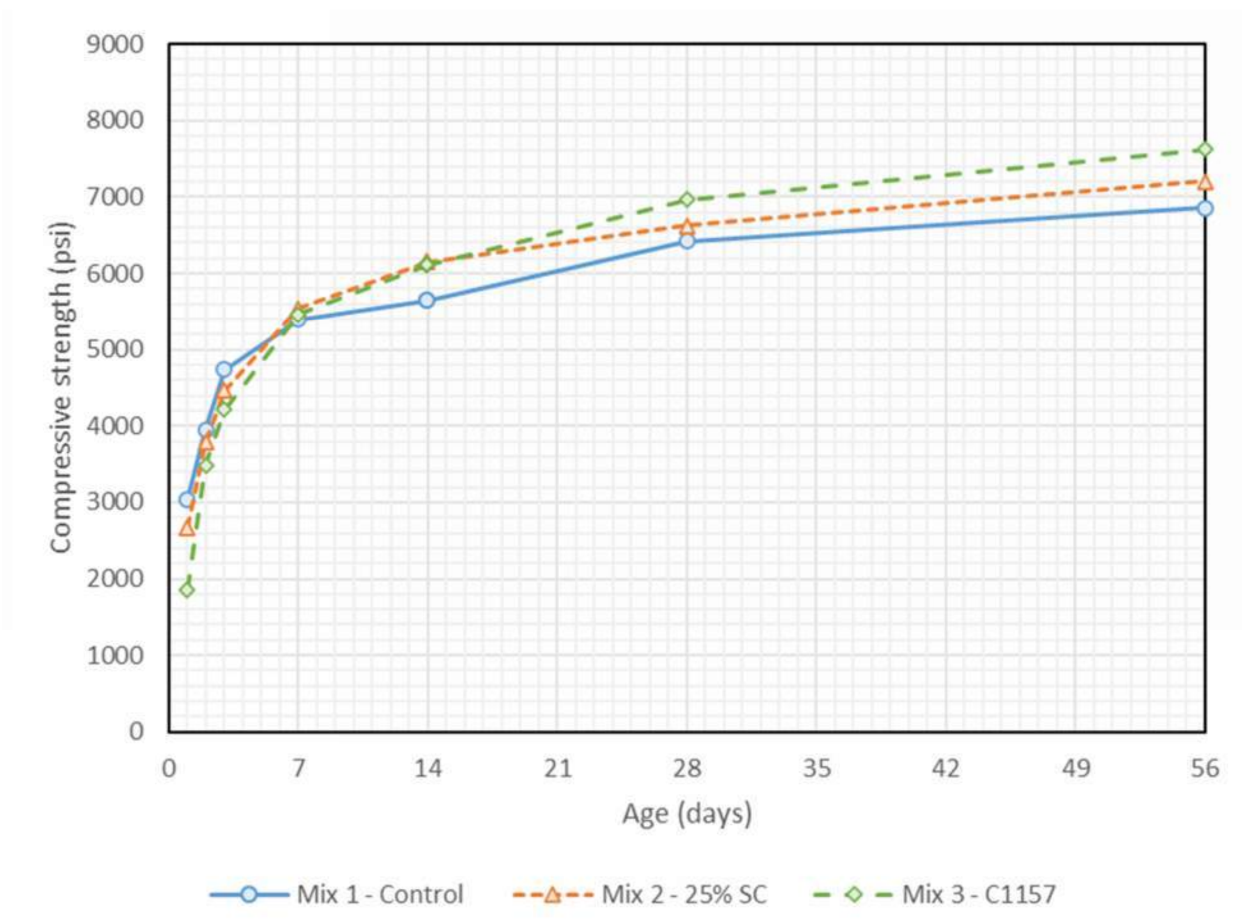

Figure 3. Compressive Strength Results.

Splitting Tensile Strength

The splitting tensile strength of each mix was tested on three 4x8 cylinders at 1, 2, 3, 7, 14, 28, and 56 days, with results presented in **Table 10** and plotted in **Figure 4**. Mix 1 and Mix 2 have comparable splitting tensile strengths at all ages. Mix 3 had lowest 1-day strength but comparable to higher splitting tensile strength values at later ages.

Table 10. Splitting Tensile Strength Results (psi)

Age (days)	Mix 1 - Control	Mix 2 - 25% SC	Mix 3 - C1157
1	398	345	263
2	457	450	503
3	488	452	522
7	633	572	578
14	597	608	690
28	655	688	705
56	658	728	700

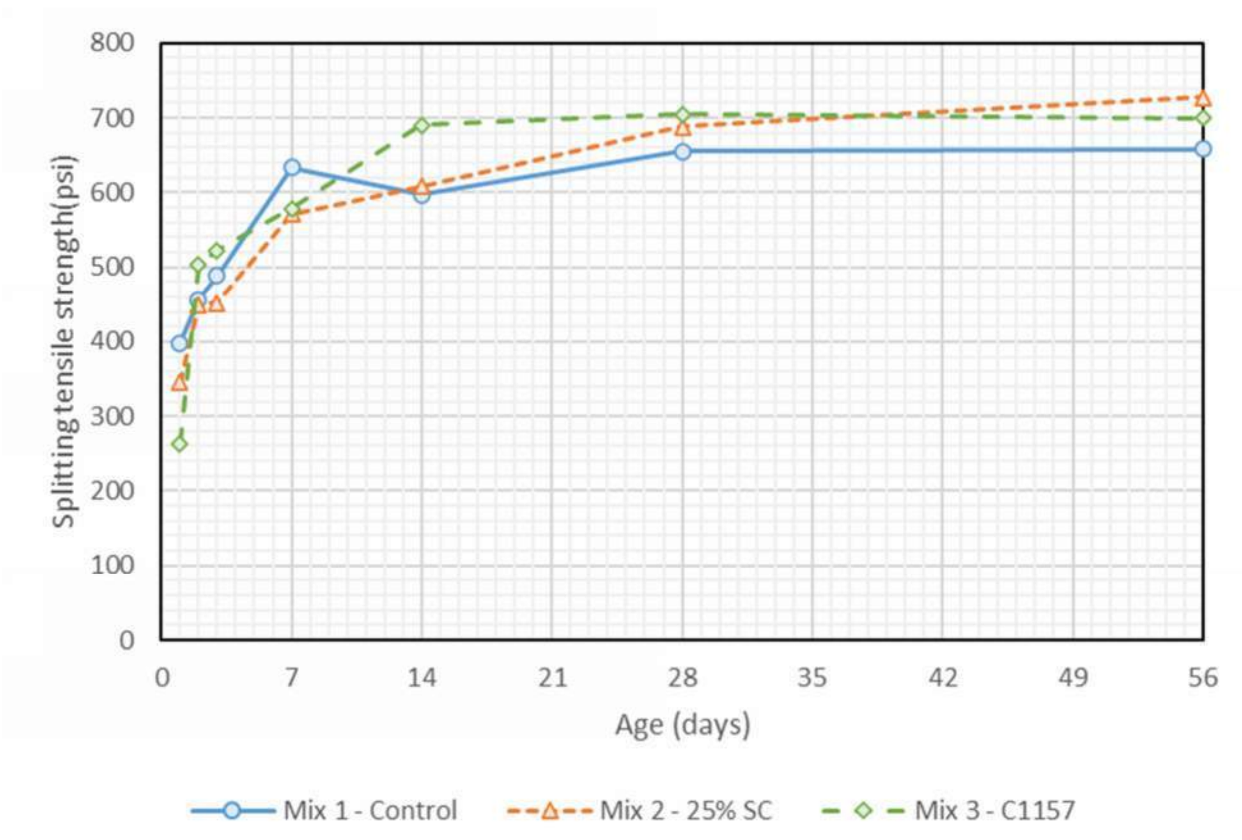

Figure 4. Splitting Tensile Results.

Modulus of Elasticity

The modulus of elasticity of each mix was assessed on two 4x8 cylinders at 1, 2, 3, 7, 14, 28, and 56 days in accordance with ASTM C469 with results presented in **Table 11** and plotted in **Figure 5**.

Table 11. Modulus of Elasticity Results (psi)

Age (days)	Mix 1 - Control	Mix 2 - 25% SC	Mix 3 - C1157
1	3,675,000	3,600,000	3,212,500
2	4,050,000	4,250,000	4,500,000
3	4,350,000	4,412,500	4,737,500
7	4,900,000	4,712,500	5,350,000
14	4,812,500	4,975,000	5,387,500
28	5,037,500	5,250,000	5,450,000
56	5,225,000	5,262,500	5,587,500

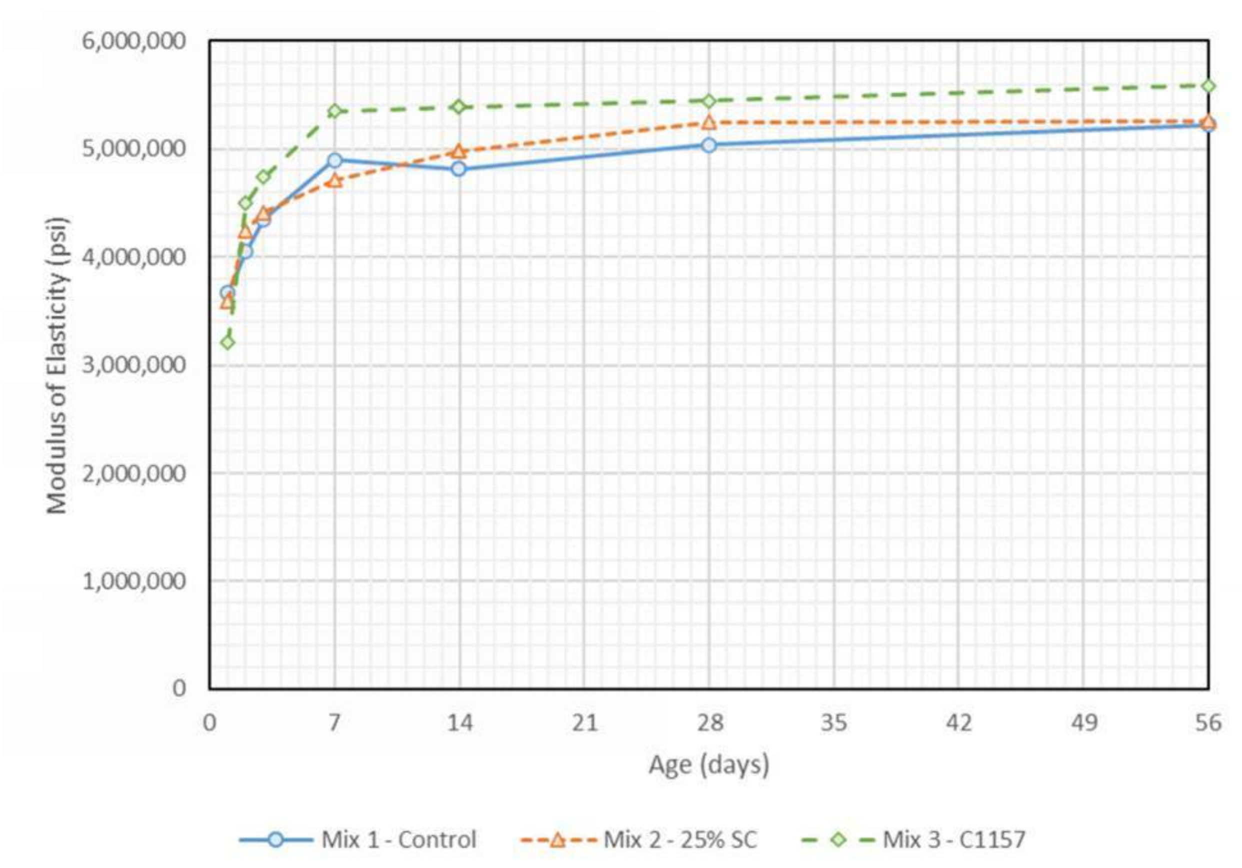

Figure 5. Modulus of Elasticity Results.

Maturity Curves

The maturity curves were developed per ASTM C1074 for all three mixes with respect to compressive strength, splitting tensile strength, and modulus of elasticity. Two 4x8 inch cylinders were instrumented with maturity meters to measure the time and temperature history prior to testing compressive strength, splitting tensile strength, and modulus of elasticity at 1, 2, 3, 7, 14, and 28 days of age. Maturity equations and curves for compressive strength, splitting tensile strength, and modulus of elasticity are shown in **Figure 6**, **Figure 7**, and **Figure 8**, respectively. The gain in physical properties (maturity) of concrete is related to its hydration temperature history (product of the concrete temperature and age). Especially when placing concrete in low temperatures, maturity of the concrete can help estimate the strength for formwork stripping or in this case, lifting of the tilt-up panels.

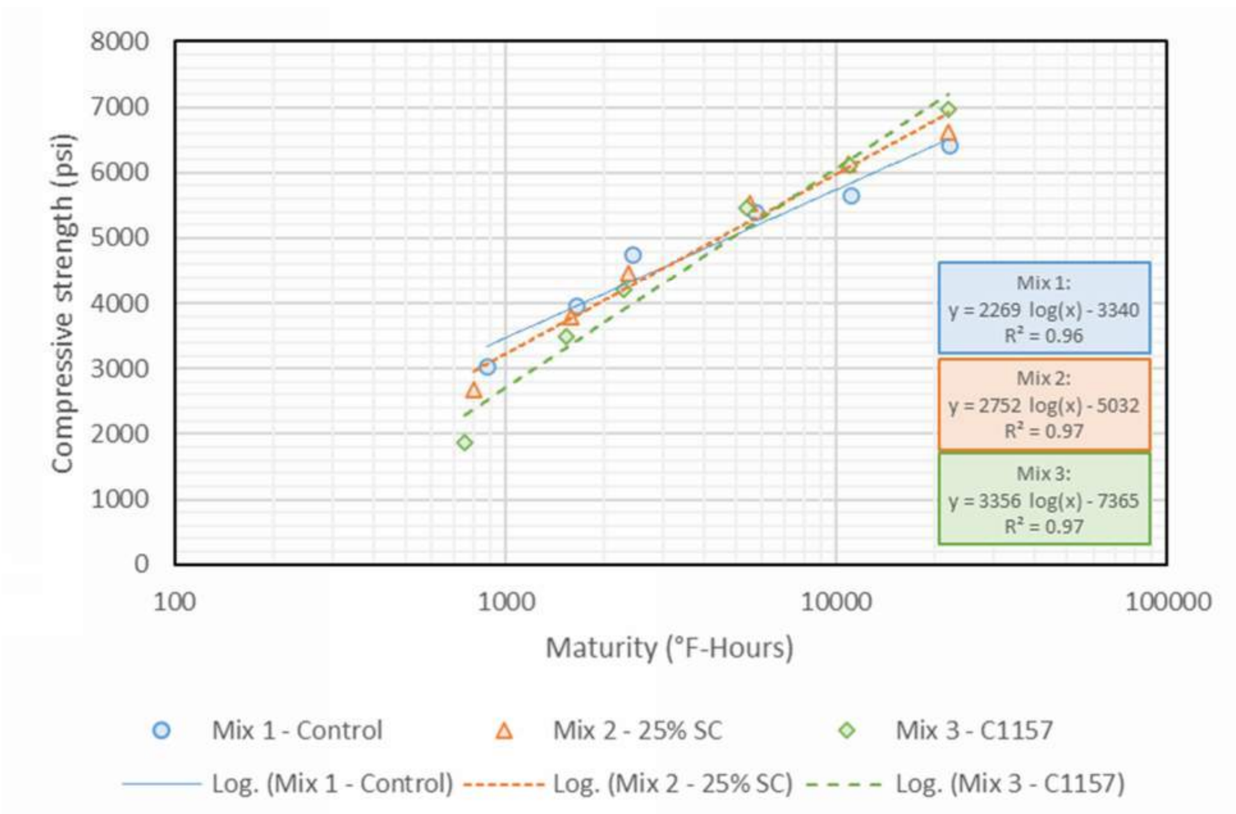

Figure 6. Maturity Plot for Compressive Strength.

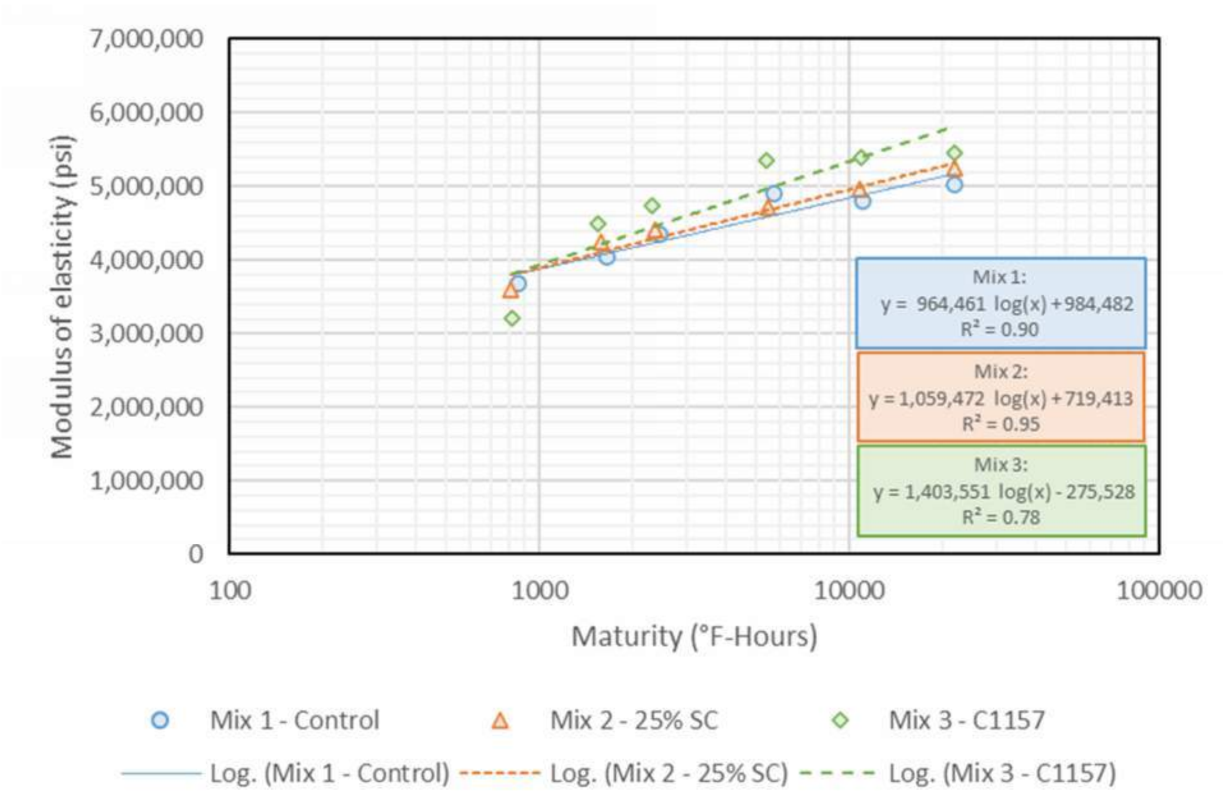

Figure 7. Maturity Plot for Splitting Tensile Strength.

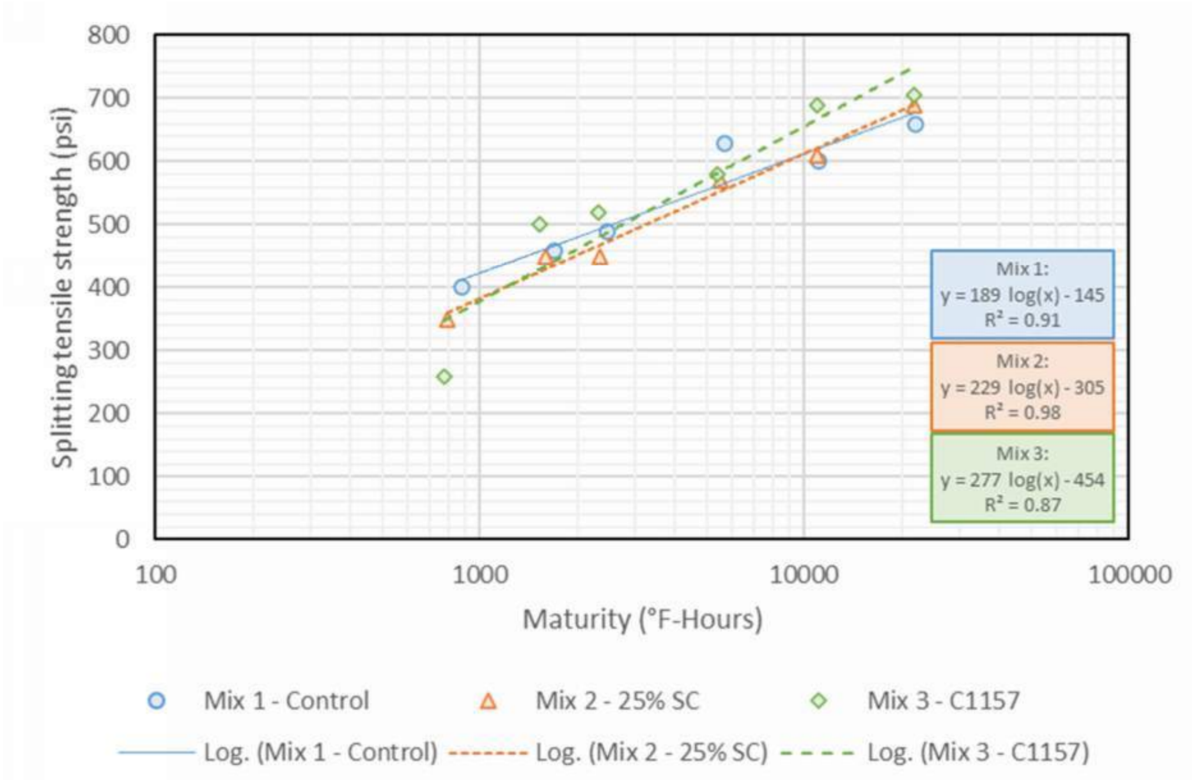

Figure 8. Maturity Plot for Modulus of Elasticity.

Drying Shrinkage

The drying shrinkage test was performed on three prisms, measuring 4 x 4 x 11.25 inches, on all three mixes according to ASTM C157 (modified to a 7-day moist cure) with results presented in

Table 12 and plotted in **Figure 9**. The moist cure was modified to include 7 days of moisture curing while still using the 24-hour reading as the initial comparator reading for which all subsequent readings were compared, consistent with ASTM C157. From the drying shrinkage data collected, Mix 2 had the highest shrinkage potential while Mix 3 had the lowest shrinkage potential. Shrinkage is important within restrained structures (e.g., reinforced tilt-up panel) as it contributes to the development of stress as the concrete dries, with lower shrinkage potential being desirable.

Table 12. Length Change Measurements (%)

Age (days)	Mix 1 - Control	Mix 2 - 25% SC	Mix 3 - C1157
1	0.000	0.000	0.000
7	0.006	0.003	0.002
8	-0.001	-0.005	-0.001
10	-0.005	-0.011	-0.006
13	-0.011	-0.016	-0.010
21	-0.018	-0.023	-0.015
28	-0.023	-0.028	-0.020
35	-0.028	-0.035	-0.020
63	-0.035	-0.039	--
97	-0.040	-0.043	-0.033

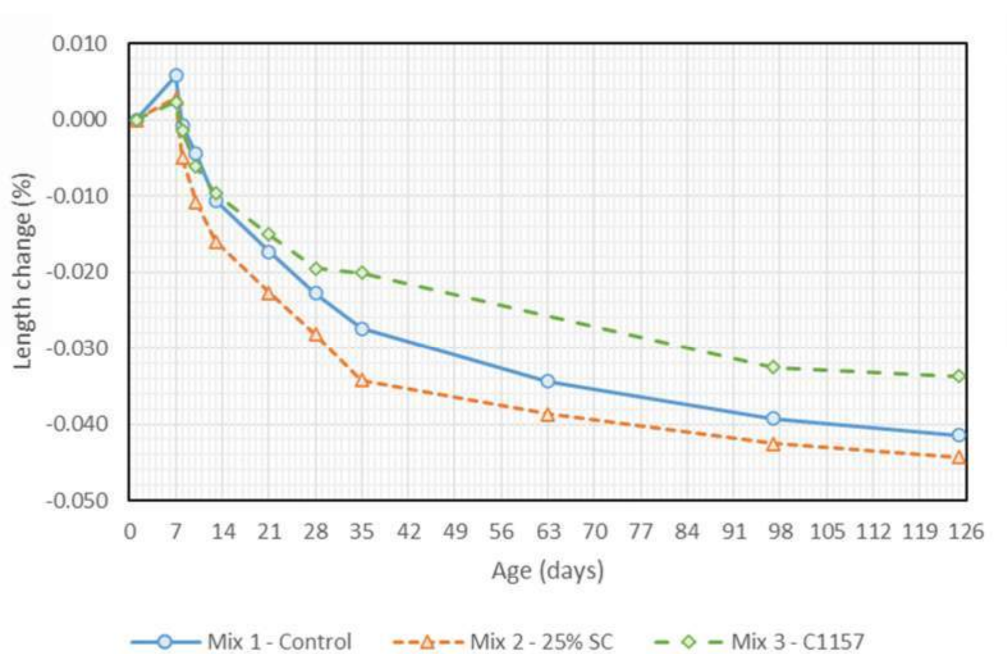

Figure 9. Drying Shrinkage Results.

Coefficient of Thermal Expansion

The coefficient of thermal expansion (CTE) test was performed at 28 and 77 days on two cylinders from each mix in accordance with AASHTO T336, and the results are presented in **Table 13**. Mix 1 and 2 had comparable CTE while Mix 3 had a 27% and 19% higher CTE value respectively at the two test ages. Additional testing would be needed to determine the significance of this higher measured value.

Table 13. Concrete Coefficient of Thermal Expansion Results (in10^{-6}/°F)

Mix ID	28 days	77 days
Mix 1 - Control	4.5	7.5
Mix 2 - 25% SC	4.7	7.8
Mix 3 - C1157	5.7	9.5

Bulk Resistivity

The bulk resistivity test was performed at 28-, 35-, 56-, and 90- days of age in general accordance with AASHTO T 402. The results are presented in **Table 14**. Three 4×8 cylinders were tested for each mix. After demolding at 24 hours of age, these cylinders were kept in a moist cure room for 28 days. The bulk resistivity of the cylinders was measured at 28 days (moisture saturated) before placing them in simulated pore solution (SPS). On day 35 and 56, the bulk resistivity was measured again after conditioning the cylinders with SPS. Electrical resistivity of concrete is a method to assess the resistance to flow of electrical current which indirectly is a measure of the concrete's ability to resist the flow of chloride ions. Applied current flows through the pore network of the concrete. A higher resistance indicates a disconnected and/or lower porosity. This in turn can mean lower permeability of the concrete.

Table 14. Uniaxial Resistivity (in Ohm-m)

Age (days)	Mix 1 - Control	Mix 2 - 25% SC	Mix 3 - C1157	Conditioning
28	64.9	103.1	992.3	100% R.H (Moist room)
35	52.4	86.6	749.0	Submerged in SPS
56	53.8	92.1	920.2	Submerged in SPS
90	55.2	105.8	973.0	Submerged in SPS

INSTRUMENTATION

Instrumentation including strain gages, inclinometers, and thermocouples were installed in each wall. The intent of the instrumentation was to monitor the strains (and induced stress) and temperatures in the wall during the curing process. During the lifting procedure, strain gages and inclinometers were used to measure strains and the angle of the wall as it was tilted up. **Figure 10** depicts the location of the instrumentation used in each of the three wall panels.

Temperature data was collected at a rate of one data point every 15 minutes. During tilt, strain and tilt data were collected at a rate of 10 Hz (ten data points per second). The following instrumentation system and specific instruments were used during the investigation:

- Campbell Scientific CR6 Datalogger with V116 input modules
- Omega/HBM KFH-3-350-C1-11L3M3R Strain Gages
- Gefran GIB-Z-360-A-2A Single Axis Inclination Sensors
- Omega PR-T-24-SLE Thermocouples.

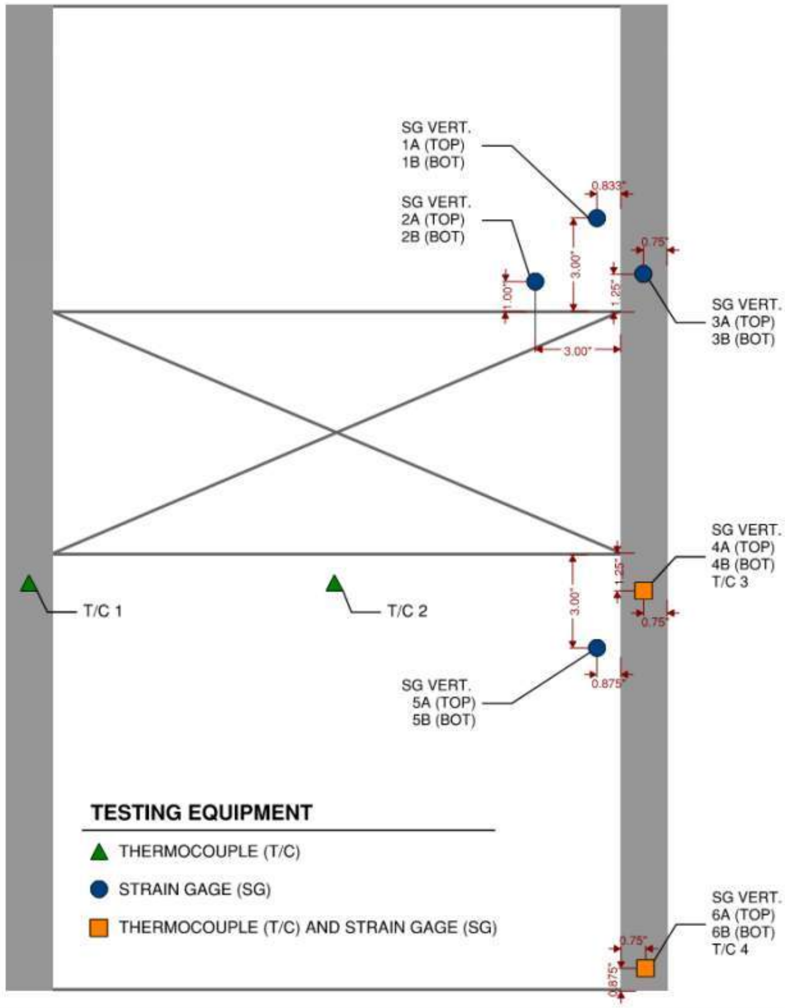

Figure 10. Typical Instrumentation Layout.

FIELD OBSERVATIONS AND TESTING

Concrete was placed for all three tilt-up panels on November 27, 2023, at Clayco's storage yard in St. Louis, Missouri. WJE was present during the placement to observe the pumpability, ease of consolidating, and finishabilty of all three mixes in addition to documenting the quality control testing performed by SCI Engineering (SCI). WJE also installed concrete maturity meters (Giatec SmartRock® 3 sensor) at the northwest and southwest corners of each panel, with probes tied to the top mat of reinforcing steel approximately 1 foot off the corner of each panel. These probes were used to measure and monitor the in-place concrete temperatures and maturity to provide in-place strength estimates based on laboratory developed maturity curves.

The ambient temperatures on the day of the placement ranged from 26°F in the morning to a high of 45°F in the afternoon with relative humidity between 60% to 30%, respectively. Ice was removed from the base concrete slab surface prior to concrete placement.

Up to four truckloads of concrete (approximately 27 cubic yards) were needed to fill the panel forms for each panel. The batch tickets for each truck load are included in **Appendix E**. Concrete was easily pumped into place for all three mixes. The plastic concrete properties were measured by SCI on one truck load per mix, and the results are presented in **Table 15**.

Table 15. Concrete Plastic Properties

Property	Mix 1	Mix 2	Mix 3
Temperature (F)	79	80	73
Slump (in.)	3.5*	4.25*	9.0
Air Content (%)	2.3	2.3	3.5
Unit Weight (lb/ft^3)	152.0	148.2	142.8

**Slump was higher at the time of placement, sufficient time elapsed between the time of placement and measurement of slump creating a measured slump loss*

The finishing processes for each panel included a vibratory screed (**Figure 11**), with manual screeding of areas not accessible with the vibratory screed, followed by bull floating shortly after final screeding. Concure was applied to the surface of each slab shortly after screeding as an evaporation retarder and finishing aid, with additional Concure used to close the surface of the Mix 3 slab. The surface of Mix 1 through Mix 3 closed easily with the vibratory screed. However, hand screeding of Mix 3 was very difficult to perform and did not close the surface (and therefore likely contributed to the need for more Concure in the hand screeded areas). This was expected based on the thixotropic rheology of the Mix 3 compared to the other mixes observed during laboratory testing. Mix 3 flows well when energy is introduced into the mix (i.e., vibratory screed) but is difficult to move from a resting position.

After sufficient stiffening and cessation of bleeding, each slab received a light power trowel finish with multiple passes of a walk-behind trowel machine equipped with trowel blades (**Figure 12**).

Table 16 presents the timing of the finishing procedures relative to the batching time of each mix. For example, "+55" means 55 minutes elapsed between batching of the concrete and the activity noted. After the final troweling, each slab was covered with insulated curing blankets.

Figure 11. Vibratory screeding of Mix 1.

Figure 12. Light power trowel being applied to Mix 2.

Table 16. Finishing Sequence (in minutes*)

Activity	Mix 1	Mix 2	Mix 3
Screeding	+55	+60	+90
Bull-Floating	+65	+70	+100
1st Pass	+150	+155	+145
Last Pass	+255	+270	+265
Curing/Protection	+265	+280	+270

*minutes from batching

Concrete specimens were fabricated for each mix from the same truck load of concrete sampled for plastic concrete properties. There were 20 total 4x8 inch cylinders fabricated with eleven cylinders being stored underneath the curing blankets on top of the southwest corner of each panel and nine cylinders for standard curing. In addition, a total seven 6x6x20 inch prisms were fabricated for flexural strength testing and were stored underneath the curing blankets on top of the southwest corner of each slab.

Prior to lifting the tilt-up wall panels, the project required a minimum compressive strength of 2,500 psi and a minimum flexural strength of 500 psi (as measured by ASTM C78). **Table 17** presents a summary of the compressive strength test results, and **Table 18** presents the results of the flexural strength testing. Test reports are provided in the **Appendix F**. In these tables, "Standard" refers to standard curing of compressive strength cylinders per ASTM C31 as compared to "Field" curing, which represents curing of the compressive strength cylinders and flexural strength beams on top of the slab underneath the insulated blankets. "Maturity" represents the estimated in-place strength based on the time and temperature history of the in-place concrete using maturity curves (see Laboratory Testing section of this report for developed maturity curves) for each mix.

Table 17. Compressive Strength – ASTM C39 (in psi)

Test Age (days)	Mix 1			Mix 2			Mix 3*		
	Standard	Field	Maturity**	Standard	Field	Maturity**	Standard	Field	Maturity**
1	-	-	2,830	-	-	2,210	-	-	370
2	-	5,090	3,580	-	3,710	3,150	-	90	650
3	-	5,230	3,980	-	4,300	3,640	410	440	1,700
4	-	5,470	4,110	-	4,420	3,820	-	390	2,400
5	-	-	4,230	-	-	3,990	-	950	2,930
7	5,500	-	4,350	5,290	-	4,160	830	1,760	3,570
14	-	6,050	-	-	6,090	-	-	-	-
29	6,310	6,620	-	6,850	6,940	-	5,030	5,870	-

*Much colder temperatures at the southwest corner of the Panel 3 (location of the field cure cylinders) and inappropriate handling of the cylinders at early ages likely caused significant compromise in the measured compressive strength.

** Average of two maturity probes

Table 18. Flexural Strength Results – ASTM C78 (in psi)

Test Age (days)	Mix 1			Mix 2			Mix 3*		
	Standard	Field	Maturity**	Standard	Field	Maturity**	Standard	Field	Maturity**
1	-	-	434	-	-	394	-	-	131
2	-	665	521	-	600	471	-	65	243
3	-	700	566	-	720	513	-	225	351
4	-	-	582	-	-	527	-	-	425
5	-	-	595	-	-	543	-	445	479
7	-	820	601	-	795	547	-	580	512
29		865	-	-	925	-	-	790	-

*Much colder temperatures at the southwest corner of the Panel 3 (location of the field cure cylinders)

** Average of two maturity probes

Based on the strength development of Mix 1 and 2 of the "Field" cured cylinders, these panels were tilted after 3 days. Mix 3 was tilted after 7 days. It is noted that Mix 3 had cooler temperatures as delivered and much cooler internal concrete temperatures in the southwest corner of the panel as compared to the other two mixes, which was the location of the "field" cured cylinders and flexural strength beams.

Temperature data collected during the curing process of each specimen via internal thermocouples shows the rise and fall of internal temperature with the specimens during the curing process (**Figure 13**). The following maximum temperatures were reached for Mix 1-3, respectively: 92.7 deg. F (TC3), 82.0 deg. F (TC3) and, 79.3 deg. F (TC3). While Mix 1 and Mix 3 were trending towards equilibrium with the daily average temperature, Mix 2 equilibrated on approximately Dec. 3, six days after the pour.

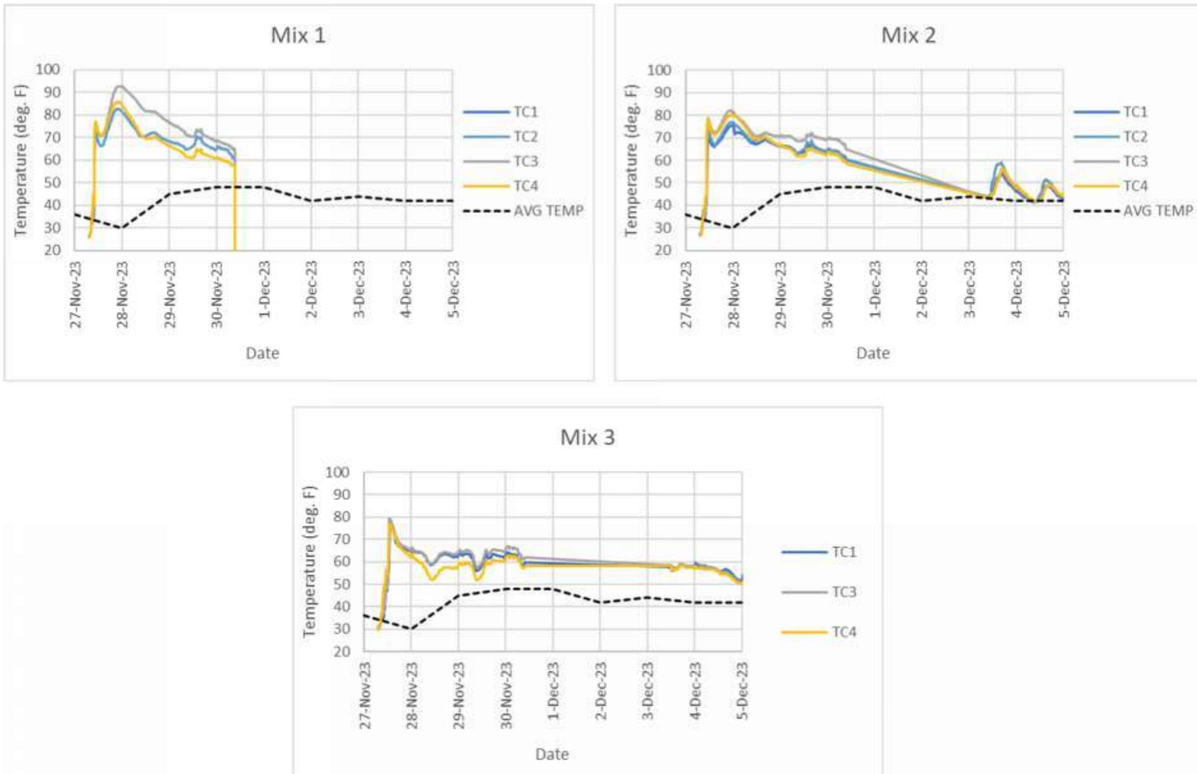

Figure 13. Temperature versus time for Mixes 1-3 after casting (11/27-12/5).

During lifting each panel was lifted from the pad on rigging, tilted vertically, and spun 180 degrees prior to final placement with shoring. During the lift, strain and inclinometer data was recorded (**Figure 14).** Strain gage measurement recording during the lifting proved difficult. For Mix 1, wiring was torn from the DAQ at approximately 7 minutes into the lift and corrected at approximately 17 minutes.

For all mixes, inclinometer data proved reliable. During the lift when the tilt data is at 0 degrees, the wall is flat on the slab, strains build during the lifting process, the specimen is spun at approximately 85 degrees before vertical placement. As expected, strains climbed during the initial lifting from the slab. Mix 1 and 3 peaked at Gage 4B, while Mix 2 peaked at Gage 5B, both below the opening. Further studies should consider alternative methods for strain measurements as reliability and meaningfulness of the data is limited.

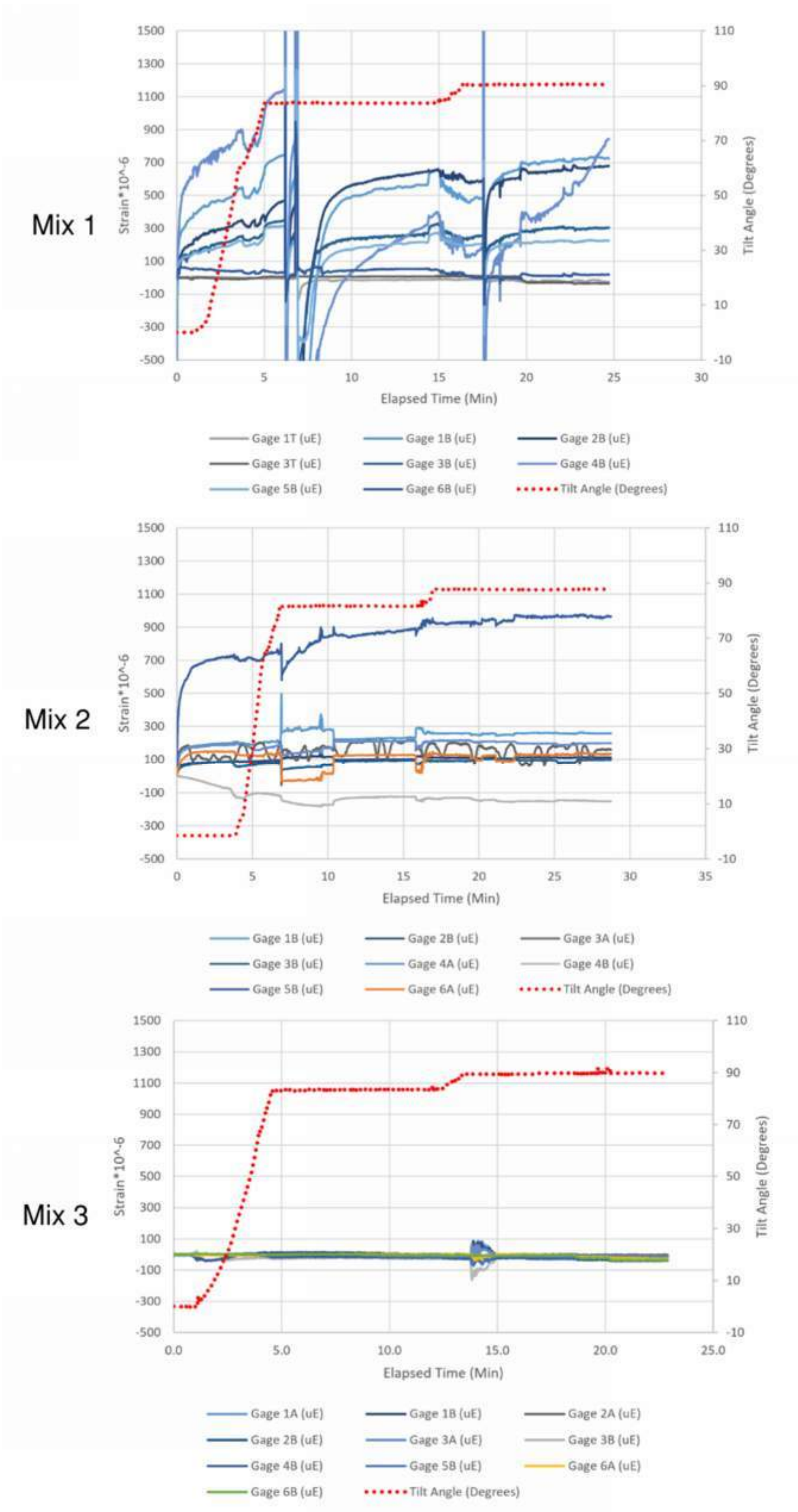

Figure 14. Inclinometer and Strain Gage Measurements for Mix 1-3.

SUMMARY AND LESSONS LEARNED

Three concrete mixes for tilt-up wall panels with varying degrees of embodied carbon were tested in the laboratory and through a field pilot. The goal was to understand the performance and potential challenges associated with reduced embodied carbon mixes for this application. The three mixes, Mix 1 - Control, Mix 2 - 25% Slag cement, and Mix 3 - ASTM C1157 cement had embodied carbon of 209, 169 and 100 kg CO_2 e/yd^3 respectively.

Laboratory Testing

- The three mixes were designed to have similar plastic properties consistent with typical pumpable concrete used in tilt-up walls, target slump of 6 to 8 inches and plastic air content less than 2.5%.
- All three mixtures were workable and could be placed, consolidated, and finished; although, the thixotropic properties of Mix 3 required more effort (external vibration) to place and finish.
- The initial and final setting times (ASTM C403) of Mixes 1 and 2 were comparable (3:15 and 4:40, respectively) while Mix 3 had an earlier initial set (2:55) and delayed final set (7:10).
- Mix 2 and Mix 3 generated 15% and 61% less heat of hydration (ASTM C1702) during the first 24 hours compared to Mix 1. Over the first 7 days, Mix 2 and Mix 3 generated 8% and 62% less heat. Having a lower heat of hydration has advantages in mass concrete applications but means less potential to retain heat to support the hydration reaction and can result in slower strength gain during cooler temperatures.
- The setting times and heat of hydration results suggest that Mix 1 and Mix 2 will behave similarly but Mix 3 may slow construction during cooler temperatures.
- Mix 1 and Mix 2 had comparable times at which bleeding stopped (ASTM C232). Mix 3 had no measurable bleed water, which can impact finishability of the mix and will require early curing to minimize the risk of plastic shrinkage cracking.
- Mix 1 and Mix 2 had comparable compressive strength (ASTM C39) gain with time. Mix 3 had slower strength gain at very early ages up to 3 days but had comparable (at 7 and 14 days) and higher (at 28 and 56 days) compressive strength at later ages.
- Mix 1 and Mix 2 had comparable splitting tensile strength (ASTM C496) while Mix 3 had the lowest 1-day splitting tensile strength but comparable or higher splitting tensile strengths at later ages.
- The modulus of elasticity (ASTM C469) of Mix 1 and Mix 2 were comparable at all test ages. At 1 day, Mix 3 had the lowest modulus of elasticity, but this changed by the second day and thereafter, when the modulus of elasticity of Mix 3 was the highest of the three mixes by up to 10% at 14 days. At later ages, the modulus of elasticity for the three mixes was similar.
- The maturity curves (ASTM C1074) were developed with respect to compressive strength, splitting tensile strength, and modulus of elasticity. Especially when placing concrete in low temperatures, maturity of the concrete can help estimate the strength for formwork stripping or in this case, lifting of the tilt-up panels.
- Mix 2 had the highest shrinkage potential with Mix 3 having the lowest shrinkage potential (ASTM C157).
- The coefficient of thermal expansion test (AASHTO T 336) was performed at 28 and 77 days. Mix 1 and Mix 2 had comparable CTE while Mix 3 had a 27% and 19% higher CTE value at 28 and 77 days, respectively. More testing and research are needed understand the significance, or lack thereof, of this measured difference and potential reason(s).

- The lower strength gain of Mix 3 at very early ages, coupled with higher stiffness and higher CTE, increases the risk of restrained thermal cracking at early ages. The lower overall shrinkage of Mix 3 reduces the risk of drying shrinkage cracking at later ages.
- The bulk resistivity (AASHTO T 402) of the moist cured cylinder specimens was measured at 28 days (moisture saturated) and again at 35, 56, and 90 days after saturating the cylinders with synthetic pore solution. Mix one has the lowest resistivity, followed by Mix 2, which had a resistivity that was approximately 92% higher at 90 days. The resistivity of Mix 3 was approximately 18 times higher than that of Mix 1 at 90 days. A higher resistance indicates a disconnected and/or lower porosity and is often related to a lower permeability of the concrete.

Field Pilot

- All three mixes could be placed, finished and tilted.
- The effort and ease of finishing Mix 3 using a vibratory screed was comparable to the other mixes, but it was difficult to hand screed the thixotropic Mix 3 and required the use of additional finishing aid.
- Panels made with Mixes 1 and 2 were tilted at 3 days as planned while Mix 3 was tilted at 7 days.
- The delay in strength gain of Mix 3 was likely due to the cold ambient temperatures. In addition, the field cured cylinders for Mix 3 were exposed to much colder temperatures due to not being insulated adequately. The lower heat of hydration of Mix 3 makes it susceptible to low temperatures where the hydration reaction is not supported, resulting in slower strength gain at low temperatures.
- The slow strength gain of Mix 3 due to the cold temperatures illustrates the need to understand behavior over a range of temperatures and helped identify the potential need for having different mixes for the summer and winter conditions to achieve carbon reduction targets.
- Limited useful data was acquired from the instrumented strain gages. There was difficulty in recording data through the lifting process as wiring was damaged. The limited data collected showed that the maximum strain was recorded below the opening in the tilt-up wall panel.

APPENDIX. Environmental Product Declaration

MIX 1 - Control

READY MIX CONCRETE PRODUCED BY:OZINGA

FACILITY:	St. Louis - Average Plant
STRENGTH:	5000 psi @ 28 days
MIX NAME:	5020

IMPACT INDICATOR		PER YD3	PER M3
Global Warming Potential	kg CO_2e	208.98	273.34
Ozone Depletion	kg CFC11e	7.19E-06	9.41E-06
Acidification	kg SO2e	0.43	0.57
Eutrophication	kg NE	0.29	0.37
SFP (Smog)	kg O3e	9.76	12.76
Non-renew. energy	MJ, NCV	1777.86	2325.35

DRAFT

GENERAL INFORMATION		
Declared Product	Ready-mixed concrete produced by Ozinga	
Date of Issue	December 14, 2023	
Period of Validity	August 13th, 2025	
EPD Holder	Ozinga Bros., Inc. 19001 Old LaGrange Road Mokena, IL 60448 www.ozinga.com	OZINGA®
Program Operator	ASTM International 100 Bar Harbor Drive West Conshohocken, PA 19428-2959, USA	ASTM INTERNATIONAL Helping our world work better
LCA and EPD Developer	WAP Sustainability Consulting 1701 Market Street Chattanooga, TN 37408 www.wapsustainability.com	Athena Sustainable Materials Institute
Core PCR	ISO 21930:2017 Sustainability in Building Construction - Environmental Declaration of Building Products	
Sub-category PCR	NSF International Product Category Rule (PCR) for Concrete Version 2.2 (December 2022), Verified by Thomas P. Gloria, Ph.D., Industrial Ecology Consultants	
Independent LCA Reviewer and EPD Verifier	Independent verification of the declaration and data, according to ISO 21930:2017 and ISO 14025:2006 ☐ Internal ☒ External Thomas P. Gloria, Ph.D., Industrial Ecology Consultants	
For Additional Explanatory Material	Manufacture Representative: Ryan Cialdella (ryancialdella@ozinga.com) Software Tool: Theta by WAP Sustainability Consulting V.1.0.	

The declared product meets the following product specifications:

- ACI 211: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- ACI 318: Building Code Requirements for Structural Concrete.
- ASTM C94 Standard Specification for Ready-Mixed Concrete.
- CSI Masterformat Division 03-30-00: Cast-in-Place Concrete.
- UNSPSC Code 30111500: Ready Mix

Disclaimer:
EPDS are comparable only if they comply with this document, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works.

This EPD was calculated using manufacturer specific cement data that represents 100% of the total cement used in this mix.

METHODOLOGICAL FRAMEWORK

DECLARED UNIT

The declared unit is 1 cubic meter (1 cubic yard) of ready mixed concrete product. The defined concrete mix is intended for commercial applications developed and produced by Ozinga. Key product variables include:

- Compressive strength - Compressive strengths are represented in the mix design and includes the number of days after pouring as apart of the reference value: e.g. 3,000 psi @ 28 days; 4,000 psi @ 56 days; 6,000 psi @ 90 days; etc.
- Water to cementitious materials ratio (w/cm) – Varies but generally lower for a higher strength non-air entrained mix design (above 5,000 psi (34.5 MPa)) in accordance with ACI 211.1 recommendations
- SCM use – various mix designs call for Portland cement displacement by incorporating fly ash (FA) and/or slag cement (SL)
- Admixtures use – Admixtures use was specified for the mix design that was modeled. Admixtures include air-entraining admixture, water reducing and accelerating admixtures, high range water reducer admixtures, and carbon dioxide.
- No hazardous substances are present in the declared product.
- The ready mixed concrete products represented in this EPD are comprised of :

  BatchWater (ASTM C1602), Crushed Coarse Aggregate (ASTM C33), Natural Fine Aggregate (ASTM C33), Water Re ducer (ASTM C494), Portland Limestone Cement (ASTM C595)

SCOPE OF LCA

A summary of life cycle stages included in the EPD is identified in Figure 1 as follows:

- A1: Raw Material Supply (upstream processes): Extraction, handling, and processing of the raw materials used in the production of concrete, cement, supplementary cementitious materials, aggregate (coarse and fine), water, admixtures, and other materials or chemicals used in concrete mixtures.
- A2: Transportation: Transportation of these materials from the supplier to the ‘gate’ of the concrete producer.
- A3: Manufacturing (core processes): The energy used to store, batch, mix and distribute the concrete and operate the facility (concrete plant).

A summary of activities excluded from the EPD is as follows:

- Production, manufacture, and construction of manufacturing capital goods and infrastructure.
- Production and manufacture of production equipment, delivery vehicles, and laboratory equipment.
- Personnel-related activities (travel, furniture, and office supplies)
- Energy and water use related to company management and sales activities.

CONTINUED ON NEXT PAGE

METHODOLOGICAL FRAMEWORK CONTINUED

CUT-OFF RULES

The cut-off criteria for all activity stage flows considered within the system boundary conform with ISO 21930: 2017 Section 7.1.8. Specifically, the cut-off criteria were applied as follows:

- All inputs and outputs for which data are available are included in the calculated effects and no collected core process data are excluded.
- A one percent cut-off is considered for renewable and non-renewable primary energy consumption and the total mass of inputs within a unit process. The sum of the total neglected flows does not exceed 5% of all energy consumption and mass of inputs.
- All flows known to contribute a significant impact or to uncertainty (e.g., portland cement and admixtures) are included.
- The cut-off rules are not applied to hazardous and toxic material flows – all of which are included in the life cycle inventory.
- Proxy data was used for admixtures used by Ozinga that did not align with any of the admixture categories published in the European Federation of Concrete Admixtures Associations (EFCA) EPDs. In those cases, the Water Reducing Admixture data was selected as a conservative assumption as per the NCF PCR Appendix A.

ALLOCATION

The allocation of co-products or secondary flows cross the system boundary conforms with the ISO 21930: 2017 Section 7.2.4. allocation criteria were applied as follows:

- Allocation was not applied to any of the gate-to-gate production facilities.
- For Secondary Data sources, the NSF PCR default allocation selection (i.e. "Cut-off" or "Alloc Rec") was applied.
- The product category rules for this EPD recognize fly ash, silica fume and slag as recovered materials and thus the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a concrete material input.
- A portion (30%) of the reported fleet energy use for truck mixing plants was allocated to the mixing facility.

BUILDING LIFE CYCLE INFORMATION MODULES (X: Included in LCA; MND: Module Not Declared)

Production State			Construction Stage		Use Stage							End-Of-Life Stage			
Extraction Upstream Production	Transport to Facility	Manufacturing	Transport to Site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Sqc	De-Construction /Demolition	Transport to Waste Process, or Disposal	Waste Processing	Disposal of Waste
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

DATA SOURCES

This EPD is based on foreground LCI data collected from the participating company's production facilities for the calendar year 2020. All upstream material, resource and energy carrier inputs have been sourced from various industry-average datasets and literature. Many of these data sets are defaulted to those specified for use in the NSF PCR 2021. The following Table describes each LCI data source and includes the data quality assessment.

MATERIALS	LCI DATA SOURCE	YEAR	GEOGRAPHY	DATA QUALITY
Portland Cement and Limestone Cement, ASTM C595, AASHTO M 240, or CSA A3001	Holcim - Ste. Genevieve Blended Type IL	2021	North America	Technology: very good, Time: very good, Geography: very good, Completeness: very good, Reliability: very good
Slag Cement, ASTM C989	Slag Cement Association EPD of North America Slag Cement (2021)	2021	North America	Technology: very good, Time: very good, Geography: very good, Completeness: very good, Reliability: very good
Fly Ash, ASTM C618	None, no incoming burden, only inbound transport is considered*	N/A	N/A	N/A
Silica Fume, ASTM C1240	None, no incoming burden, only inbound transport is considered*	N/A	N/A	N/A
Crushed Aggregates, coarse and fine, ASTM C33	ecoinvent 3.4: "Gravel, crushed {RoW}| production | Cut-off, U" (2018), modified with US average electricity	2001	World/US	Technology: very good, Time: poor, Geography: good, Completeness: very good, Reliability: very good
Natural Aggregates, coarse and fine, ASTM C33	ecoinvent 3.4: "Gravel, round {RoW}| gravel and sand quarry operation | Cut-off, U" (2018), modified with US average electricity	2001	World/US	Technology: very good, Time: poor, Geography: good, Completeness: very good, Reliability: very good
Manufactured Lightweight Aggregates, ASTM C330	ecoinvent 3.4: Expanded clay {RoW}| production | Cut-off, U (2018), modified with US average electricity	2000	World/US	Technology: good, Time: poor, Geography: good, Completeness: very good, Reliability: very good
Gypsum	ecoinvent 3.5: Gypsum, mineral {RoW}| gypsum quarry operation | Alloc Rec, U	2021	World/US	Technology: good, Time: poor, Geography: good, Completeness: very good, Reliability: very good
Admixtures and Carbon Dioxide, ASTM C494	GCP Applied Technologies LCA for Concrete Admixtures ecoinvent 3.5: Carbon dioxide liquid {RoW}| production | Cut-off U	2021	North America	Technology: very good, Time: very good, Geography: fair, Completeness: very good, Reliability: very good
Batch and Wash Water, ASTM C1602	ecoinvent 3.4: Tap water {RoW}| market for | Cut-off, U (2018), modified with US average electricity	2011	World/US	Technology: very good, Time: good, Geography: good, Completeness: very good, Reliability: very good
Road Transport	USLCI 2014: Transport, combination truck, short-haul, diesel powered/tkm/RNA (2014)	2010	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Rail Transport	USLCI 2014: Transport, train, diesel powered / US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Ocean Transport	USLCI 2014: Transport, ocean freighter, average fuel mix/US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Electricity	ecoinvent 3.4: Electricity, low voltage {XX}| market for | Cut-off, U (2018)	2015	North America	Technology: very good, Time: very good, Geography: very good, Completeness: very good, Reliability: very good
Diesel	USLCI 2014: Diesel, combusted in industrial boiler / US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Gasoline	USLCI 2014: Gasoline, combusted in equipment /US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Liquefied Propane Gas	USLCI 2014: Liquefied petroleum gas, combusted in industrial boiler /US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Hazardous Solid Waste	ecoinvent 3.4: Hazardous waste, for incineration {RoW}| treatment of hazardous waste, hazardous waste incineration | Alloc, Rec, U (2018), modified with US electricity	2011	World/US	Technology: very good, Time: good, Geography: good, Completeness: very good, Reliability: very good
Non-Hazardous Solid Waste	ecoinvent 3.4: Inert waste {RoW}| treatment of, sanitary landfill | Alloc Rec, U (2018), modified with US average electricity	2011	World/US	Technology: very good, Time: good, Geography: good, Completeness: very good, Reliability: very good

The product category rules for this EPD recognize fly ash, silica fume and slag as recovered materials and thus the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a concrete material input.

CALCULATED RESULTS A1-A3

FACILITY: St. Louis - Average Plant

MIX NAME: 5020

STRENGTH: 5000 psi @ 28 days

DECLARED UNIT: 1 cubic meter (1 cubic yard) ready mix concrete produced at Ozinga Ready Mix Concrete

CORE MANDATORY IMPACT INDICATOR			PER YD3	PER M3
Global warming potential	GWP	kg C02e	208.98	273.34
Depletion potential of the stratospheric ozone layer	ODP	kg CFC11e	7.19E-06	9.41E-06
Acidification potential of soil and water sources	AP	kg SO2e	0.43	0.57
Eutrophication potential	EP	kg Ne	0.29	0.37
Formation potential of tropospheric ozone	SFP	kg 03e	9.76	12.76
Abiotic depletion potential for fossil resources	ADPf	MJ, NCV	1157.23	1513.60
Abiotic depletion potential for non-fossil mineral resources	ADPe	kg Sbe	6.67E-05	8.72E-05
Fossil fuel depletion	FFD	MJ Surplus	38.97	50.97
USE OF PRIMARY RESOURCES				
Renewable primary energy carrier used as energy	RPRE	MJ, NCV	17.52	22.91
Renewable primary energy carrier used as material	RPRM	MJ, NCV	0.00	0.00
Non-renewable primary energy carrier used as energy	NRPRE	MJ, NCV	1777.86	2325.35
Non-renewable primary energy carrier used as material	NRPRM	MJ, NCV	0.00	0.00
SECONDARY MATERIAL, SECONDARY FUEL AND RECOVERED ENERGY				
Secondary material	SM	kg	0.00	0.00
Renewable secondary fuel	RSF	MJ, NCV	0.00	0.00
Non-renewable secondary fuel	NRSF	MJ, NCV	13.30	17.40
Recovered energy	RE	MJ, NCV	0.00	0.00
MANDATORY INVENTORY PARAMETERS				
Consumption of freshwater resources	FW	m3	1.61	2.10
Calcination and carbonation emissions	CCE	kg CO2e	116.91	152.92
INDICATORS DESCRIBING WASTE				
Hazardous waste disposed	HWD	kg	1.37E-05	1.79E-05
Non-hazardous waste disposed	NHWD	kg	0.86	1.13
High-level radioactive waste, conditioned, to final repository	HLRW	m3	6.13E-04	8.02E-04
Intermediate- and low-level radioactive waste, to final repository	ILLRW	m3	2.29E-06	3.00E-06
Components for re-use	CRU	kg	0.00	0.00
Materials for recycling	MR	kg	0.00	0.00
Materials for energy recovery	MER	kg	0.00	0.00
Recovered energy exported from the product system	EE	MJ, NCV	0.00	0.00

REFERENCES

- American Concrete Institute (2009) ACI 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
- American Concrete Institute (2008) ACI 318: Building Code Requirements for Structural Concrete.
- ASTM International General Program Instructions (2020) v8.0
- Bare, J. (2012) Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) v2.1.
- European Federation of Concrete Admixture Associations (2015). EFCA Environmental Declarations for Admixtures.
- International Organization for Standardization (2017) ISO 21930:2017 Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services.
- National Renewable Energy Laboratory (2019) U.S. Life Cycle Inventory Database http://www.nrel.gov/lci/
- NSF International (2021) Product Category Rule for Concrete, Version 2.1
- ASTM International (2018) ASTM C94: Standard Specification for Ready-Mixed Concrete.
- Construction Specifications Institute (CSI) MasterFormat Division 03-30-00 Cast-in- Place Concrete
- CSA Group (2014) CSA A23.1-09/A23.2-14 - Concrete materials and methods of concrete construction / Test methods and standard practices for concrete.
- EN 15804:2012 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products.
- ISO 14040:2006 Environmental Management - Life cycle assessment - Principles and framework
- ISO 14044:2006/AMD 1:2017/ AMD 2:2020 Environmental Management – Life cycle assessment – Requirements and guidelines
- Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., & Weidema, B. (2016) The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, 21, 1218–1230.

READY MIX CONCRETE PRODUCED BY:OZINGA

FACILITY:	St. Louis - Average Plant
STRENGTH:	5000 psi @ 28 days
MIX NAME:	5030

IMPACT INDICATOR		PER YD3	PER M3
Global Warming Potential	kg CO_2e	168.74	220.71
Ozone Depletion	kg CFC11e	6.30E-06	8.23E-06
Acidification	kg SO2e	0.39	0.51
Eutrophication	kg NE	0.25	0.32
SFP (Smog)	kg O3e	8.68	11.36
Non-renew. energy	MJ, NCV	1523.75	1993.00

DRAFT

GENERAL INFORMATION		
Declared Product	Ready-mixed concrete produced by Ozinga	
Date of Issue	December 14, 2023	
Period of Validity	August 13th, 2025	
EPD Holder	Ozinga Bros., Inc. 19001 Old LaGrange Road Mokena, IL 60448 www.ozinga.com	OZINGA®
Program Operator	ASTM International 100 Bar Harbor Drive West Conshohocken, PA 19428-2959, USA	ASTM INTERNATIONAL Helping our world work better
LCA and EPD Developer	WAP Sustainability Consulting 1701 Market Street Chattanooga, TN 37408 www.wapsustainability.com	Athena Sustainable Materials Institute
Core PCR	ISO 21930:2017 Sustainability in Building Construction - Environmental Declaration of Building Products	
Sub-category PCR	NSF International Product Category Rule (PCR) for Concrete Version 2.2 (December 2022), Verified by Thomas P. Gloria, Ph.D., Industrial Ecology Consultants	
Independent LCA Reviewer and EPD Verifier	Independent verification of the declaration and data, according to ISO 21930:2017 and ISO 14025:2006 ☐ Internal ☒ External Thomas P. Gloria, Ph.D., Industrial Ecology Consultants	
For Additional Explanatory Material	Manufacture Representative: Ryan Cialdella (ryancialdella@ozinga.com) Software Tool: Theta by WAP Sustainability Consulting V.1.0.	

The declared product meets the following product specifications:

- ACI 211: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- ACI 318: Building Code Requirements for Structural Concrete.
- ASTM C94 Standard Specification for Ready-Mixed Concrete.
- CSI Masterformat Division 03-30-00: Cast-in-Place Concrete.
- UNSPSC Code 30111500: Ready Mix

Disclaimer:
EPDS are comparable only if they comply with this document, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works.

This EPD was calculated using manufacturer specific cement data that represents 100% of the total cement used in this mix.

METHODOLOGICAL FRAMEWORK

DECLARED UNIT

The declared unit is 1 cubic meter (1 cubic yard) of ready mixed concrete product. The defined concrete mix is intended for commercial applications developed and produced by Ozinga. Key product variables include:

- Compressive strength - Compressive strengths are represented in the mix design and includes the number of days after pouring as apart of the reference value: e.g. 3,000 psi @ 28 days; 4,000 psi @ 56 days; 6,000 psi @ 90 days; etc.
- Water to cementitious materials ratio (w/cm) – Varies but generally lower for a higher strength non-air entrained mix design
  (above 5,000 psi (34.5 MPa)) in accordance with ACI 211.1 recommendations
- SCM use – various mix designs call for Portland cement displacement by incorporating fly ash (FA) and/or slag cement (SL)
- Admixtures use – Admixtures use was specified for the mix design that was modeled. Admixtures include air-entraining admixture, water reducing and accelerating admixtures, high range water reducer admixtures, and carbon dioxide.
- No hazardous substances are present in the declared product.
- The ready mixed concrete products represented in this EPD are comprised of :
  BatchWater (ASTM C1602), Crushed Coarse Aggregate (ASTM C33), Natural Fine Aggregate (ASTM C33), Water Re ducer (ASTM C494), Portland Limestone Cement (ASTM C595), Slag Cement (ASTM C989)

SCOPE OF LCA

A summary of life cycle stages included in the EPD is identified in Figure 1 as follows:

- A1: Raw Material Supply (upstream processes): Extraction, handling, and processing of the raw materials used in the production of concrete, cement, supplementary cementitious materials, aggregate (coarse and fine), water, admixtures, and other materials or chemicals used in concrete mixtures.
- A2: Transportation: Transportation of these materials from the supplier to the 'gate' of the concrete producer.
- A3: Manufacturing (core processes): The energy used to store, batch, mix and distribute the concrete and operate the facility (concrete plant).

A summary of activities excluded from the EPD is as follows:

- Production, manufacture, and construction of manufacturing capital goods and infrastructure.
- Production and manufacture of production equipment, delivery vehicles, and laboratory equipment.
- Personnel-related activities (travel, furniture, and office supplies)
- Energy and water use related to company management and sales activities.

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METHODOLOGICAL FRAMEWORK CONTINUED

CUT-OFF RULES

The cut-off criteria for all activity stage flows considered within the system boundary conform with ISO 21930: 2017 Section 7.1.8. Specifically, the cut-off criteria were applied as follows:

- All inputs and outputs for which data are available are included in the calculated effects and no collected core process data are excluded.
- A one percent cut-off is considered for renewable and non-renewable primary energy consumption and the total mass of inputs within a unit process. The sum of the total neglected flows does not exceed 5% of all energy consumption and mass of inputs.
- All flows known to contribute a significant impact or to uncertainty (e.g., portland cement and admixtures) are included.
- The cut-off rules are not applied to hazardous and toxic material flows – all of which are included in the life cycle inventory.
- Proxy data was used for admixtures used by Ozinga that did not align with any of the admixture categories published in the European Federation of Concrete Admixtures Associations (EFCA) EPDs. In those cases, the Water Reducing Admixture data was selected as a conservative assumption as per the NCF PCR Appendix A.

ALLOCATION

The allocation of co-products or secondary flows cross the system boundary conforms with the ISO 21930: 2017 Section 7.2.4. allocation criteria were applied as follows:

- Allocation was not applied to any of the gate-to-gate production facilities.
- For Secondary Data sources, the NSF PCR default allocation selection (i.e. "Cut-off" or "Alloc Rec") was applied.
- The product category rules for this EPD recognize fly ash, silica fume and slag as recovered materials and thus the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a concrete material input.
- A portion (30%) of the reported fleet energy use for truck mixing plants was allocated to the mixing facility.

BUILDING LIFE CYCLE INFORMATION MODULES (X: Included in LCA; MND: Module Not Declared)

Production State			Construction Stage		Use Stage							End-Of-Life Stage			
Extraction Upstream Production	Transport to Facility	Manufacturing	Transport to Site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Sqc	De-Construction /Demolition	Transport to Waste Process, or Disposal	Waste Processing	Disposal of Waste
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

DATA SOURCES

This EPD is based on foreground LCI data collected from the participating company's production facilities for the calendar year 2020. All upstream material, resource and energy carrier inputs have been sourced from various industry-average datasets and literature. Many of these data sets are defaulted to those specified for use in the NSF PCR 2021. The following Table describes each LCI data source and includes the data quality assessment.

MATERIALS	LCI DATA SOURCE	YEAR	GEOGRAPHY	DATA QUALITY
Portland Cement and Limestone Cement, ASTM C595, AASHTO M 240, or CSA A3001	Holcim - Ste. Genevieve Blended Type IL	2021	North America	Technology: very good, Time: very good, Geography: very good, Completeness: very good, Reliability: very good
Slag Cement, ASTM C989	Holcim - South Chicago Slag Cement	2021	North America	Technology: very good, Time: very good, Geography: very good, Completeness: very good, Reliability: very good
Fly Ash, ASTM C618	None, no incoming burden, only inbound transport is considered*	N/A	N/A	N/A
Silica Fume, ASTM C1240	None, no incoming burden, only inbound transport is considered*	N/A	N/A	N/A
Crushed Aggregates, coarse and fine, ASTM C33	ecoinvent 3.4: "Gravel, crushed {RoW}| production | Cut-off, U" (2018), modified with US average electricity	2001	World/US	Technology: very good, Time: poor, Geography: good, Completeness: very good, Reliability: very good
Natural Aggregates, coarse and fine, ASTM C33	ecoinvent 3.4: "Gravel, round {RoW}| gravel and sand quarry operation | Cut-off, U" (2018), modified with US average electricity	2001	World/US	Technology: very good, Time: poor, Geography: good, Completeness: very good, Reliability: very good
Manufactured Lightweight Aggregates, ASTM C330	ecoinvent 3.4: Expanded clay {RoW}| production | Cut-off, U (2018), modified with US average electricity	2000	World/US	Technology: good, Time: poor, Geography: good, Completeness: very good, Reliability: very good
Gypsum	ecoinvent 3.5: Gypsum, mineral {RoW}| gypsum quarry operation | Alloc Rec, U	2021	World/US	Technology: good, Time: poor, Geography: good, Completeness: very good, Reliability: very good
Admixtures and Carbon Dioxide, ASTM C494	GCP Applied Technologies LCA for Concrete Admixtures ecoinvent 3.5: Carbon dioxide liquid {RoW}| production | Cut-off U	2021	North America	Technology: very good, Time: very good, Geography: fair, Completeness: very good, Reliability: very good
Batch and Wash Water, ASTM C1602	ecoinvent 3.4: Tap water {RoW}| market for | Cut-off, U (2018), modified with US average electricity	2011	World/US	Technology: very good, Time: good, Geography: good, Completeness: very good, Reliability: very good
Road Transport	USLCI 2014: Transport, combination truck, short-haul, diesel powered/tkm/RNA (2014)	2010	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Rail Transport	USLCI 2014: Transport, train, diesel powered / US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Ocean Transport	USLCI 2014: Transport, ocean freighter, average fuel mix/US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Electricity	ecoinvent 3.4: Electricity, low voltage {XX}| market for | Cut-off, U (2018)	2015	North America	Technology: very good, Time: very good, Geography: very good, Completeness: very good, Reliability: very good
Diesel	USLCI 2014: Diesel, combusted in industrial boiler / US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Gasoline	USLCI 2014: Gasoline, combusted in equipment /US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Liquefied Propane Gas	USLCI 2014: Liquefied petroleum gas, combusted in industrial boiler /US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Hazardous Solid Waste	ecoinvent 3.4: Hazardous waste, for incineration {RoW}| treatment of hazardous waste, hazardous waste incineration | Alloc, Rec, U (2018), modified with US electricity	2011	World/US	Technology: very good, Time: good, Geography: good, Completeness: very good, Reliability: very good
Non-Hazardous Solid Waste	ecoinvent 3.4: Inert waste {RoW}| treatment of, sanitary landfill | Alloc Rec, U (2018), modified with US average electricity	2011	World/US	Technology: very good, Time: good, Geography: good, Completeness: very good, Reliability: very good

** The product category rules for this EPD recognize fly ash, silica fume and slag as recovered materials and thus the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a concrete material input.*

CALCULATED RESULTS A1-A3

FACILITY: St. Louis - Average Plant

MIX NAME: 5030

STRENGTH: 5000 psi @ 28 days

DECLARED UNIT: 1 cubic meter (1 cubic yard) ready mix concrete produced at Ozinga Ready Mix Concrete

CORE MANDATORY IMPACT INDICATOR			PER YD3	PER M3
Global warming potential	GWP	kg C02e	168.74	220.71
Depletion potential of the stratospheric ozone layer	ODP	kg CFC11e	6.30E-06	8.23E-06
Acidification potential of soil and water sources	AP	kg SO2e	0.39	0.51
Eutrophication potential	EP	kg Ne	0.25	0.32
Formation potential of tropospheric ozone	SFP	kg 03e	8.68	11.36
Abiotic depletion potential for fossil resources	ADPf	MJ, NCV	957.49	1252.36
Abiotic depletion potential for non-fossil mineral resources	ADPe	kg Sbe	6.91E-05	9.03E-05
Fossil fuel depletion	FFD	MJ Surplus	38.81	50.77
USE OF PRIMARY RESOURCES				
Renewable primary energy carrier used as energy	RPRE	MJ, NCV	17.88	23.39
Renewable primary energy carrier used as material	RPRM	MJ, NCV	0.00	0.00
Non-renewable primary energy carrier used as energy	NRPRE	MJ, NCV	1523.75	1993.00
Non-renewable primary energy carrier used as material	NRPRM	MJ, NCV	0.00	0.00
SECONDARY MATERIAL, SECONDARY FUEL AND RECOVERED ENERGY				
Secondary material	SM	kg	0.00	0.00
Renewable secondary fuel	RSF	MJ, NCV	0.00	0.00
Non-renewable secondary fuel	NRSF	MJ, NCV	9.98	13.05
Recovered energy	RE	MJ, NCV	0.00	0.00
MANDATORY INVENTORY PARAMETERS				
Consumption of freshwater resources	FW	m3	1.59	2.08
Calcination and carbonation emissions	CCE	kg CO2e	87.68	114.69
INDICATORS DESCRIBING WASTE				
Hazardous waste disposed	HWD	kg	2.15E-04	2.81E-04
Non-hazardous waste disposed	NHWD	kg	0.86	1.13
High-level radioactive waste, conditioned, to final repository	HLRW	m3	6.13E-04	8.02E-04
Intermediate- and low-level radioactive waste, to final repository	ILLRW	m3	1.97E-06	2.58E-06
Components for re-use	CRU	kg	0.00	0.00
Materials for recycling	MR	kg	0.00	0.00
Materials for energy recovery	MER	kg	0.00	0.00
Recovered energy exported from the product system	EE	MJ, NCV	0.00	0.00

REFERENCES

- American Concrete Institute (2009) ACI 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
- American Concrete Institute (2008) ACI 318: Building Code Requirements for Structural Concrete.
- ASTM International General Program Instructions (2020) v8.0
- Bare, J. (2012) Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) v2.1.
- European Federation of Concrete Admixture Associations (2015). EFCA Environmental Declarations for Admixtures.
- International Organization for Standardization (2017) ISO 21930:2017 Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services.
- National Renewable Energy Laboratory (2019) U.S. Life Cycle Inventory Database http://www.nrel.gov/lci/
- NSF International (2021) Product Category Rule for Concrete, Version 2.1
- ASTM International (2018) ASTM C94: Standard Specification for Ready-Mixed Concrete.
- Construction Specifications Institute (CSI) MasterFormat Division 03-30-00 Cast-in- Place Concrete
- CSA Group (2014) CSA A23.1-09/A23.2-14 - Concrete materials and methods of concrete construction / Test methods and standard practices for concrete.
- EN 15804:2012 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products.
- ISO 14040:2006 Environmental Management - Life cycle assessment - Principles and framework
- ISO 14044:2006/AMD 1:2017/ AMD 2:2020 Environmental Management – Life cycle assessment – Requirements and guidelines
- Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., & Weidema, B. (2016) The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, 21, 1218–1230.

MIX 3 - C1157

READY MIX CONCRETE PRODUCED BY:OZINGA

FACILITY:	St. Louis - Average Plant
STRENGTH:	5000 psi @ 28 days
MIX NAME:	CSC1157

IMPACT INDICATOR		PER YD3	PER M3
Global Warming Potential	kg CO_2e	99.65	130.33
Ozone Depletion	kg CFC11e	4.62E-06	6.04E-06
Acidification	kg SO2e	0.49	0.64
Eutrophication	kg NE	0.36	0.47
SFP (Smog)	kg O3e	8.42	11.02
Non-renew. energy	MJ, NCV	1362.77	1782.43

GENERAL INFORMATION		
Declared Product	Ready-mixed concrete produced by Ozinga	
Date of Issue	December 14, 2023	
Period of Validity	August 13th, 2025	
EPD Holder	Ozinga Bros., Inc. 19001 Old LaGrange Road Mokena, IL 60448 www.ozinga.com	OZINGA®
Program Operator	ASTM International 100 Bar Harbor Drive West Conshohocken, PA 19428-2959, US/	ASTM INTERNATIONAL Helping our world work better
LCA and EPD Developer	WAP Sustainability Consulting 1701 Market Street Chattanooga, TN 37408 www.wapsustainability.com	Athena Sustainable Materials Institute
Core PCR	ISO 21930:2017 Sustainability in Building Construction - Environmental Declaration of Building Products	
Sub-category PCR	NSF International Product Category Rule (PCR) for Concrete Version 2.2 (December 2022), Verified by Thomas P. Gloria, Ph.D., Industrial Ecology Consultants	
Independent LCA Reviewer and EPD Verifier	Independent verification of the declaration and data, according to ISO 21930:2017 and ISO 14025:2006 ☐ Internal ☒ External Thomas P. Gloria, Ph.D., Industrial Ecology Consultants	
For Additional Explanatory Material	Manufacture Representative: Ryan Cialdella (ryancialdella@ozinga.com) Software Tool: Theta by WAP Sustainability Consulting V.1.0.	

The declared product meets the following product specifications:

- ACI 211: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- ACI 318: Building Code Requirements for Structural Concrete.
- ASTM C94 Standard Specification for Ready-Mixed Concrete.
- CSI Masterformat Division 03-30-00: Cast-in-Place Concrete.
- UNSPSC Code 30111500: Ready Mix

Disclaimer:
EPDS are comparable only if they comply with this document, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works.

This EPD was calculated using manufacturer specific cement data that represents 100% of the total cement used in this mix.

METHODOLOGICAL FRAMEWORK

DECLARED UNIT

The declared unit is 1 cubic meter (1 cubic yard) of ready mixed concrete product. The defined concrete mix is intended for commercial applications developed and produced by Ozinga. Key product variables include:

- Compressive strength - Compressive strengths are represented in the mix design and includes the number of days after pouring as apart of the reference value: e.g. 3,000 psi @ 28 days; 4,000 psi @ 56 days; 6,000 psi @ 90 days; etc.
- Water to cementitious materials ratio (w/cm) – Varies but generally lower for a higher strength non-air entrained mix design (above 5,000 psi (34.5 MPa)) in accordance with ACI 211.1 recommendations
- SCM use – various mix designs call for Portland cement displacement by incorporating fly ash (FA) and/or slag cement (SL)
- Admixtures use – Admixtures use was specified for the mix design that was modeled. Admixtures include air-entraining admixture, water reducing and accelerating admixtures, high range water reducer admixtures, and carbon dioxide.
- No hazardous substances are present in the declared product.
- The ready mixed concrete products represented in this EPD are comprised of :

  BatchWater (ASTM C1602), Crushed Coarse Aggregate (ASTM C33), Natural Fine Aggregate (ASTM C33), Accelerating Admixture - Non Chlorides (ASTM C494), Water Reducer - High Range (ASTM C494), Portland Limestone Cement

SCOPE OF LCA

A summary of life cycle stages included in the EPD is identified in Figure 1 as follows:

- A1: Raw Material Supply (upstream processes): Extraction, handling, and processing of the raw materials used in the production of concrete, cement, supplementary cementitious materials, aggregate (coarse and fine), water, admixtures, and other materials or chemicals used in concrete mixtures.
- A2: Transportation: Transportation of these materials from the supplier to the 'gate' of the concrete producer.
- A3: Manufacturing (core processes): The energy used to store, batch, mix and distribute the concrete and operate the facility (concrete plant).

A summary of activities excluded from the EPD is as follows:

- Production, manufacture, and construction of manufacturing capital goods and infrastructure.
- Production and manufacture of production equipment, delivery vehicles, and laboratory equipment.
- Personnel-related activities (travel, furniture, and office supplies)
- Energy and water use related to company management and sales activities.

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METHODOLOGICAL FRAMEWORK CONTINUED

CUT-OFF RULES

The cut-off criteria for all activity stage flows considered within the system boundary conform with ISO 21930: 2017 Section 7.1.8. Specifically, the cut-off criteria were applied as follows:

- All inputs and outputs for which data are available are included in the calculated effects and no collected core process data are excluded.
- A one percent cut-off is considered for renewable and non-renewable primary energy consumption and the total mass of inputs within a unit process. The sum of the total neglected flows does not exceed 5% of all energy consumption and mass of inputs.
- All flows known to contribute a significant impact or to uncertainty (e.g., portland cement and admixtures) are included.
- The cut-off rules are not applied to hazardous and toxic material flows – all of which are included in the life cycle inventory.
- Proxy data was used for admixtures used by Ozinga that did not align with any of the admixture categories published in the European Federation of Concrete Admixtures Associations (EFCA) EPDs. In those cases, the Water Reducing Admixture data was selected as a conservative assumption as per the NCF PCR Appendix A.

ALLOCATION

The allocation of co-products or secondary flows cross the system boundary conforms with the ISO 21930: 2017 Section 7.2.4. allocation criteria were applied as follows:

- Allocation was not applied to any of the gate-to-gate production facilities.
- For Secondary Data sources, the NSF PCR default allocation selection (i.e. "Cut-off" or "Alloc Rec") was applied.
- The product category rules for this EPD recognize fly ash, silica fume and slag as recovered materials and thus the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a concrete material input.
- A portion (30%) of the reported fleet energy use for truck mixing plants was allocated to the mixing facility.

BUILDING LIFE CYCLE INFORMATION MODULES (X: Included in LCA; MND: Module Not Declared)

Production State			Construction Stage		Use Stage							End-Of-Life Stage			
Extraction Upstream Production	Transport to Facility	Manufacturing	Transport to Site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Sqc	De-Construction /Demolition	Transport to Waste Process, or Disposal	Waste Processing	Disposal of Waste
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

DATA SOURCES

This EPD is based on foreground LCI data collected from the participating company's production facilities for the calendar year 2020. All upstream material, resource and energy carrier inputs have been sourced from various industry-average datasets and literature. Many of these data sets are defaulted to those specified for use in the NSF PCR 2021. The following Table describes each LCI data source and includes the data quality assessment.

MATERIALS	LCI DATA SOURCE	YEAR	GEOGRAPHY	DATA QUALITY
Portland Cement and Limestone Cement, ASTM C595, AASHTO M 240, or CSA A3001	Ozinga CarbonSense Cement	2021	North America	Technology: very good, Time: very good, Geography: very good, Completeness: very good, Reliability: very good
Slag Cement, ASTM C989	Slag Cement Association EPD of North America Slag Cement (2021)	2021	North America	Technology: very good, Time: very good, Geography: very good, Completeness: very good, Reliability: very good
Fly Ash, ASTM C618	None, no incoming burden, only inbound transport is considered*	N/A	N/A	N/A
Silica Fume, ASTM C1240	None, no incoming burden, only inbound transport is considered*	N/A	N/A	N/A
Crushed Aggregates, coarse and fine, ASTM C33	ecoinvent 3.4: "Gravel, crushed {RoW}| production | Cut-off, U" (2018), modified with US average electricity	2001	World/US	Technology: very good, Time: poor, Geography: good, Completeness: very good, Reliability: very good
Natural Aggregates, coarse and fine, ASTM C33	ecoinvent 3.4: "Gravel, round {RoW}| gravel and sand quarry operation | Cut-off, U" (2018), modified with US average electricity	2001	World/US	Technology: very good, Time: poor, Geography: good, Completeness: very good, Reliability: very good
Manufactured Lightweight Aggregates, ASTM C330	ecoinvent 3.4: Expanded clay {RoW}| production | Cut-off, U (2018), modified with US average electricity	2000	World/US	Technology: good, Time: poor, Geography: good, Completeness: very good, Reliability: very good
Gypsum	ecoinvent 3.5: Gypsum, mineral {RoW}| gypsum quarry operation | Alloc Rec, U	2021	World/US	Technology: good, Time: poor, Geography: good, Completeness: very good, Reliability: very good
Admixtures and Carbon Dioxide, ASTM C494	GCP Applied Technologies LCA for Concrete Admixtures ecoinvent 3.5: Carbon dioxide liquid {RoW}| production | Cut-off U	2021	North America	Technology: very good, Time: very good, Geography: fair, Completeness: very good, Reliability: very good
Batch and Wash Water, ASTM C1602	ecoinvent 3.4: Tap water {RoW}| market for | Cut-off, U (2018), modified with US average electricity	2011	World/US	Technology: very good, Time: good, Geography: good, Completeness: very good, Reliability: very good
Road Transport	USLCI 2014: Transport, combination truck, short-haul, diesel powered/tkm/RNA (2014)	2010	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Rail Transport	USLCI 2014: Transport, train, diesel powered / US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Ocean Transport	USLCI 2014: Transport, ocean freighter, average fuel mix/US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Electricity	ecoinvent 3.4: Electricity, low voltage {XX}| market for | Cut-off, U (2018)	2015	North America	Technology: very good, Time: very good, Geography: very good, Completeness: very good, Reliability: very good
Diesel	USLCI 2014: Diesel, combusted in industrial boiler / US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Gasoline	USLCI 2014: Gasoline, combusted in equipment /US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Liquefied Propane Gas	USLCI 2014: Liquefied petroleum gas, combusted in industrial boiler /US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Hazardous Solid Waste	ecoinvent 3.4: Hazardous waste, for incineration {RoW}| treatment of hazardous waste, hazardous waste incineration | Alloc, Rec, U (2018), modified with US electricity	2011	World/US	Technology: very good, Time: good, Geography: good, Completeness: very good, Reliability: very good
Non-Hazardous Solid Waste	ecoinvent 3.4: Inert waste {RoW}| treatment of, sanitary landfill | Alloc Rec, U (2018), modified with US average electricity	2011	World/US	Technology: very good, Time: good, Geography: good, Completeness: very good, Reliability: very good

** The product category rules for this EPD recognize fly ash, silica fume and slag as recovered materials and thus the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a concrete material input.*

CALCULATED RESULTS A1-A3

FACILITY: St. Louis - Average Plant

MIX NAME: CSC1157

STRENGTH: 5000 psi @ 28 days

DECLARED UNIT: 1 cubic meter (1 cubic yard) ready mix concrete produced at Ozinga Ready Mix Concrete

CORE MANDATORY IMPACT INDICATOR			PER YD3	PER M3
Global warming potential	GWP	kg C02e	99.65	130.33
Depletion potential of the stratospheric ozone layer	ODP	kg CFC11e	4.62E-06	6.04E-06
Acidification potential of soil and water sources	AP	kg SO2e	0.49	0.64
Eutrophication potential	EP	kg Ne	0.36	0.47
Formation potential of tropospheric ozone	SFP	kg 03e	8.42	11.02
Abiotic depletion potential for fossil resources	ADPf	MJ, NCV	1038.46	1358.26
Abiotic depletion potential for non-fossil mineral resources	ADPe	kg Sbe	1.79	2.34
Fossil fuel depletion	FFD	MJ Surplus	41.92	54.83
USE OF PRIMARY RESOURCES				
Renewable primary energy carrier used as energy	RPRE	MJ, NCV	132.09	172.77
Renewable primary energy carrier used as material	RPRM	MJ, NCV	0.00	0.00
Non-renewable primary energy carrier used as energy	NRPRE	MJ, NCV	1362.77	1782.43
Non-renewable primary energy carrier used as material	NRPRM	MJ, NCV	0.00	0.00
SECONDARY MATERIAL, SECONDARY FUEL AND RECOVERED ENERGY				
Secondary material	SM	kg	0.00	0.00
Renewable secondary fuel	RSF	MJ, NCV	0.00	0.00
Non-renewable secondary fuel	NRSF	MJ, NCV	4.08	5.34
Recovered energy	RE	MJ, NCV	0.00	0.00
MANDATORY INVENTORY PARAMETERS				
Consumption of freshwater resources	FW	m3	1.73	2.26
Calcination and carbonation emissions	CCE	kg CO2e	7.08	9.26
INDICATORS DESCRIBING WASTE				
Hazardous waste disposed	HWD	kg	4.89E-03	6.40E-03
Non-hazardous waste disposed	NHWD	kg	4.26	5.57
High-level radioactive waste, conditioned, to final repository	HLRW	m3	0.01	0.02
Intermediate- and low-level radioactive waste, to final repository	ILLRW	m3	1.21E-06	1.59E-06
Components for re-use	CRU	kg	0.00	0.00
Materials for recycling	MR	kg	0.00	0.00
Materials for energy recovery	MER	kg	0.00	0.00
Recovered energy exported from the product system	EE	MJ, NCV	0.00	0.00

REFERENCES

- American Concrete Institute (2009) ACI 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
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- ASTM International General Program Instructions (2020) v8.0
- Bare, J. (2012) Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) v2.1.
- European Federation of Concrete Admixture Associations (2015). EFCA Environmental Declarations for Admixtures.
- International Organization for Standardization (2017) ISO 21930:2017 Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services.
- National Renewable Energy Laboratory (2019) U.S. Life Cycle Inventory Database http://www.nrel.gov/lci/
- NSF International (2021) Product Category Rule for Concrete, Version 2.1
- ASTM International (2018) ASTM C94: Standard Specification for Ready-Mixed Concrete.
- Construction Specifications Institute (CSI) MasterFormat Division 03-30-00 Cast-in- Place Concrete
- CSA Group (2014) CSA A23.1-09/A23.2-14 - Concrete materials and methods of concrete construction / Test methods and standard practices for concrete.
- EN 15804:2012 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products.
- ISO 14040:2006 Environmental Management - Life cycle assessment - Principles and framework
- ISO 14044:2006/AMD 1:2017/ AMD 2:2020 Environmental Management – Life cycle assessment – Requirements and guidelines
- Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., & Weidema, B. (2016) The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, 21, 1218–1230.

APPENDIX. Raw Material Characterization

ASTM C127 Relative Density and Absorption of Coarse Aggregate

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: Rob Bee **Date:** 11/9/2023
Checked by: ______ **Date:** ______

Balance:
- ☑ SN# B543618517
- ☐ SN# 1121330641
- ☐ SN# AE826228
- ☐ ______

Oven:
- ☑ SN# 004N0079
- ☐ SN# 804N0020
- ☐ East Thermotron 7466C
- ☐ ______

Sieve:
- ☑ #4 10408819
- ☐ #8 10418854
- ☐ #16 11467169
- ☐ ______

Aggregate starting condtion:
- ☑ Oven dried
- ☐ Not oven dried

Sample ID	Relative Density, Oven Dry	Relative Density, SSD	Relative Density, Apparent	Absorption, %
Coarse	2.64	2.67	2.71	0.9

ASTM C128 Relative Density and Absorption of Fine Aggregate

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: Rob Bee **Date:** 11/9/2023

Checked by: ______ **Date:** ______

Oven:
- ☐ SN# 004N0079
- ☐ SN# 804N0020
- ☐ East Thermotron 7466C
- ☐ ______

Balance:
- ☒ B543618517
- ☐ 1121330641
- ☐ AE826228
- ☐ ______

Pycno-meter
- ☒ Pyrex 500ML A
- ☐ Pyrex 500ML B
- ☐ ______

Mold:
- ☒ WJE 1301 A
- ☐ ______

Tamper:
- ☒ WJE 1301 B
- ☐ ______

Aggregate starting condtion:
- ☒ Oven dried
- ☐ Not oven dried

Sample ID	Relative Density, Oven Dry	Relative Density, SSD	Relative Density, Apparent	Absorption (%)
Fine	2.58	2.61	2.67	1.2

Calculations Based on the Gravimetric Procedure

ASTM C136 Sieve Analysis of Fine and Coarse Aggregates

WJE Project No: 2023.4830 **Project Coordinator:** Todd Nelson

Operator: Rob Bee **Date:** 11/8/2023

Checked by: ____________ **Date:** ____________

Balance:
- ☑ B543618517
- ☐ 1121330641
- ☐ 1121203170

Oven:
- ☐ 004N0079
- ☐ 804N0020
- ☐ Hot Plate

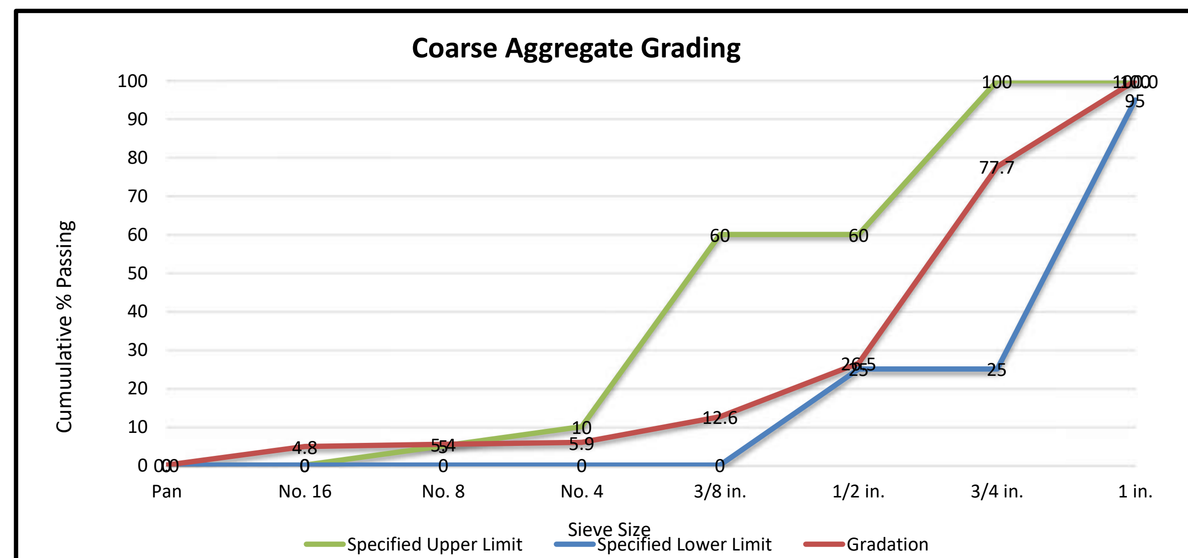
Condition:
- ☐ Wet
- ☑ Dry
- ☐ As Received

Shaker:
- ☑ Shaker 8852
- ☐ By Hand

ASTM C117 Procedure:
- ☑ A - Plain Water
- ☐ B - Wetting Agent
- ☐ N/A - Not performed

Original Weight (g):	7008.9	**% Lost by Sieving:**	0.2	**Sample ID:**
Dry Weight After Washing (g):	6815.4	**% Finer than No. 200 by Washing:**	2.8	**Specification:** ASTM C33 Coarse Aggregate 57

Sieve Size	Sieve Serial Number	Individual Weight Retained (g)	Individual Percent Retained	Cumulative Percent Retained	Cumulative Percent Passing
1 in.	8726	0.0	0	0	100
3/4 in.	8727	1515.2	22	22	78
1/2 in.	8728	3485.5	51	73	27
3/8 in.	8729	946.6	14	87	13
No. 4	8730	457.9	7	94	6
No. 8	8731	32.8	0	95	5
No. 16	8732	40.9	1	95	5
Pan and Wash	-	326.1	4.8	100	0.0
TOTAL		6805.0	100.00		



Comments: ____________

ASTM C117 Test Methods for Materials Finer Than 75-um (No. 200) Sieve in Mineral Aggregates by Washing and ASTM C136 Sieve Analysis of Fine and Coarse Aggregates

WJE Project No.: 2023.4830 **Project Coordinator:** Todd Nelson

Operator: Rob Bee **Date:** 11/8/2023

Checked by: ______ **Date:** ______

Balance:
- ☒ B543618517
- ☐ 1121330641
- ☐ AE826228

Oven:
- ☐ 004N0079
- ☐ 804N0020
- ☐ East Thermotron

Condition:
- ☐ Wet
- ☒ Dry
- ☐ As Received

Shaker:
- ☒ RO-Tap ID# 13971
- ☐ By Hand

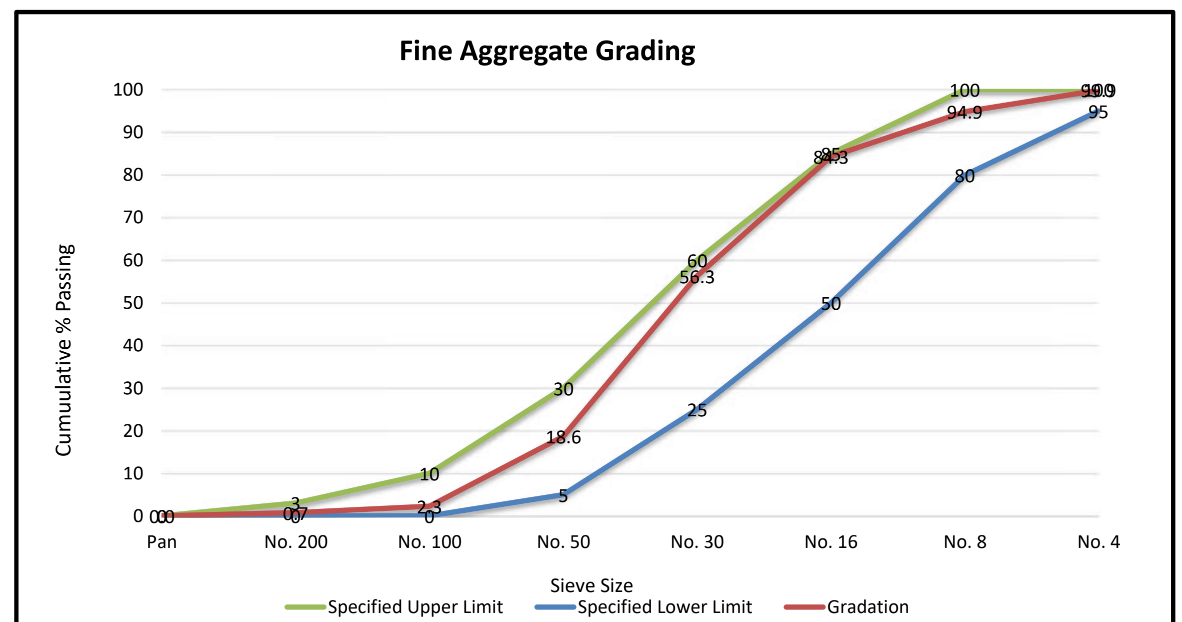
ASTM C117 Procedure:
- ☒ A - Plain Water
- ☐ B - Wetting Agent
- ☐ N/A - Not performed

Original Weight (g):	3654.6	**% Lost by Sieving:**	0.2	**Sample ID:**	Fine
Dry Weight After Washing (g):	3628.4	**% Finer than No. 200 by Washing:**	0.7	**Specification:**	ASTM C33 Fine Aggregate

Sieve Size	Sieve Serial Number	Individual Weight Retained (g)	Individual Percent Retained	Cumulative Percent Retained	Cumulative Percent Passing
No. 4	8730	3.5	0	0	99.9
No. 8	8731	183.6	5	5	94.9
No. 16	8732	384.8	11	16	84.3
No. 30	8733	1023.1	28	44	56.3
No. 50	8734	1372.6	38	81	18.6
No. 100	8735	598.2	16	98	2.3
No. 200	6053	55.1	1.5	99	0.7
Pan	-	0.8	0.0	100*	0.0*
Wash	-	26.2	0.7		
TOTAL		3647.9	99		

* Includes material removed by washing.

Fineness Modulus: **2.44**



Comments: ______

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

MOISTURE CONTENT WORKSHEET

ASTM C566 Total Evaporable Moisture Content of Aggregate by Drying

Project No: 2023.4830.0

Project Coordinator: Todd Nelson

Operator: Rob Bee **Date:** 11/7/2023

Checked by: **Date:**

Oven ID: Asset #2140 **Scale ID:** Asset # 2215

Sample ID	Container Weight (g)	Weight of Container + Sample Wet (g)	Weight of Container + Sample Dry (g)	Weight of Sample Before Drying (g)	Weight of Sample After Drying (g)	Water Weight (g)	Moisture Content (%)
Coarse	710.40	5168.20	5031.20	4457.80	4320.80	137.00	3.07
Fine	681.70	7072.50	6763.60	6390.80	6081.90	308.90	4.83

Comments:

Particle Technology Labs
The Particle Experts

Report of Analysis

PTL Project 61490-62

Prepared for:	Karthik Pattaje	**P.O.#:**	01767
Company:	WISS, JANNEY, ELSTNER ASSOCIATES, INC.	**Sample(s) Received:**	2023-12-01

PARTICLE SIZE SUMMARY

SAMPLE(S) SUBMITTED
Type IL Cement, St- Gen, MO (Holcim)
Type IL Cement
Slag, Chicago, IL (Holcim)
Slag
CarbonSense Cement, Ozinga
CSC1157

Analytical information, results, and any further commentary are detailed on the following page(s).

Technical Review: [signature] 2023-12-15

Amanda Redman
Particle Characterization Chemist II

Date

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PARTICLE SIZE SUMMARY

INSTRUMENT	ACCESSORY	TECHNIQUE
Malvern Mastersizer 3000	Hydro MV	LASER Diffraction - Liquid Dispersion
REFERENCE(S)		
PTL Test Method: N/A	**Previous PTL Project:** 60251-91	
Client Method: N/A		

PARTICLE SIZE DATA SUMMARY

SAMPLE ID	CUMULATIVE VOLUME % LESS THAN INDICATED SIZE (µm)		
	Dv (10)	**Dv (50)**	**Dv (90)**
Type IL Cement, St- Gen, MO (Holcim)			
Type IL Cement	1.82	10.7	32.1
Slag, Chicago, IL (Holcim)			
Slag	1.42	8.58	45.8
CarbonSense Cement, Ozinga			
CSC1157	2.31	12.0	33.9

Attachment(s):

- An explanation page titled *Interpreting Your Malvern Mastersizer Fine Particle Analysis.*
- Original result page(s).

Comment(s):

N/A

Particle Technology Labs
555 Rogers Street, Downers Grove, IL 60515
630.969.2703
www.particletechlabs.com

INTERPRETING YOUR MALVERN MASTERSIZER FINE PARTICLE ANALYSIS

Introduction

The particle size analysis of your sample(s) has been conducted on a Malvern® MasterSizer LASER diffractor. This instrument is considered an ensemble analyzer that calculates a volume distribution from the LASER (**L**ight **A**mplification by **S**timulated **E**mission of **R**adiation) diffraction pattern of a suspension of particles. This raw scatter data are then processed using a complex algorithm and presented on the basis of **EQUIVALENT SPHERICAL DIAMETER**. The Malvern equipment currently in use at Particle Technology Labs (PTL) are the *MasterSizer 2000 and the MasterSizer 3000.*

The Data

The header section contains various user-entered information including client name, sample identification, and analysis notes. Each project submitted to PTL is given a unique seven-digit code (PTL Project #) which can be found on these data pages, although its location is dependent on the instrumentation used. On the MasterSizer 2000 and 3000 data, the PTL Project # appears at the bottom of the page and is identified as File Name or within the File. Please refer to this PTL Project # when contacting us with any questions regarding the analysis.

The data output also provides the parameters specific to the instrument being used, as well as the parameters specific to the analysis. The optical model (composed of the sample's refractive index as well as the imaginary absorption value) is required if determining the particle size using Mie theory. This theory can be used on any size particles, but is specifically recommended over the use of the Fraunhofer approximation according to ISO 13320:2020 for material in the size region less than approximately 50 µm. Please note that, unless otherwise requested or provided by the client, the analysis of an unknown material is generally conducted using the standard instrument default optical values as detailed below.

System Default Values

SETTINGS	MASTERSIZER 2000 / MASTERSIZER 3000	
	WET	DRY
Analysis Model	General Purpose	General Purpose
Presentation	Default	Default
Sample RI Value	1.520	1.520

The Fraunhofer approximation, which does not require specific knowledge of the optical properties of the sample, can be applied for large particles if a known refractive index of the material is not available or the sample is composed of multiple components. If the actual RI of the sample material is provided at a later date, the raw data can be recalculated to adjust for the refractive index.

Please note the following commonly reported values when reviewing your data:

- **Tabulated Data:** Always appears as a Cumulative % less than (*Volume Under* %) unless otherwise requested.
- **Span:** Value related to the width of the curve, expressed as $\frac{[Dv(90) - Dv(10)]}{Dv(50)}$ or $\frac{d(0.9) - d(0.1)}{d(0.5)}$ depending on the instrument.
- **D[3,2]:** Surface-weighted mean diameter (Sauter diameter)
- **D[4,3]:** Volume-weighted MEAN
- **10%, 50%, 90% size values:** Indicates the size median which 10%, 50%, or 90% of the particles within the distribution is smaller than (example: Dv(90) or d(0.9): 140 µm, this means that 90% of the particulate is smaller than 140 µm on a volume basis).
- **Specific Surface Area:** If a calculated Specific Surface Area value is reported, consider this value only as an approximate surface area since calculations are based upon **non-porous spheres**. It is not a replacement for a result produced from an actual gas adsorption instrument due to the above assumption.

Also included is the Particle Size Distribution DIFFERENTIAL HISTOGRAM. This histogram shows the Tabulated Data as a **Differential Volume Percent Less Than Indicated Size**. Please note the histogram for the *MasterSizer 3000* also generally includes a CUMULATIVE Curve representative of the Tabulated Data.

For additional questions specific to your analysis results, please contact us directly.

Malvern 3000 Liquid Analysis v.2

ptl Particle Technology Labs

Measurement Details	
Client	WISS, JANNEY, ELSTNER ASSOCIATES, INC.
Test Method	N/A
Operator Name	fhamilton
SOP File Name	HydroMV.cfg
Carrier	Non-aqueous
Notes	N/A

Measurement Details	
Sample Name	Average of 'Type IL Cement, St-Gen, MO (Holcim)'
Sample ID	Type IL Cement
PTL ID	526655-62
Analysis Date Time	12/11/2023 7:02:52 AM
Measurement Date Time	12/11/2023 7:02:52 AM
Result Source	Averaged

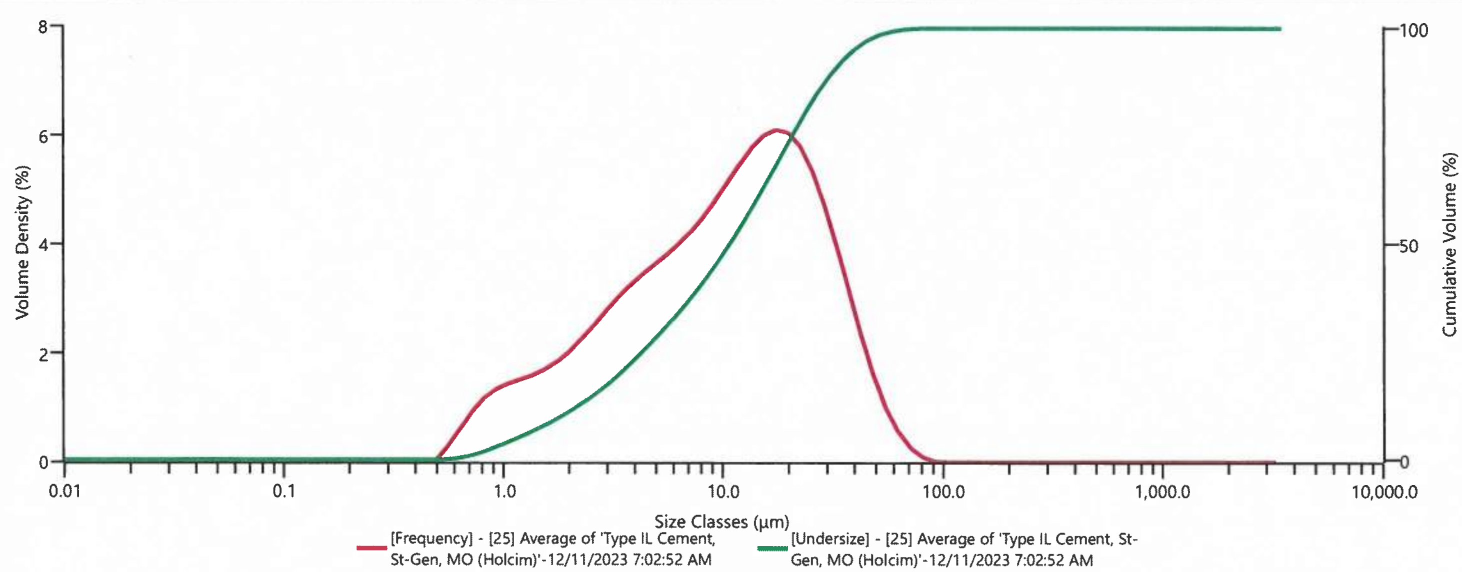
Analysis	
Particle Name	Cement
Particle Refractive Index	1.700
Particle Absorption Index	0.100
Weighted Residual	0.55 %
Laser Power	79.52 %
Laser Obscuration	14.19 %
Accessory Name	Hydro MV
Software Version	3.88.2211.150

Result	
Dispersant Name	IPA
Dispersant Refractive Index	1.378
Analysis Model	General Purpose
Analysis Sensitivity	Normal
Are particles non-spherical?	Yes
Scattering Model	Mie
Accessory Serial No.	MAL1211922
Instrument Serial No.	MAL1220065
Virtual Lens Range	

Dv (10)	1.82 µm
Dv (50)	10.7 µm
Dv (90)	32.1 µm

D [4,3]	14.3 µm
Span	2.818

Frequency (compatible) and Undersize



Measurement Details	
File Path	R:\Malvern 3000\Measurement Data\61490-62.mmes
Record Number	25
Average Result Records	21, 22, 23, 24

FH 2023-12-11
AR 2023-12-12

Malvern 3000 Liquid Analysis v.2

Measurement Details	
Client	WISS, JANNEY, ELSTNER ASSOCIATES, INC.
Test Method	N/A
Operator Name	fhamilton
SOP File Name	HydroMV.cfg
Carrier	Non-aqueous
Notes	N/A

Measurement Details	
Sample Name	Average of 'Type IL Cement, St-Gen, MO (Holcim)'
Sample ID	Type IL Cement
PTL ID	526655-62
Analysis Date Time	12/11/2023 7:02:52 AM
Measurement Date Time	12/11/2023 7:02:52 AM
Result Source	Averaged

Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.166	0.00	2.75	16.02	45.6	97.08	756	100.00
0.0114	0.00	0.188	0.00	3.12	18.32	51.8	98.42	859	100.00
0.0129	0.00	0.214	0.00	3.55	20.82	58.9	99.26	976	100.00
0.0147	0.00	0.243	0.00	4.03	23.52	66.9	99.72	1110	100.00
0.0167	0.00	0.276	0.00	4.58	26.38	76.0	99.93	1260	100.00
0.0189	0.00	0.314	0.00	5.21	29.40	86.4	100.00	1430	100.00
0.0215	0.00	0.357	0.00	5.92	32.57	98.1	100.00	1630	100.00
0.0244	0.00	0.405	0.00	6.72	35.90	111	100.00	1850	100.00
0.0278	0.00	0.460	0.00	7.64	39.41	127	100.00	2100	100.00
0.0315	0.00	0.523	0.00	8.68	43.15	144	100.00	2390	100.00
0.0358	0.00	0.594	0.24	9.86	47.14	163	100.00	2710	100.00
0.0407	0.00	0.675	0.74	11.2	51.41	186	100.00	3080	100.00
0.0463	0.00	0.767	1.52	12.7	55.96	211	100.00	3500	100.00
0.0526	0.00	0.872	2.51	14.5	60.77	240	100.00		
0.0597	0.00	0.991	3.63	16.4	65.78	272	100.00		
0.0679	0.00	1.13	4.84	18.7	70.87	310	100.00		
0.0771	0.00	1.28	6.10	21.2	75.93	352	100.00		
0.0876	0.00	1.45	7.43	24.1	80.78	400	100.00		
0.0995	0.00	1.65	8.85	27.4	85.25	454	100.00		
0.113	0.00	1.88	10.38	31.1	89.20	516	100.00		
0.128	0.00	2.13	12.07	35.3	92.51	586	100.00		
0.146	0.00	2.42	13.94	40.1	95.13	666	100.00		

Measurement Details	
File Path	R:\Malvern 3000\Measurement Data\61490-62.mmes
Record Number	25
Average Result Records	21, 22, 23, 24

Malvern 3000 Liquid Analysis v.2

ptl Particle Technology Labs

Measurement Details	
Client	WISS, JANNEY, ELSTNER ASSOCIATES, INC.
Test Method	N/A
Operator Name	fhamilton
SOP File Name	HydroMV.cfg
Carrier	Non-aqueous
Notes	N/A

Measurement Details	
Sample Name	Average of 'Slag, Chicago IL (Holcim)'
Sample ID	Slag
PTL ID	526656-62
Analysis Date Time	12/8/2023 11:28:22 AM
Measurement Date Time	12/8/2023 11:28:22 AM
Result Source	Averaged

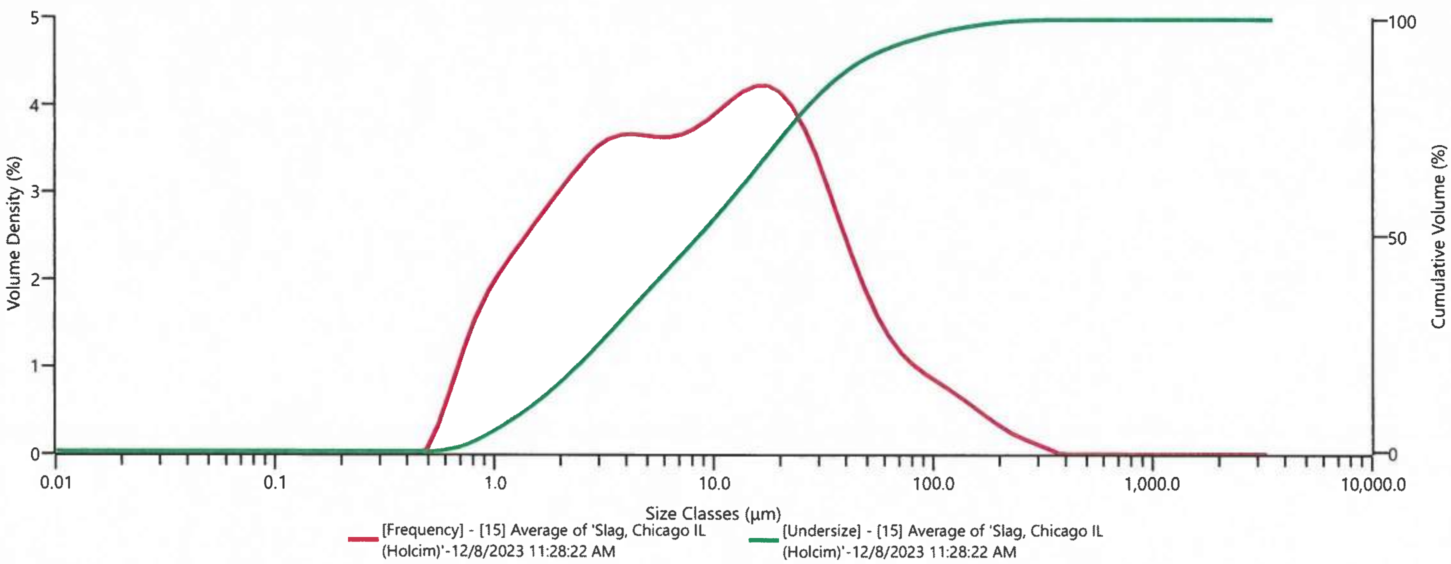
Analysis	
Particle Name	Cement
Particle Refractive Index	1.700
Particle Absorption Index	0.100
Weighted Residual	0.70 %
Laser Power	79.40 %
Laser Obscuration	13.62 %
Accessory Name	Hydro MV
Software Version	3.88.2211.150

Result	
Dispersant Name	IPA
Dispersant Refractive Index	1.378
Analysis Model	General Purpose
Analysis Sensitivity	Normal
Are particles non-spherical?	Yes
Scattering Model	Mie
Accessory Serial No.	MAL1211922
Instrument Serial No.	MAL1220065
Virtual Lens Range	

Dv (10)	1.42 µm
Dv (50)	8.58 µm
Dv (90)	45.8 µm

D [4,3]	19.6 µm
Span	5.166

Frequency (compatible) and Undersize



Measurement Details	
File Path	R:\Malvern 3000\Measurement Data\61490-62.mmes
Record Number	15
Average Result Records	11, 12, 13, 14

FH 2023 12-11
KR 2023-12-12

Malvern 3000 Liquid Analysis v.2

ptl Particle Technology Labs

Measurement Details

Client WISS, JANNEY, ELSTNER ASSOCIATES, INC.
Test Method N/A
Operator Name fhamilton
SOP File Name HydroMV.cfg
Carrier Non-aqueous
Notes N/A

Measurement Details

Sample Name Average of 'Slag, Chicago IL (Holcim)'
Sample ID Slag
PTL ID 526656-62
Analysis Date Time 12/8/2023 11:28:22 AM
Measurement Date Time 12/8/2023 11:28:22 AM
Result Source Averaged

Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.166	0.00	2.75	23.00	45.6	89.96	756	100.00
0.0114	0.00	0.188	0.00	3.12	25.93	51.8	91.54	859	100.00
0.0129	0.00	0.214	0.00	3.55	28.94	58.9	92.87	976	100.00
0.0147	0.00	0.243	0.00	4.03	31.99	66.9	93.99	1110	100.00
0.0167	0.00	0.276	0.00	4.58	35.04	76.0	94.96	1260	100.00
0.0189	0.00	0.314	0.00	5.21	38.08	86.4	95.81	1430	100.00
0.0215	0.00	0.357	0.00	5.92	41.10	98.1	96.57	1630	100.00
0.0244	0.00	0.405	0.00	6.72	44.12	111	97.26	1850	100.00
0.0278	0.00	0.460	0.00	7.64	47.16	127	97.87	2100	100.00
0.0315	0.00	0.523	0.02	8.68	50.26	144	98.40	2390	100.00
0.0358	0.00	0.594	0.29	9.86	53.44	163	98.85	2710	100.00
0.0407	0.00	0.675	0.91	11.2	56.72	186	99.21	3080	100.00
0.0463	0.00	0.767	1.89	12.7	60.09	211	99.49	3500	100.00
0.0526	0.00	0.872	3.18	14.5	63.55	240	99.69		
0.0597	0.00	0.991	4.72	16.4	67.07	272	99.84		
0.0679	0.00	1.13	6.45	18.7	70.59	310	99.94		
0.0771	0.00	1.28	8.34	21.2	74.05	352	100.00		
0.0876	0.00	1.45	10.40	24.1	77.37	400	100.00		
0.0995	0.00	1.65	12.61	27.4	80.49	454	100.00		
0.113	0.00	1.88	14.99	31.1	83.34	516	100.00		
0.128	0.00	2.13	17.51	35.3	85.88	586	100.00		
0.146	0.00	2.42	20.19	40.1	88.08	666	100.00		

Measurement Details

File Path R:\Malvern 3000\Measurement Data\61490-62.mmes
Record Number 15
Average Result Records 11, 12, 13, 14

Malvern 3000 Liquid Analysis v.2

Measurement Details	
Client	WISS, JANNEY, ELSTNER ASSOCIATES, INC.
Test Method	N/A
Operator Name	fhamilton
SOP File Name	HydroMV.cfg
Carrier	Non-aqueous
Notes	N/A

Measurement Details	
Sample Name	Average of 'CarbonSense Cement, Ozinga'
Sample ID	CSC1157
PTL ID	526657-62
Analysis Date Time	12/8/2023 11:45:55 AM
Measurement Date Time	12/8/2023 11:45:55 AM
Result Source	Averaged

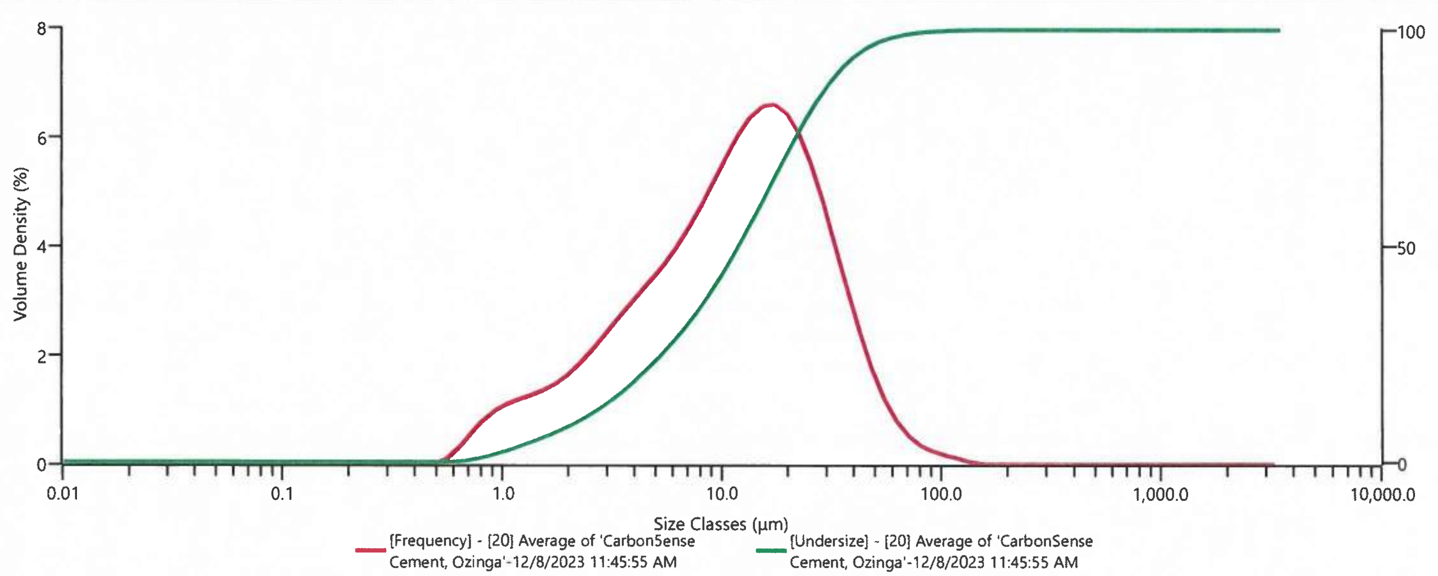
Analysis	
Particle Name	Cement
Particle Refractive Index	1.700
Particle Absorption Index	0.100
Weighted Residual	0.60 %
Laser Power	79.41 %
Laser Obscuration	13.80 %
Accessory Name	Hydro MV
Software Version	3.88.2211.150

Result	
Dispersant Name	IPA
Dispersant Refractive Index	1.378
Analysis Model	General Purpose
Analysis Sensitivity	Normal
Are particles non-spherical?	Yes
Scattering Model	Mie
Accessory Serial No.	MAL1211922
Instrument Serial No.	MAL1220065
Virtual Lens Range	

Dv (10)	2.31 µm
Dv (50)	12.0 µm
Dv (90)	33.9 µm

D [4,3]	15.8 µm
Span	2.639

Frequency (compatible) and Undersize



Measurement Details	
File Path	R:\Malvern 3000\Measurement Data\61490-62.mmes
Record Number	20
Average Result Records	16, 17, 18, 19

FH 2023-12-11
AK 2023-12-12

Malvern 3000 Liquid Analysis v.2

Particle Technology Labs

Measurement Details

Client WISS, JANNEY, ELSTNER ASSOCIATES, INC.
Test Method N/A
Operator Name fhamilton
SOP File Name HydroMV.cfg
Carrier Non-aqueous
Notes N/A

Measurement Details

Sample Name Average of 'CarbonSense Cement, Ozinga'
Sample ID CSC1157
PTL ID 526657-62
Analysis Date Time 12/8/2023 11:45:55 AM
Measurement Date Time 12/8/2023 11:45:55 AM
Result Source Averaged

Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.166	0.00	2.75	12.30	45.6	95.75	756	100.00
0.0114	0.00	0.188	0.00	3.12	14.29	51.8	97.19	859	100.00
0.0129	0.00	0.214	0.00	3.55	16.50	58.9	98.17	976	100.00
0.0147	0.00	0.243	0.00	4.03	18.92	66.9	98.83	1110	100.00
0.0167	0.00	0.276	0.00	4.58	21.56	76.0	99.25	1260	100.00
0.0189	0.00	0.314	0.00	5.21	24.42	86.4	99.53	1430	100.00
0.0215	0.00	0.357	0.00	5.92	27.50	98.1	99.72	1630	100.00
0.0244	0.00	0.405	0.00	6.72	30.83	111	99.86	1850	100.00
0.0278	0.00	0.460	0.00	7.64	34.46	127	99.96	2100	100.00
0.0315	0.00	0.523	0.00	8.68	38.42	144	100.00	2390	100.00
0.0358	0.00	0.594	0.08	9.86	42.75	163	100.00	2710	100.00
0.0407	0.00	0.675	0.32	11.2	47.44	186	100.00	3080	100.00
0.0463	0.00	0.767	0.79	12.7	52.47	211	100.00	3500	100.00
0.0526	0.00	0.872	1.47	14.5	57.78	240	100.00		
0.0597	0.00	0.991	2.29	16.4	63.26	272	100.00		
0.0679	0.00	1.13	3.22	18.7	68.77	310	100.00		
0.0771	0.00	1.28	4.22	21.2	74.14	352	100.00		
0.0876	0.00	1.45	5.28	24.1	79.20	400	100.00		
0.0995	0.00	1.65	6.41	27.4	83.79	454	100.00		
0.113	0.00	1.88	7.64	31.1	87.78	516	100.00		
0.128	0.00	2.13	9.01	35.3	91.11	586	100.00		
0.146	0.00	2.42	10.55	40.1	93.75	666	100.00		

Measurement Details

File Path R:\Malvern 3000\Measurement Data\61490-62.mmes
Record Number 20
Average Result Records 16, 17, 18, 19

APPENDIX. Plastic Properties

ASTM C403-23 - Setting Time of Concrete by Penetration Resistance

Project Number: 2023.4830.0 **Lab Coordinator:** T. Nelson **Project Manager:** T. Van Dam

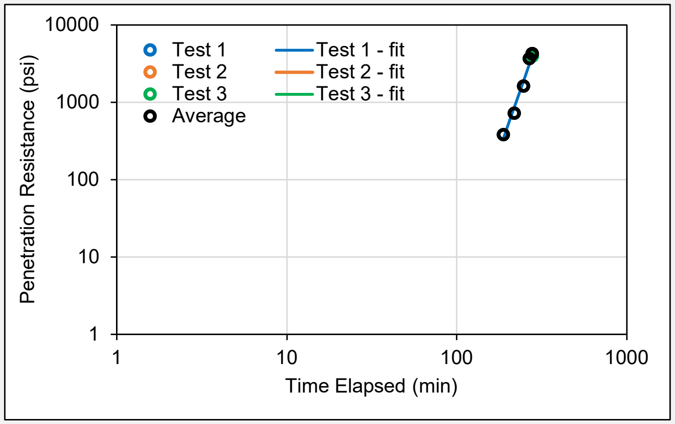
Operator: M. Haddad **Initials:** MH **Date:** 11/8/2023
Checked by: K. Pattaje **Initials:** KP **Date:** 11/17/2023

Mix ID: Mix 1-1

Time Batched: 11/8/2023 13:52

	Test 1	Test 2	Test 3
Mortar Temp. after Sieving (°F):	73.4		
Ambient Temp. at Start of Test (°F):	73.4		
Ambient Temp. at End of Test (°F):	73.6		

Time of Reading	Time Elapsed (min)	Penetration Resistance (psi)			
		Test 1	Test 2	Test 3	Average
11/8/23 13:52	0				
11/8/23 17:00	188	380			380
11/8/23 17:30	218	720			720
11/8/23 18:00	248	1620			1620
11/8/23 18:20	268	3680			3680
11/8/23 18:30	278	4240			4240
Time of Initial Set (h:mm):		3:20			**3:20**
Time of Final Set (h:mm):		4:38			**4:40**



Comments:

ASTM C403-23 - Setting Time of Concrete by Penetration Resistance

Project Number: 2023.4830 **Lab Coordinator:** T. Nelson **Project Manager:** T. Van Dam

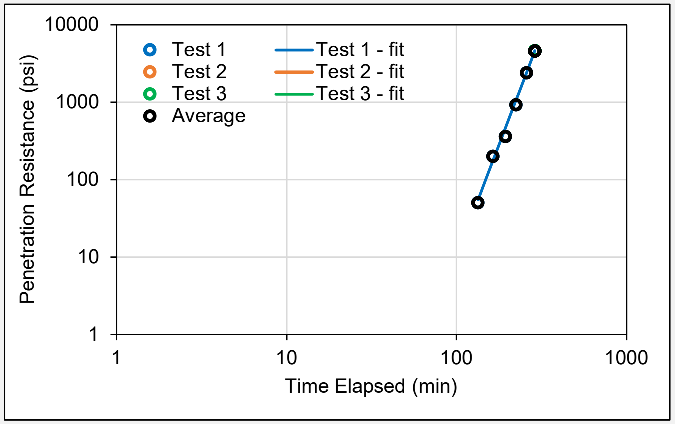
Operator: M. Haddad **Initials:** MH **Date:** 11/9/2023
Checked by: K. Pattaje **Initials:** KP **Date:** 11/17/2023

Mix ID: Mix 2-1

Time Batched: 11/9/2023 9:16

	Test 1	Test 2	Test 3
Mortar Temp. after Sieving (°F):	71.4		
Ambient Temp. at Start of Test (°F):	73.2		
Ambient Temp. at End of Test (°F):	73.4		

Time of Reading	Time Elapsed (min)	Penetration Resistance (psi)			
		Test 1	Test 2	Test 3	Average
11/9/23 9:16	0				
11/9/23 11:30	134	50			50
11/9/23 12:00	164	200			200
11/9/23 12:30	194	360			360
11/9/23 13:00	224	920			920
11/9/23 13:35	259	2400			2400
11/9/23 14:05	289	4560			4560
Time of Initial Set (h:mm):		3:17			**3:15**
Time of Final Set (h:mm):		4:42			**4:40**



Comments:

ASTM C403-23 - Setting Time of Concrete by Penetration Resistance

Project Number: 2023.4830.0 **Lab Coordinator:** T. Nelson **Project Manager:** T. Van Dam

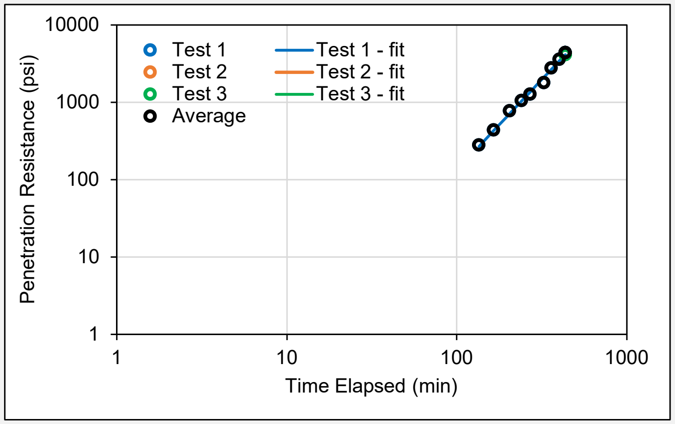
Operator: M. Haddad **Initials:** MH **Date:** 11/15/2023
Checked by: K. Pattaje **Initials:** KP **Date:** 11/17/2023

Mix ID: 3-3

Time Batched: 11/15/2023 9:45

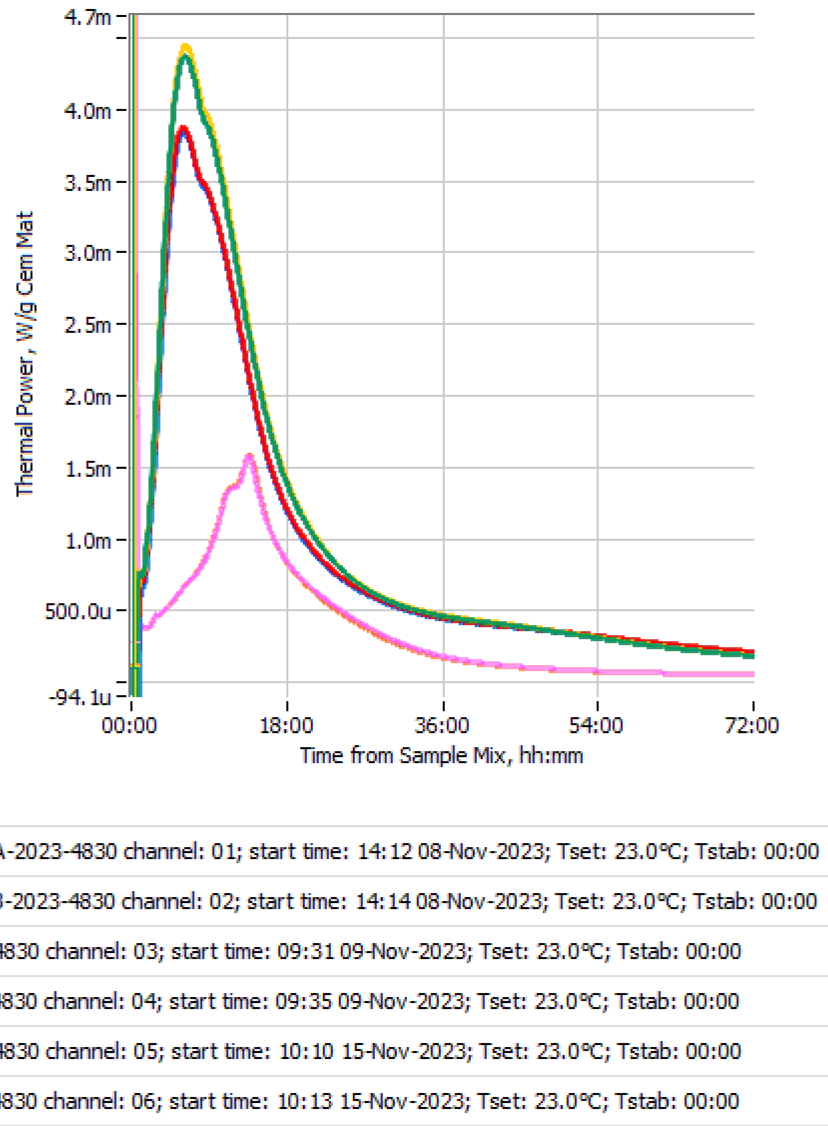
	Test 1	Test 2	Test 3
Mortar Temp. after Sieving (°F):	73.4		
Ambient Temp. at Start of Test (°F):	73.5		
Ambient Temp. at End of Test (°F):	73.0		

Time of Reading	Time Elapsed (min)	Penetration Resistance (psi)			
		Test 1	Test 2	Test 3	Average
11/15/23 9:45	0				
11/15/23 12:00	135	280			280
11/15/23 12:30	165	440			440
11/15/23 13:10	205	780			780
11/15/23 13:45	240	1060			1060
11/15/23 14:15	270	1280			1280
11/15/23 15:10	325	1800			1800
11/15/23 15:45	360	2800			2800
11/15/23 16:25	400	3600			3600
11/15/23 17:00	435	4400			4400
Time of Initial Set (h:mm):		2:56			**2:55**
Time of Final Set (h:mm):		7:08			**7:10**



Comments:

ASTM C1702. Heat of Hydration using Isothermal Calorimetry



ASTM C232-21 Bleeding of Concrete

Project Number: 2023.4830.0 **Lab Coordinator:** T. Nelson **Project Manager:** T. Van dam

Operator: R. Bee **Initials:** RB **Date:** 11/10/2023
Checked by: K. Pattaje **Initials:** KP **Date:** 11/17/2023

Mix ID & Batch No.: Mix 1-3

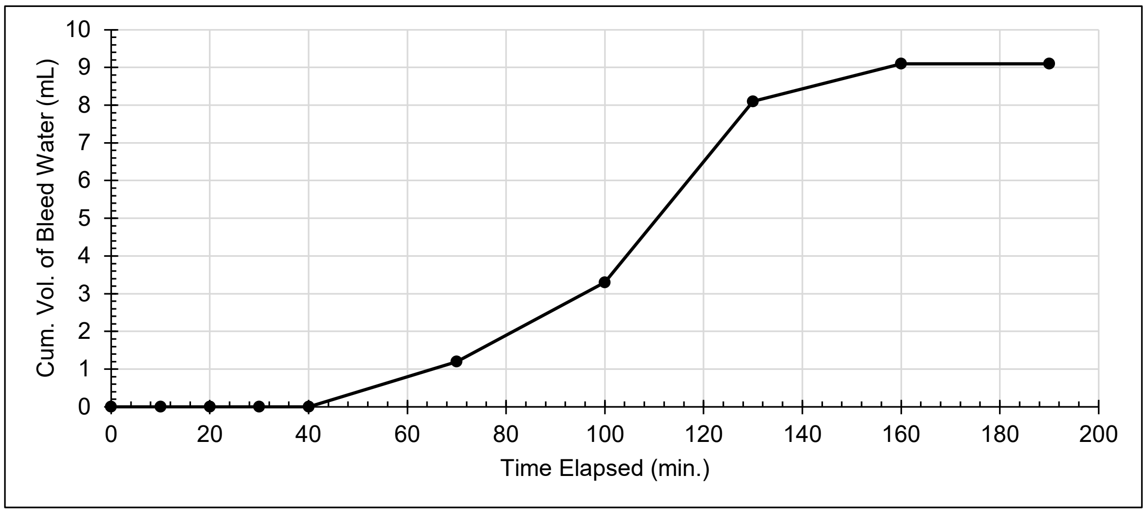
Date Batched: 11/10/2023

Time Batched: 8:12 AM

☐ Wet-sieved

Scales Used:
☐ Asset No. 2214
☒ Asset No. 2215
☐ Asset No. 2866
☐ Asset No. 5089
☐ Other: ________

Sample	Total Accumulated Bleed Water (%)	Time Req. for Cessation of Bleeding (min.)
Mix 1-3	0.4	190



Comments: ________

ASTM C232-21 Bleeding of Concrete

Project Number: 2023.4830.0 **Lab Coordinator:** T. Nelson **Project Manager:** T. Van dam

Operator: R. Bee **Initials:** RB **Date:** 11/15/2023
Checked by: K. Pattaje **Initials:** KP **Date:** 11/17/2023

Mix ID & Batch No.: Mix 2- 3

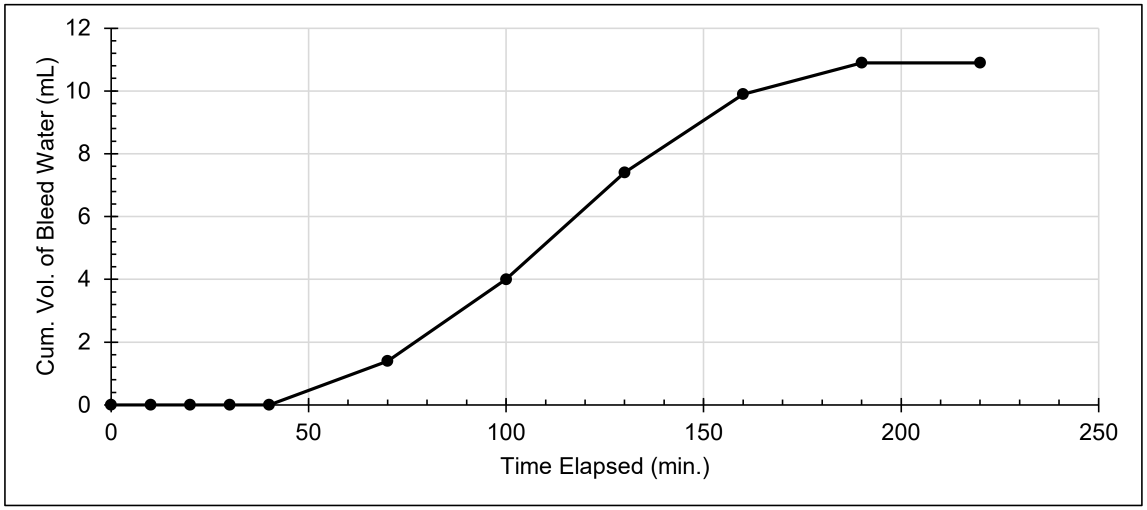
☐ Wet-sieved

Scales Used:
☐ Asset No. 2214
☒ Asset No. 2215
☐ Asset No. 2866
☐ Asset No. 5089
☐ Other:

Date Batched: 11/15/2023

Time Batched: 10:43 AM

Sample	Total Accumulated Bleed Water (%)	Time Req. for Cessation of Bleeding (min.)
Mix 2-4	0.5	220



Comments:

ASTM C232-21 Bleeding of Concrete

Project Number: 2023.4830.0 **Lab Coordinator:** T. Nelson **Project Manager:** T. Van dam

Operator: R. Bee **Initials:** RB **Date:** 11/15/2023
Checked by: K. Pattaje **Initials:** KP **Date:** 11/17/2023

Mix ID & Batch No.: Mix 3-3

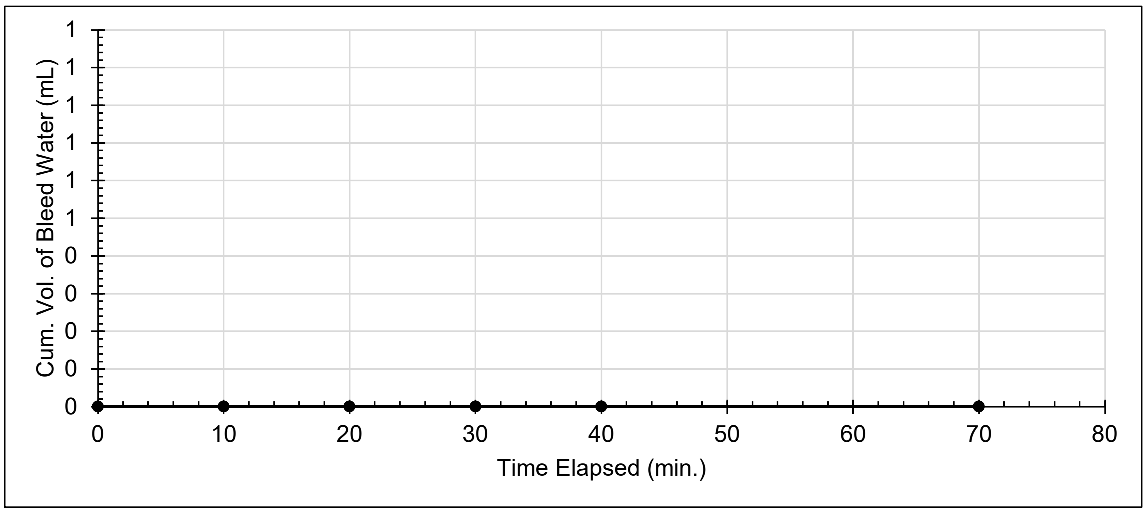
Date Batched: 11/15/2023

Time Batched: 9:43 AM

☐ Wet-sieved

Scales Used:
☐ Asset No. 2214
☒ Asset No. 2215
☐ Asset No. 2866
☐ Asset No. 5089
☐ Other: ________

Sample	Total Accumulated Bleed Water (%)	Time Req. for Cessation of Bleeding (min.)
Mix 3-3	0.0	70



Comments: ________

APPENDIX. Hardened Properties

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/9/2023

Checked by: T.Nelson **Date:** 11/9/2023

Capping Method
- ▫ Sulfur
- ▫ Lapped
- ▪ End Ground
- ▫ Unbonded

Conditioning
- ▫ As Received
- ▪ Wet
- ▫ Dry

Capping
- ▪ Plane
- ▫ Sound
- ▫ Other

Calipers
- ▪ 12/060107
- ▫ B657697
- ▫ Other 995

Test Machine
- ▪ Test Mark SN# 11005
- ▫ Satec ID: 120HLVC1240
- ▫ Other

Cast Date: 11/8/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix 1_1	7.82	150.1	3.99	12.52	36,660	2,928	1.96	1	None	1
Mix 1_2	7.81	150.2	3.99	12.52	38,330	3,062	1.96	1	None	1
Mix 1_3	7.80	149.5	4.00	12.59	39,430	3,132	1.95	1	None	1
Average	--	**150**	--	--	--	**3,040**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 1:45 pm

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/10/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Capping Method
- ☐ Sulfur
- ☐ Lapped
- ☒ End Ground
- ☐ Unbonded

Conditioning
- ☐ As Received
- ☒ Wet
- ☐ Dry

Capping
- ☒ Plane
- ☐ Sound
- ☐ Other

Calipers
- ☒ 12/060107
- ☐ B657697
- ☐ Other 995

Test Machine
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ Other

Cast Date: 11/8/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix 1_1	7.83	148.0	4.02	12.66	50,150	3,962	1.95	1	None	2
Mix 1_2	7.77	148.1	4.01	12.65	50,910	4,025	1.94	1	None	2
Mix 1_3	7.76	149.0	4.00	12.59	48,520	3,854	1.94	1	None	2
Average	--	**148**	--	--	--	**3,950**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 13:40

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ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.483 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/11/2023

Checked by: T.Nelson **Date:** 11/22/2023

Capping Method
- ▫ Sulfur
- ▫ Lapped
- ▣ End Ground
- ▫ Unbonded

Conditioning
- ▫ As Received
- ▣ Wet
- ▫ Dry

Capping
- ▣ Plane
- ▫ Sound
- ▫ Other

Calipers
- ▣ 12/060107
- ▫ B657697
- ▫ Other 995

Test Machine
- ▣ Test Mark SN# 11005
- ▫ Satec ID: 120HLVC1240
- ▫ Other

Cast Date: 11/8/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix 1_1	7.79	146.7	4.03	12.78	56,370	4,412	1.93	1	None	3
Mix 1_2	7.82	150.4	3.99	12.51	55,660	4,449	1.96	1	None	3
Mix 1_3	7.76	148.5	4.01	12.59	67,490	5,360	1.94	2	None	3
Average	--	**149**	--	--	--	**4,740**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 13:15

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/15/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Capping Method
- ☐ Sulfur
- ☐ Lapped
- ☒ End Ground
- ☐ Unbonded

Conditioning
- ☐ As Received
- ☒ Wet
- ☐ Dry

Capping
- ☒ Plane
- ☐ Sound
- ☐ Other

Calipers
- ☐ 12/060107
- ☒ B657697
- ☐ Other 995

Test Machine
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ Other

Cast Date: 11/8/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix 1_1	7.76	148.8	4.00	12.54	68,230	5,442	1.94	1	None	7
Mix 1_2	7.76	148.5	4.01	12.59	67,490	5,360	1.94			7
Mix 1_3	7.72	148.5	4.01	12.64	67,740	5,358	1.92	2	None	7
Average	--	**149**	--	--	--	**5,390**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 14:15

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/22/2023

Checked by: K. Pattaje **Date:** 11/28/2023

Capping Method
- ☐ Sulfur
- ☐ Lapped
- ☒ End Ground
- ☐ Unbonded

Conditioning
- ☐ As Received
- ☒ Wet
- ☐ Dry

Capping
- ☒ Plane
- ☐ Sound
- ☐ Other

Calipers
- ☐ 12/060107
- ☒ B657697
- ☐ Other 995

Test Machine
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ Other

Cast Date: 11/8/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix 1_A	7.76	148.6	4.02	12.66	69,290	5,471	1.93	1	None	14
Mix 1_B	7.81	149.2	4.02	12.66	72,040	5,691	1.95	1	None	14
Mix 1_C	7.79	149.6	4.01	12.61	73,110	5,796	1.94	2	None	14
Average	--	**149**	--	--	--	**5,650**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 3:15 pm

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0

Project Coordinator: T. Nelson

Operator: M. Haddad **Date:** 12/6/2023

Checked by: K. Pattaje **Date:** 12/6/2023

Capping Method
- ☐ Sulfur
- ☐ Lapped
- ☒ End Ground
- ☐ Unbonded

Conditioning
- ☐ As Received
- ☒ Wet
- ☐ Dry

Capping
- ☒ Plane
- ☐ Sound
- ☐ Other

Calipers
- ☒ 12/060107
- ☐ B657697
- ☐ Other 995

Test Machine
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ Other

Cast Date: 11/8/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix 1_A	7.81	149.6	4.00	12.55	81,450	6,491	1.95	1	None	28
Mix 1_B	7.80	149.5	4.01	12.63	79,870	6,326	1.95	2	None	28
Mix 1_C	7.82	148.2	4.01	12.63	81,520	6,455	1.95	1	None	28
Average	--	**149**	--	--	--	**6,420**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 1:15 pm

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0

Project Coordinator: T. Nelson

Operator: M. Haddad **Date:** 1/3/2024

Checked by: K. Pattaje **Date:** 1/4/2024

Capping Method
- [ ] Sulfur
- [ ] Lapped
- [x] End Ground
- [ ] Unbonded

Conditioning
- [ ] As Received
- [x] Wet
- [ ] Dry

Capping
- [x] Plane
- [ ] Sound
- [ ] Other

Calipers
- [x] 12/060107
- [ ] B657697
- [ ] Other 995

Test Machine
- [x] Test Mark SN# 11005
- [ ] Satec ID: 120HLVC1240
- [ ] Other

Cast Date: 11/8/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix 1_A	7.78	149.7	4.01	12.59	87,250	6,928	1.94	1	None	56
Mix 1_B	7.74	149.5	4.01	12.59	86,640	6,879	1.93	1	None	56
Mix 1_C	7.80	148.5	4.02	12.67	85,930	6,782	1.94	1	None	56
Average	--	**149**	--	--	--	**6,860**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 9:20 am

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/10/2023

Checked by: T.Nelson **Date:** 11/10/2023

Capping Method
- Sulfur
- Lapped
- End Ground
- Unbonded

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other 995

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/9/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix_2_1	7.79	148.8	4.01	12.60	33,860	2,687	1.94	1	None	1
Mix_2_2	7.83	153.6	3.95	12.22	33,550	2,745	1.98	1	None	1
Mix_2_3	7.79	145.8	4.03	12.76	32,740	2,565	1.93	2	None	1
Average	--	**149**	--	--	--	**2,670**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments:

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.483 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/11/2023

Checked by: T.Nelson **Date:** 11/22/2023

Capping Method
- Sulfur
- Lapped
- End Ground
- Unbonded

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other 995

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/9/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix_2_1	7.80	150.1	4.00	12.56	46,620	3,713	1.95	1	None	2
Mix_2_2	7.84	150.3	3.99	12.51	47,540	3,801	1.96	2	None	2
Mix_2_3	7.82	149.0	4.00	12.58	48,310	3,841	1.95	1	None	2
Average	--	**150**	--	--	--	**3,790**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 9:15 am

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0

Project Coordinator: T. Nelson

Operator: M. Haddad **Date:** 11/12/2023

Checked by: T.Nelson **Date:** 11/22/2023

Capping Method
- Sulfur
- Lapped
- End Ground
- Unbonded

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other 995

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/9/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix_2_1	7.81	148.3	4.02	12.70	57,260	4,507	1.94	1	None	3
Mix_2_2	7.83	147.9	4.00	12.56	55,860	4,447	1.96	1	None	3
Mix_2_3	7.77	148.3	4.01	12.64	56,050	4,436	1.94	1	None	3
Average	--	**148**	--	--	--	**4,460**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 9:20 am

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.483 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/16/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Capping Method	Conditioning	Capping	Calipers	Test Machine
☐ Sulfur	☐ As Received	☒ Plane	☐ 12/060107	☒ Test Mark SN# 11005
☐ Lapped	☒ Wet	☐ Sound	☒ B657697	☐ Satec ID: 120HLVC1240
☒ End Ground	☐ Dry	☐ Other	☐ Other 995	☐ Other
☐ Unbonded				

Cast Date: 11/9/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix_2_1	7.82	149.5	4.01	12.62	69,020	5,471	1.95	2	None	7
Mix_2_2	7.82	148.9	4.01	12.63	70,980	5,620	1.95	1	None	7
Mix_2_3	7.80	150.4	4.01	12.64	69,690	5,515	1.94	2	None	7
Average	--	**150**	--	--	--	**5,540**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 9:15 am

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/23/2023

Checked by: K. Pattaje **Date:** 11/28/2023

Capping Method
- [ ] Sulfur
- [ ] Lapped
- [x] End Ground
- [ ] Unbonded

Conditioning
- [ ] As Received
- [x] Wet
- [ ] Dry

Capping
- [x] Plane
- [ ] Sound
- [ ] Other

Calipers
- [ ] 12/060107
- [x] B657697
- [ ] Other 995

Test Machine
- [x] Test Mark SN# 11005
- [ ] Satec ID: 120HLVC1240
- [ ] Other

Cast Date: 11/9/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix_2_1	7.72	147.8	4.02	12.67	77,430	6,110	1.92	2	None	14
Mix_2_2	7.74	150.1	4.01	12.60	77,140	6,123	1.93	1	None	14
Mix_2_3	7.76	149.3	4.01	12.63	78,100	6,186	1.94	1	None	14
Average	--	**149**	--	--	--	**6,140**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 8:20 am

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 12/7/2023

Checked by: K. Pattaje **Date:** 12/8/2023

Capping Method
- ☐ Sulfur
- ☐ Lapped
- ☒ End Ground
- ☐ Unbonded

Conditioning
- ☐ As Received
- ☒ Wet
- ☐ Dry

Capping
- ☒ Plane
- ☐ Sound
- ☐ Other

Calipers
- ☒ 12/060107
- ☐ B657697
- ☐ Other 995

Test Machine
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ Other

Cast Date: 11/9/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix_2_1	7.83	150.0	4.01	12.60	79,400	6,303	1.95	1	None	28
Mix_2_2	7.87	149.3	4.02	12.66	88,080	6,955	1.96	1	None	28
Mix_2_3	7.89	149.6	4.01	12.64	83,240	6,588	1.97	2	None	28
Average	--	**150**	--	--	--	**6,620**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 11:50 am

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ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 1/4/2024

Checked by: K. Pattaje **Date:** 1/4/2024

Capping Method
- [ ] Sulfur
- [ ] Lapped
- [x] End Ground
- [ ] Unbonded

Conditioning
- [ ] As Received
- [x] Wet
- [ ] Dry

Capping
- [x] Plane
- [ ] Sound
- [ ] Other

Calipers
- [x] 12/060107
- [ ] B657697
- [ ] Other 995

Test Machine
- [x] Test Mark SN# 11005
- [ ] Satec ID: 120HLVC1240
- [ ] Other

Cast Date: 11/9/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix_2_1	7.80	150.4	4.01	12.64	90,120	7,129	1.94	1	None	56
Mix_2_2	7.83	150.0	4.01	12.62	91,480	7,247	1.95	1	None	56
Mix_2_3	7.80	149.9	4.00	12.57	91,300	7,262	1.95	1	None	56
Average	--	**150**	--	--	--	**7,210**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 8:10 am

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.483 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/15/2023

Checked by: T.Nelson **Date:** 11/15/2023

Capping Method
- Sulfur
- Lapped
- [x] End Ground
- Unbonded

Conditioning
- As Received
- [x] Wet
- Dry

Capping
- [x] Plane
- Sound
- Other

Calipers
- 12/060107
- [x] B657697
- Other 995

Test Machine
- [x] Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/14/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix_3_1 - 1 Day	7.79	152.0	4.01	12.60	22,710	1,802	1.94	2	None	1
Mix_3_2 - 1 Day	7.82	150.4	4.00	12.59	23,530	1,870	1.95	1	None	1
Mix_3_3 - 1 Day	7.81	149.5	4.03	12.72	24,460	1,922	1.94	1	None	1
Average	--	**151**	--	--	--	**1,860**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 12:10 pm

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/16/2023

Checked by: T.Nelson **Date:** 11/16/2023

Capping Method
- ☐ Sulfur
- ☐ Lapped
- ☒ End Ground
- ☐ Unbonded

Conditioning
- ☐ As Received
- ☒ Wet
- ☐ Dry

Capping
- ☒ Plane
- ☐ Sound
- ☐ Other

Calipers
- ☐ 12/060107
- ☒ B657697
- ☐ Other 995

Test Machine
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ Other

Cast Date: 11/14/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix 3 - 2 Day A	7.73	151.0	4.02	12.66	42,700	3,373	1.93	1	None	2
Mix 3 - 2 Day B	7.83	150.8	4.02	12.70	45,570	3,587	1.95	1	None	2
Mix 3 - 2 Day C	7.82	150.8	4.01	12.65	44,570	3,524	1.95	1	None	2
Average	--	**151**	--	--	--	**3,490**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 12:18 pm

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/17/2023

Checked by: T.Nelson **Date:** 11/17/2023

Capping Method
- ☐ Sulfur
- ☐ Lapped
- ☒ End Ground
- ☐ Unbonded

Conditioning
- ☐ As Received
- ☒ Wet
- ☐ Dry

Capping
- ☒ Plane
- ☐ Sound
- ☐ Other

Calipers
- ☐ 12/060107
- ☒ B657697
- ☐ Other 995

Test Machine
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ Other

Cast Date: 11/14/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix 3 - 3 Day A	7.82	151.4	4.00	12.55	49,670	3,957	1.95	1	None	3
Mix 3 - 3 Day B	7.83	151.8	4.01	12.59	55,690	4,423	1.96	2	None	3
Mix 3 - 3 Day C	7.82	152.6	3.99	12.52	53,180	4,247	1.96	1	None	3
Average	--	**152**	--	--	--	**4,210**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 11:30

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/21/2023

Checked by: T.Nelson **Date:** 11/22/2023

Capping Method	**Conditioning**	**Capping**	**Calipers**	**Test Machine**
[ ] Sulfur	[ ] As Received	[x] Plane	[ ] 12/060107	[x] Test Mark SN# 11005
[ ] Lapped	[x] Wet	[ ] Sound	[x] B657697	[ ] Satec ID: 120HLVC1240
[x] End Ground	[ ] Dry	[ ] Other	[ ] Other 995	[ ] Other
[ ] Unbonded				

Cast Date: 11/14/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix 3 - 7 Day A	7.84	151.7	4.00	12.58	71,940	5,718	1.96	2	None	7
Mix 3 - 7 Day B	7.84	151.5	4.01	12.60	67,390	5,349	1.96	1	None	7
Mix 3 - 7 Day C	7.79	150.5	4.02	12.67	67,450	5,325	1.94	2	None	7
Average	--	**151**	--	--	--	**5,460**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 12:10

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0

Project Coordinator: T. Nelson

Operator: M. Haddad **Date:** 11/28/2023

Checked by: T.Nelson **Date:** 11/28/2023

Capping Method
- Sulfur
- Lapped
- End Ground
- Unbonded

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other 995

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/14/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix 3 - 14 Day A	7.89	151.0	4.01	12.62	75,660	5,994	1.97	2	None	14
Mix 3 - 14 Day B	7.87	149.3	4.01	12.61	74,670	5,921	1.96	1	None	14
Mix 3 - 14 Day C	7.86	150.9	4.01	12.62	80,690	6,394	1.96	2	None	14
Average	--	**150**	--	--	--	**6,100**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 12:38

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 12/12/2023

Checked by: K. Pattaje **Date:** 12/18/2023

Capping Method
- Sulfur
- Lapped
- End Ground (checked)
- Unbonded

Conditioning
- As Received
- Wet (checked)
- Dry

Capping
- Plane (checked)
- Sound
- Other

Calipers
- 12/060107 (checked)
- B657697
- Other 995

Test Machine
- Test Mark SN# 11005 (checked)
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/14/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix 3 - 28 Day A	7.85	151.3	4.00	12.55	85,210	6,789	1.96	1	None	28
Mix 3 - 28 Day B	7.85	152.0	4.00	12.53	89,640	7,155	1.96	2	None	28
Mix 3 - 28 Day C	7.86	150.5	4.01	12.60	87,350	6,935	1.96	1	None	28
Average	--	**151**	--	--	--	**6,960**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 11:05

ASTM C39 Compressive Strength of Concrete Cylinders

Project No: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 1/9/2024

Checked by: K. Pattaje **Date:** 1/9/2024

Capping Method
- ☐ Sulfur
- ☐ Lapped
- ☒ End Ground
- ☐ Unbonded

Conditioning
- ☐ As Received
- ☒ Wet
- ☐ Dry

Capping
- ☒ Plane
- ☐ Sound
- ☐ Other

Calipers
- ☒ 12/060107
- ☐ B657697
- ☐ Other 995

Test Machine
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ Other

Cast Date: 11/14/2023

Sample ID	Capped Length (in.)	Density (lbs/ft³)	Avg. Dia. (in.)	Area (in.²)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects	Age of sample (days)
Mix 3 - 56 Day A	7.73	149.9	4.00	12.57	94,200	7,494	1.93	1	None	56
Mix 3 - 56 Day B	7.79	150.3	4.01	12.64	98,070	7,756	1.94	1	None	56
Mix 3 - 56 Day C	7.86	152.3	3.99	12.47	94,830	7,607	1.97	1	None	56
Average	--	**151**	--	--	--	**7,620**	--	--	--	--

The results presented in this test report relate only to the items tested.

Comments: Tested at 12:15

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ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0   **Project Coordinator:** T. Nelson

Operator: M. Haddad   **Date:** 11/9/2023
Checked by: T. Nelson   **Date:** 11/10/2023

Test Machine: ☑ Test Mark SN# 11005 ☐ Satec ID: 120HLVC1240 ☐ ________
Calipers: ☐ Starrett 12/060107 ☑ Generic B65697 ☐ ________
Type: ☑ Cylinder ☐ Core ☐ ________
Curing: ☐ Standard (Saturated) ☐ ASTM C42 / ACI 318 ☑ Stripped

Age of Specimens (days): 1

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix 1_1	7.82	3.99	20,480	420	20	Center	None
Mix 1_2	7.80	4.02	18,960	385	20	Center	None
Mix 1_3	7.83	4.05	19,360	390	20	Center	None
			Average	**398**			

Comments

Tested at 2:50 pm

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/10/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Test Machine: ☑ Test Mark SN# 11005 ☐ Satec ID: 120HLVC1240 ☐ ________

Calipers: ☑ Starrett 12/060107 ☐ Generic B65697 ☐ ________

Type: ☑ Cylinder ☐ Core ☐ ________

Curing: ☑ Standard (Saturated) ☐ ASTM C42 / ACI 318 ☐ Stripped

Age of Specimens (days): 2

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix 1_1	7.83	3.99	23,190	475	60	Center	None
Mix 1_2	7.84	4.00	22,570	460	60	Center	None
Mix 1_3	7.80	4.02	21,350	435	60	Center	None
			Average	**457**			

Comments

Tested at 2:30 pm

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/11/2023

Checked by: K. Pattaje **Date:** 11/17/2023

Test Machine:
- ☑ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ ______

Calipers:
- ☑ Starrett 12/060107
- ☐ Generic B65697
- ☐ ______

Type:
- ☑ Cylinder
- ☐ Core
- ☐ ______

Curing:
- ☑ Standard (Saturated)
- ☐ ASTM C42 / ACI 318
- ☐ Stripped

Age of Specimens (days): 3

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix 1_1	7.80	4.01	24,830	505	80	Center	None
Mix 1_2	7.80	4.01	24,110	490	80	Center	None
Mix 1_3	7.81	3.99	23,130	470	80	Center	None
			Average	**488**			

Comments

Tested at 1:45 pm

WJE | ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/15/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Test Machine:
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ ____

Calipers:
- ☐ Starrett 12/060107
- ☒ Generic B65697
- ☐ ____

Type:
- ☒ Cylinder
- ☐ Core
- ☐ ____

Curing:
- ☒ Standard (Saturated)
- ☐ ASTM C42 / ACI 318
- ☐ Stripped

Age of Specimens (days): 7

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix 1_1	7.82	4.00	31,870	650	95	Center	None
Mix 1_2	7.81	4.02	30,120	610	95	Center	None
Mix 1_3	7.81	4.00	31,390	640	95	Center	None
			Average	**633**			

Comments

Tested at 2:00 pm

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/22/2023

Checked by: K. Pattaje **Date:** 11/28/2023

Test Machine:
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ ____

Calipers:
- ☐ Starrett 12/060107
- ☒ Generic B65697
- ☐ ____

Type:
- ☒ Cylinder
- ☐ Core
- ☐ ____

Curing:
- ☒ Standard (Saturated)
- ☐ ASTM C42 / ACI 318
- ☐ Stripped

Age of Specimens (days): 14

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix 1_1	7.81	4.01	28,020	570	95	Center	None
Mix 1_2	7.76	4.01	28,670	585	95	Center	None
Mix 1_3	7.76	4.01	30,930	635	95	Center	None
			Average	**597**			

Comments

Tested at 4:00 pm

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 12/6/2023
Checked by: K. Pattaje **Date:** 12/6/2023

Test Machine:
- ☑ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ ______

Calipers:
- ☑ Starrett 12/060107
- ☐ Generic B65697
- ☐ ______

Type:
- ☑ Cylinder
- ☐ Core
- ☐ ______

Curing:
- ☑ Standard (Saturated)
- ☐ ASTM C42 / ACI 318
- ☐ Stripped

Age of Specimens (days): 28

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix 1 - 1	7.81	4.02	33,400	680	95	Center	None
Mix 1 - 2	7.82	4.02	32,060	650	95	Center	None
Mix 1 - 3	7.82	3.99	31,170	635	95	Center	None
			Average	**655**			

Comments

Tested at 2:05 pm

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 1/3/2024

Checked by: K. Pattaje **Date:** 1/4/2024

Test Machine:
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ ____

Calipers:
- ☒ Starrett 12/060107
- ☐ Generic B65697
- ☐ ____

Type:
- ☒ Cylinder
- ☐ Core
- ☐ ____

Curing:
- ☒ Standard (Saturated)
- ☐ ASTM C42 / ACI 318
- ☐ Stripped

Age of Specimens (days): 56

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix 1 - 1	7.81	4.00	33,000	670	95	center	none
Mix 1 - 2	7.82	4.00	31,580	645	95	center	none
Mix 1 - 3	7.82	3.99	32,430	660	95	center	none
			Average	**658**			

Comments

Tested at 11:15 am

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0

Project Coordinator: T. Nelson

Operator: M. Haddad **Date:** 11/10/2023

Checked by: T. Nelson **Date:** 11/10/2023

Test Machine:
- [x] Test Mark SN# 11005
- [ ] Satec ID: 120HLVC1240
- [ ] ______

Calipers:
- [ ] Starrett 12/060107
- [x] Generic B65697
- [ ] ______

Type:
- [x] Cylinder
- [ ] Core
- [ ] ______

Curing:
- [ ] Standard (Saturated)
- [ ] ASTM C42 / ACI 318
- [x] Stripped

Age of Specimens (days): 1

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix_2_1	7.86	4.01	16,630	335	50	Center	None
Mix_2_2	7.80	4.00	17,600	360	50	Center	None
Mix_2_3	7.82	4.03	16,860	340	50	Center	None

Comments

Tested at 9:30 am

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0

Project Coordinator: T. Nelson

Operator: M. Haddad **Date:** 11/11/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Test Machine:
- ☑ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ ____________

Calipers:
- ☑ Starrett 12/060107
- ☐ Generic B65697
- ☐ ____________

Type:
- ☑ Cylinder
- ☐ Core
- ☐ ____________

Curing:
- ☑ Standard (Saturated)
- ☐ ASTM C42 / ACI 318
- ☐ Stripped

Age of Specimens (days): 2

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix_2_1	7.77	4.01	22,360	455	75	Center	None
Mix_2_2	7.81	3.98	21,880	445	75	Center	None
Mix_2_3	7.81	4.03	22,190	450	75	Center	None
			Average	**450**			

Comments

Tested at 9:45 am

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/12/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Test Machine: ☑ Test Mark SN# 11005 ☐ Satec ID: 120HLVC1240 ☐

Calipers: ☑ Starrett 12/060107 ☐ Generic B65697 ☐

Type: ☑ Cylinder ☐ Core ☐

Curing: ☑ Standard (Saturated) ☐ ASTM C42 / ACI 318 ☐ Stripped

Age of Specimens (days): 3

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix_2_1	7.82	4.01	22,460	455	85	Center	None
Mix_2_2	7.86	4.01	22,020	445	85	Center	None
Mix_2_3	7.81	3.98	22,280	455	85	Center	None

Comments

Tested at 9:00 am

WJE | ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/16/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Test Machine:
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ ______

Calipers:
- ☐ Starrett 12/060107
- ☒ Generic B65697
- ☐ ______

Type:
- ☒ Cylinder
- ☐ Core
- ☐ ______

Curing:
- ☒ Standard (Saturated)
- ☐ ASTM C42 / ACI 318
- ☐ Stripped

Age of Specimens (days): 7

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix_2_1	7.77	4.01	29,240	595	90	Center	None
Mix_2_2	7.78	4.01	27,980	570	90	Center	None
Mix_2_3	7.78	3.99	26,750	550	90	Center	None

Comments

Tested at 9:55 am

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/23/2023
Checked by: K. Pattaje **Date:** 11/28/2023

Test Machine:
- [x] Test Mark SN# 11005
- [ ] Satec ID: 120HLVC1240
- [ ] ______

Calipers:
- [ ] Starrett 12/060107
- [x] Generic B65697
- [ ] ______

Type:
- [x] Cylinder
- [ ] Core
- [ ] ______

Curing:
- [x] Standard (Saturated)
- [ ] ASTM C42 / ACI 318
- [ ] Stripped

Age of Specimens (days): 14

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix_2_1	7.86	4.00	29,640	600	95	Center	None
Mix_2_2	7.86	4.02	30,190	610	95	Center	None
Mix_2_3	7.86	4.03	30,610	615	95	Center	None
			Average	**608**			

Comments

Tested at 9:00 am

WJE | ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 12/7/2023

Checked by: K. Pattaje **Date:** 12/8/2023

Test Machine:
- ☑ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ ______

Calipers:
- ☑ Starrett 12/060107
- ☐ Generic B65697
- ☐ ______

Type:
- ☑ Cylinder
- ☐ Core
- ☐ ______

Curing:
- ☑ Standard (Saturated)
- ☐ ASTM C42 / ACI 318
- ☐ Stripped

Age of Specimens (days): 28

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix 2-2 1	7.90	3.99	33,160	670	95	Center	None
Mix 2-2 2	7.88	4.02	34,320	690	95	Center	None
Mix 2-2 3	7.91	4.01	35,200	705	95	Center	None
			Average	**688**			

Comments

Tested at 12:30 pm

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 1/4/2024

Checked by: K. Pattaje **Date:** 1/4/2024

Test Machine: ☒ Test Mark SN# 11005 ☐ Satec ID: 120HLVC1240 ☐ ____

Calipers: ☒ Starrett 12/060107 ☐ Generic B65697 ☐ ____

Type: ☒ Cylinder ☐ Core ☐ ____

Curing: ☒ Standard (Saturated) ☐ ASTM C42 / ACI 318 ☐ Stripped

Age of Specimens (days): 56

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix 2-2 1	7.91	4.02	36,110	725	95	Center	None
Mix 2-2 2	7.86	4.01	37,050	750	95	Center	None
Mix 2-2 3	7.86	4.00	35,020	710	95	Center	None
			Average	**728**			

Comments

Tested at 9:00 am

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/15/2023

Checked by: T.Nelson **Date:** 11/15/2023

Test Machine:
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐

Calipers:
- ☐ Starrett 12/060107
- ☒ Generic B65697
- ☐

Type:
- ☒ Cylinder
- ☐ Core
- ☐

Curing:
- ☐ Standard (Saturated)
- ☐ ASTM C42 / ACI 318
- ☒ Stripped

Age of Specimens (days): 1

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix_3_1	7.94	4.00	13,870	280	10	Center	None
Mix_3_2	7.93	4.04	13,120	260	10	Center	None
Mix_3_3	7.99	4.03	12,760	250	10	Center	None
Average				**263**			

Comments

Tested at 12:45 pm

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/16/2023
Checked by: T.Nelson **Date:** 11/16/2023

Test Machine:
- [x] Test Mark SN# 11005
- [ ] Satec ID: 120HLVC1240
- [ ] ______

Calipers:
- [ ] Starrett 12/060107
- [x] Generic B65697
- [ ] ______

Type:
- [x] Cylinder
- [ ] Core
- [ ] ______

Curing:
- [x] Standard (Saturated)
- [ ] ASTM C42 / ACI 318
- [ ] Stripped

Age of Specimens (days): 2

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
1	7.78	4.01	24,640	505	35	Center	None
2	7.78	4.01	25,650	525	35	Center	None
3	7.80	4.00	23,550	480	35	Center	None
Average				**503**			

Comments

Tested at 12:00 pm

WJE | ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/17/2023
Checked by: K. Pattaje **Date:** 11/17/2023

Test Machine:
- [x] Test Mark SN# 11005
- [ ] Satec ID: 120HLVC1240
- [ ] ____________

Calipers:
- [ ] Starrett 12/060107
- [x] Generic B65697
- [ ] ____________

Type:
- [x] Cylinder
- [ ] Core
- [ ] ____________

Curing:
- [x] Standard (Saturated)
- [ ] ASTM C42 / ACI 318
- [ ] Stripped

Age of Specimens (days): 3

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix_3_1	7.84	4.00	26,880	545	75	Center	None
Mix_3_2	7.80	4.00	25,520	520	75	Center	None
Mix_3_3	7.92	4.03	24,960	500	75	Center	None
Average				**522**			

Comments

Tested at 12:15 pm

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/21/2023
Checked by: K. Pattaje **Date:** 11/21/2023

Test Machine: ☒ Test Mark SN# 11005 ☐ Satec ID: 120HLVC1240 ☐ ______
Calipers: ☐ Starrett 12/060107 ☒ Generic B65697 ☐ ______
Type: ☒ Cylinder ☐ Core ☐ ______
Curing: ☒ Standard (Saturated) ☐ ASTM C42 / ACI 318 ☐ Stripped

Age of Specimens (days): 7

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
3-2 1	7.82	3.99	27,970	570	95	Center	None
3-2 2	7.86	4.00	28,050	570	95	Center	None
3-2 3	7.81	3.99	29,130	595	95	Center	None
Average				**578**			

Comments

Tested at 12:30 pm

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/28/2023

Checked by: K. Pattaje **Date:** 11/28/2023

Test Machine:
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ ____

Calipers:
- ☒ Starrett 12/060107
- ☐ Generic B65697
- ☐ ____

Type:
- ☒ Cylinder
- ☐ Core
- ☐ ____

Curing:
- ☒ Standard (Saturated)
- ☐ ASTM C42 / ACI 318
- ☐ Stripped

Age of Specimens (days): 14

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
3-1 1	7.91	3.99	34,400	695	95	Center	None
3-1 2	7.88	4.01	33,690	680	95	Center	None
3-1 3	7.83	4.00	34,250	695	95	Center	None
Average				**690**			

Comments

Tested at 1:20 pm

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 12/12/2023

Checked by: K. Pattaje **Date:** 12/17/2023

Test Machine: ☑ Test Mark SN# 11005 ☐ Satec ID: 120HLVC1240 ☐ ____

Calipers: ☑ Starrett 12/060107 ☐ Generic B65697 ☐ ____

Type: ☑ Cylinder ☐ Core ☐ ____

Curing: ☑ Standard (Saturated) ☐ ASTM C42 / ACI 318 ☐ Stripped

Age of Specimens (days): 28

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
3-1 1	7.83	4.00	34,530	700	95	Center	None
3-1 2	7.79	4.01	28,090	570	95	Center	None
3-1 3	7.85	4.02	35,250	710	95	Center	None
Average				**705**			

Comments

Tested at 12:20 pm; Sample 2 outlier

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C496 Splitting Tensile Strength of Cylindrical Concrete Specimens

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 1/9/2024

Checked by: K. Pattaje **Date:** 1/9/2024

Test Machine:
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ ____________

Calipers:
- ☒ Starrett 12/060107
- ☐ Generic B65697
- ☐ ____________

Type:
- ☒ Cylinder
- ☐ Core
- ☐ ____________

Curing:
- ☒ Standard (Saturated)
- ☐ ASTM C42 / ACI 318
- ☐ Stripped

Age of Specimens (days): 56

Sample ID	Average Length (in.)	Average Diameter (in.)	Max. Load (lbf.)	Splitting Tensile Strength (psi)	Estimated Proportion of Coarse Aggregate Fractured (%)	Fracture Type	Defects in Sample
Mix 3-1 1	7.86	3.99	33,210	675	95	Center	None
Mix 3-1 2	7.87	4.01	33,260	670	95	Center	None
Mix 3-1 3	7.81	4.02	35,620	725	95	Center	None
Average				**700**			

Comments

Tested at 1:10

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/9/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/8/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 1-1 A	1	7.81	3.99	12.52	150.2	38,330	3,060	1.96	1	None

Modulus of Elasticity (psi)	3,600,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/9/2023

Checked by: T.Nelson **Date:** 11/9/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/8/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 1-1 B	1	7.80	4.00	12.59	149.4	39,430	3,130	1.95	1	None

Modulus of Elasticity (psi)	3,750,000
Poisson's Ratio	

Comments:

Issue Date 8/30/18
Revision 1.0

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/10/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Capping Method ☐ Sulfur ☐ Lapped ☐ Unbonded ☐ End gound

Conditioning ☐ As Received ☐ Wet ☐ Dry

Capping ☐ Plane ☐ Sound ☐ Other

Calipers ☐ 12/060107 ☐ B657697 ☐ Other

Test Machine ☐ Test Mark SN# 11005 ☐ Satec ID: 120HLVC1240 ☐ Other

Cast Date: 11/8/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 1-1 A	2	7.77	4.01	12.65	148.0	50,910	4,020	1.94	1	None

Modulus of Elasticity (psi)	4,125,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/10/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Capping Method ▫ Sulfur ▫ Lapped ▫ Unbonded ▫ End gound

Conditioning ▫ As Received ▫ Wet ▫ Dry

Capping ▫ Plane ▫ Sound ▫ Other

Calipers ▫ 12/060107 ▫ B657697 ▫ Other

Test Machine ▫ Test Mark SN# 11005 ▫ Satec ID: 120HLVC1240 ▫ Other

Cast Date: 11/8/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 1-1 B	2	7.76	4.00	12.59	148.9	48,520	3,850	1.94	1	None

Modulus of Elasticity (psi)	3,975,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/11/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/8/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 1-1 A	3	7.82	3.99	12.52	150.3	55,660	4,450	1.96	1	None

Modulus of Elasticity (psi)	4,450,000
Poisson's Ratio	

Comments:

WJE | ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/11/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/8/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 1-1 B	3	7.87	4.01	12.61	148.4	56,540	4,480	1.96	1	None

Modulus of Elasticity (psi)	4,250,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/15/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Capping Method
- ▫ Sulfur
- ⌗ Lapped
- ▫ Unbonded
- ▫ End gound

Conditioning
- ▫ As Received
- ▫ Wet
- ▫ Dry

Capping
- ▫ Plane
- ▫ Sound
- ▫ Other

Calipers
- ▫ 12/060107
- ▫ B657697
- ▫ Other

Test Machine
- ▫ Test Mark SN# 11005
- ▫ Satec ID: 120HLVC1240
- ▫ Other

Cast Date: 11/8/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 1-1 A	7	7.76	4.01	12.60	148.4	67,490	5,360	1.94	1	None

Modulus of Elasticity (psi)	4,875,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/15/2023

Checked by: ______ **Date:** ______

Capping Method ◻ Sulfur ◻ Lapped ◻ Unbonded ◻ End gound

Conditioning ◻ As Received ◻ Wet ◻ Dry

Capping ◻ Plane ◻ Sound ◻ Other

Calipers ◻ 12/060107 ◻ B657697 ◻ Other

Test Machine ◻ Test Mark SN# 11005 ◻ Satec ID: 120HLVC1240 ◻ Other

Cast Date: 11/8/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 1-1 B	7	7.72	4.01	12.65	148.4	67,740	5,360	1.92	2	None

Modulus of Elasticity (psi)	4,925,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/22/2023

Checked by: K. Pattaje **Date:** 11/28/2023

Capping Method ▫ Sulfur ▫# Lapped ▫ Unbonded ▫ End gound

Conditioning ▫ As Received ▫ Wet ▫ Dry

Capping ▫ Plane ▫ Sound ▫ Other

Calipers ▫ 12/060107 ▫ B657697 ▫ Other

Test Machine ▫ Test Mark SN# 11005 ▫ Satec ID: 120HLVC1240 ▫ Other

Cast Date: 11/8/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 1-2 A	14	7.81	4.02	12.66	149.1	72,040	5,690	1.95	1	None

Modulus of Elasticity (psi)	4,750,000
Poisson's Ratio	

Comments:

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/22/2023

Checked by: K. Pattaje **Date:** 11/28/2023

Capping Method ☐ Sulfur ☒ Lapped ☐ Unbonded ☐ End gound

Conditioning ☐ As Received ☐ Wet ☐ Dry

Capping ☐ Plane ☐ Sound ☐ Other

Calipers ☐ 12/060107 ☐ B657697 ☐ Other

Test Machine ☐ Test Mark SN# 11005 ☐ Satec ID: 120HLVC1240 ☐ Other

Cast Date: 11/8/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 1-2 B	14	7.79	4.01	12.62	149.5	73,110	5,790	1.94	2	None

Modulus of Elasticity (psi)	4,875,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 12/6/2023

Checked by: K. Pattaje **Date:** 12/6/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/8/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 1-2 A	28	7.80	4.01	12.63	149.5	79,870	6,320	1.95	2	None

Modulus of Elasticity (psi)	5,000,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 12/6/2023

Checked by: K. Pattaje **Date:** 12/6/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/8/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 1-2 B	28	7.82	4.01	12.64	148.1	81,520	6,450	1.95	1	None

Modulus of Elasticity (psi)	5,075,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 1/3/2024

Checked by: K. Pattaje **Date:** 1/4/2024

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/8/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 1-2 A	56	7.74	4.01	12.60	149.4	86,640	6,880	1.93	1	None

Modulus of Elasticity (psi)	5,250,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 1/3/2024

Checked by: K. Pattaje **Date:** 1/4/2024

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/8/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 1-2 B	56	7.80	4.02	12.68	148.4	85,930	6,780	1.94	1	None

Modulus of Elasticity (psi)	5,200,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/10/2023

Checked by: T.Nelson **Date:** 11/10/2023

Capping Method ▫ Sulfur ▫# Lapped ▫ Unbonded ▫ End gound

Conditioning ▫ As Received ▫ Wet ▫ Dry

Capping ▫ Plane ▫ Sound ▫ Other

Calipers ▫ 12/060107 ▫ B657697 ▫ Other

Test Machine ▫ Test Mark SN# 11005 ▫ Satec ID: 120HLVC1240 ▫ Other

Cast Date: 11/9/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 2-1 A	1	7.83	3.95	12.23	153.5	33,550	2,740	1.98	1	None

Modulus of Elasticity (psi)	3,675,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830

Project Coordinator: T. Nelson

Operator: M. Haddad **Date:** 11/10/2023

Checked by: T. Nelson **Date:** 11/10/2023

Capping Method
- ☐ Sulfur
- ☒ Lapped
- ☐ Unbonded
- ☐ End gound

Conditioning
- ☐ As Received
- ☐ Wet
- ☐ Dry

Capping
- ☐ Plane
- ☐ Sound
- ☐ Other

Calipers
- ☐ 12/060107
- ☐ B657697
- ☐ Other

Test Machine
- ☐ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ Other

Cast Date: 11/9/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 2-1 B	1	7.79	4.03	12.77	145.8	32,740	2,560	1.93	2	None

Modulus of Elasticity (psi)	3,525,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830

Project Coordinator: T. Nelson

Operator: M. Haddad **Date:** 11/11/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/9/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 2-1 A	2	7.84	3.99	12.51	150.2	47,540	3,800	1.96	2	None

Modulus of Elasticity (psi)	4,275,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/11/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/9/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 2-1 B	2	7.82	4.00	12.59	148.9	48,310	3,840	1.95	1	None

Modulus of Elasticity (psi)	4,225,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/12/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/9/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 2-1 A	3	7.83	4.00	12.57	147.9	55,860	4,450	1.96	1	None

Modulus of Elasticity (psi)	4,600,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/12/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Capping Method
- Sulfur
- # Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/9/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.^{2})	Density (lb/ft^3)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 2-1 B	3	7.77	4.01	12.64	148.2	56,050	4,430	1.94	1	None

Modulus of Elasticity (psi)	4,225,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/16/2023

Checked by: **Date:**

Capping Method ▫ Sulfur ▫# Lapped ▫ Unbonded ▫ End gound

Conditioning ▫ As Received ▫ Wet ▫ Dry

Capping ▫ Plane ▫ Sound ▫ Other

Calipers ▫ 12/060107 ▫ B657697 ▫ Other

Test Machine ▫ Test Mark SN# 11005 ▫ Satec ID: 120HLVC1240 ▫ Other

Cast Date: 11/9/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 2-1 A	7	7.82	4.01	12.64	148.8	70,980	5,620	1.95	1	None

Modulus of Elasticity (psi)	4,700,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/16/2023

Checked by: ______ **Date:** ______

Capping Method ▫ Sulfur ▫# Lapped ▫ Unbonded ▫ End gound

Conditioning ▫ As Received ▫ Wet ▫ Dry

Capping ▫ Plane ▫ Sound ▫ Other

Calipers ▫ 12/060107 ▫ B657697 ▫ Other

Test Machine ▫ Test Mark SN# 11005 ▫ Satec ID: 120HLVC1240 ▫ Other

Cast Date: 11/9/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 2-1 B	7	7.80	4.01	12.64	150.3	69,690	5,510	1.94	2	None

Modulus of Elasticity (psi)	4,725,000
Poisson's Ratio	

Comments: ______

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/23/2023

Checked by: K. Pattaje **Date:** 11/28/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/9/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 2-2 A	14	7.74	4.01	12.60	150.0	77,140	6,120	1.93	1	None

Modulus of Elasticity (psi)	4,950,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/23/2023

Checked by: K. Pattaje **Date:** 11/28/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/9/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 2-2 B	14	7.76	4.01	12.63	149.2	78,100	6,180	1.94	1	None

Modulus of Elasticity (psi)	5,000,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 12/7/2023

Checked by: K. Pattaje **Date:** 12/8/2023

Capping Method ▫ Sulfur ▫ Lapped ▫ Unbonded ▫ End gound

Conditioning ▫ As Received ▫ Wet ▫ Dry

Capping ▫ Plane ▫ Sound ▫ Other

Calipers ▫ 12/060107 ▫ B657697 ▫ Other

Test Machine ▫ Test Mark SN# 11005 ▫ Satec ID: 120HLVC1240 ▫ Other

Cast Date: 11/9/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 2-2 A	28	7.87	4.02	12.67	149.2	88,080	6,950	1.96	1	None

Modulus of Elasticity (psi)	5,000,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 12/7/2023

Checked by: K. Pattaje **Date:** 12/8/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/9/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 2-2 B	28	7.89	4.01	12.64	149.5	83,240	6,580	1.97	2	None

Modulus of Elasticity (psi)	5,500,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 1/4/2024

Checked by: K. Pattaje **Date:** 1/4/2024

Capping Method ▫ Sulfur ☒ Lapped ▫ Unbonded ▫ End gound

Conditioning ▫ As Received ▪ Wet ▫ Dry

Capping ▪ Plane ▫ Sound ▫ Other

Calipers ▪ 12/060107 ▫ B657697 ▫ Other

Test Machine ▪ Test Mark SN# 11005 ▫ Satec ID: 120HLVC1240 ▫ Other

Cast Date: 11/9/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 2-2 A	56	7.83	4.01	12.63	149.9	91,480	7,240	1.95	1	None

Modulus of Elasticity (psi)	5,225,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 1/4/2024

Checked by: K. Pattaje **Date:** 1/4/2024

Capping Method
- Sulfur
- # Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/9/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 2-2 B	56	7.80	4.00	12.58	149.8	91,300	7,260	1.95	1	None

Modulus of Elasticity (psi)	5,300,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/15/2023

Checked by: T.Nelson **Date:** 11/15/2023

Capping Method ▫ Sulfur ▫# Lapped ▫ Unbonded ▫ End gound

Conditioning ▫ As Received ▫ Wet ▫ Dry

Capping ▫ Plane ▫ Sound ▫ Other

Calipers ▫ 12/060107 ▫ B657697 ▫ Other

Test Machine ▫ Test Mark SN# 11005 ▫ Satec ID: 120HLVC1240 ▫ Other

Cast Date: 11/14/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 3-2 A	1	7.82	4.00	12.59	150.3	23,530	1,870	1.95	1	None

Modulus of Elasticity (psi)	3,225,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/15/2023

Checked by: T.Nelson **Date:** 11/15/2023

Capping Method
- ▫ Sulfur
- # Lapped
- ▫ Unbonded
- ▫ End gound

Conditioning
- ▫ As Received
- ▫ Wet
- ▫ Dry

Capping
- ▫ Plane
- ▫ Sound
- ▫ Other

Calipers
- ▫ 12/060107
- ▫ B657697
- ▫ Other

Test Machine
- ▫ Test Mark SN# 11005
- ▫ Satec ID: 120HLVC1240
- ▫ Other

Cast Date: 11/14/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 3-2 B	1	7.81	4.03	12.73	149.3	24,460	1,920	1.94	1	None

Modulus of Elasticity (psi)	3,200,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/16/2023

Checked by: T.Nelson **Date:** 11/16/2023

Capping Method ◻ Sulfur ◻ Lapped ◻ Unbonded ◻ End gound

Conditioning ◻ As Received ◻ Wet ◻ Dry

Capping ◻ Plane ◻ Sound ◻ Other

Calipers ◻ 12/060107 ◻ B657697 ◻ Other

Test Machine ◻ Test Mark SN# 11005 ◻ Satec ID: 120HLVC1240 ◻ Other

Cast Date: 11/14/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 3-2 A	2	7.83	4.02	12.71	150.8	45,570	3,580	1.95	1	None

Modulus of Elasticity (psi)	4,375,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/16/2023

Checked by: T.Nelson **Date:** 11/16/2023

Capping Method ☐ Sulfur ☒ Lapped ☐ Unbonded ☐ End gound

Conditioning ☐ As Received ☐ Wet ☐ Dry

Capping ☐ Plane ☐ Sound ☐ Other

Calipers ☐ 12/060107 ☐ B657697 ☐ Other

Test Machine ☐ Test Mark SN# 11005 ☐ Satec ID: 120HLVC1240 ☐ Other

Cast Date: 11/14/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 3-2 B	2	7.82	4.01	12.65	150.8	44,570	3,520	1.95	1	None

Modulus of Elasticity (psi)	4,625,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830

Project Coordinator: T. Nelson

Operator: M. Haddad **Date:** 11/17/2023

Checked by: K.Pattaje **Date:** 11/17/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/14/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 3-2 A	3	7.83	4.01	12.60	151.7	55,690	4,420	1.96	2	None

Modulus of Elasticity (psi)	4,725,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830

Project Coordinator: T. Nelson

Operator: M. Haddad **Date:** 11/17/2023

Checked by: ______ **Date:** ______

Capping Method ▫ Sulfur ▫# Lapped ▫ Unbonded ▫ End gound

Conditioning ▫ As Received ▫ Wet ▫ Dry

Capping ▫ Plane ▫ Sound ▫ Other

Calipers ▫ 12/060107 ▫ B657697 ▫ Other

Test Machine ▫ Test Mark SN# 11005 ▫ Satec ID: 120HLVC1240 ▫ Other

Cast Date: 11/14/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 3-2 B	3	7.82	3.99	12.53	152.6	53,180	4,240	1.96	1	None

Modulus of Elasticity (psi)	4,750,000
Poisson's Ratio	

Comments: ______

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/21/2023

Checked by: K. Pattaje **Date:** 11/21/2023

Capping Method ▫ Sulfur ▫# Lapped ▫ Unbonded ▫ End gound

Conditioning ▫ As Received ▫ Wet ▫ Dry

Capping ▫ Plane ▫ Sound ▫ Other

Calipers ▫ 12/060107 ▫ B657697 ▫ Other

Test Machine ▫ Test Mark SN# 11005 ▫ Satec ID: 120HLVC1240 ▫ Other

Cast Date: 11/14/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 3-2 A	7	7.84	4.01	12.60	151.5	67,390	5,350	1.96	1	None

Modulus of Elasticity (psi)	5,150,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/21/2023

Checked by: K. Pattaje **Date:** 11/21/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/14/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 3-2 B	7	7.79	4.02	12.67	150.4	67,450	5,320	1.94	2	None

Modulus of Elasticity (psi)	5,550,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 11/28/2023

Checked by: K.Pattaje **Date:** 11/28/2023

Capping Method
- ☐ Sulfur
- ☒ Lapped
- ☐ Unbonded
- ☐ End gound

Conditioning
- ☐ As Received
- ☐ Wet
- ☐ Dry

Capping
- ☐ Plane
- ☐ Sound
- ☐ Other

Calipers
- ☐ 12/060107
- ☐ B657697
- ☐ Other

Test Machine
- ☐ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ Other

Cast Date: 11/14/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 3-1 A	14	7.87	4.01	12.62	149.2	74,670	5,920	1.96	1	None

Modulus of Elasticity (psi)	5,300,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830

Project Coordinator: T. Nelson

Operator: M. Haddad **Date:** 11/28/2023

Checked by: K. Pattaje **Date:** 11/28/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/14/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 3-1 B	14	7.86	4.01	12.63	150.8	80,690	6,390	1.96	2	None

Modulus of Elasticity (psi)	5,475,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830

Project Coordinator: T. Nelson

Operator: M. Haddad **Date:** 12/12/2023

Checked by: K. Pattaje **Date:** 12/17/2023

Capping Method
- ☐ Sulfur
- ☒ Lapped
- ☐ Unbonded
- ☒ End gound

Conditioning
- ☐ As Received
- ☒ Wet
- ☐ Dry

Capping
- ☒ Plane
- ☐ Sound
- ☐ Other

Calipers
- ☒ 12/060107
- ☐ B657697
- ☐ Other

Test Machine
- ☒ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ Other

Cast Date: 11/14/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 3-1 A	28	7.85	4.00	12.56	151.6	89,640	7,140	1.96	2	None

Modulus of Elasticity (psi)	5,450,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830

Project Coordinator: T. Nelson

Operator: M. Haddad **Date:** 12/12/2023

Checked by: K. Pattaje **Date:** 12/17/2023

Capping Method
- Sulfur
- Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/14/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 3-1 B	28	7.86	4.01	12.60	150.4	87,350	6,930	1.96	1	None

Modulus of Elasticity (psi)	5,450,000
Poisson's Ratio	

Comments:

ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 1/9/2024

Checked by: K. Pattaje **Date:** 1/9/2024

Capping Method
- ☐ Sulfur
- ☒ Lapped
- ☐ Unbonded
- ☐ End gound

Conditioning
- ☐ As Received
- ☒ Wet
- ☐ Dry

Capping
- ☐ Plane
- ☐ Sound
- ☐ Other

Calipers
- ☐ 12/060107
- ☐ B657697
- ☐ Other

Test Machine
- ☐ Test Mark SN# 11005
- ☐ Satec ID: 120HLVC1240
- ☐ Other

Cast Date: 11/14/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 3-1 A	56	7.79	4.01	12.65	150.3	98,070	7,750	1.94	1	None

Modulus of Elasticity (psi)	5,625,000
Poisson's Ratio	

Comments:

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ASTM C469 Modulus of Elasticity

Project No: 2023.4830 **Project Coordinator:** T. Nelson

Operator: M. Haddad **Date:** 1/9/2024

Checked by: K. Pattaje **Date:** 1/9/2024

Capping Method
- Sulfur
- # Lapped
- Unbonded
- End gound

Conditioning
- As Received
- Wet
- Dry

Capping
- Plane
- Sound
- Other

Calipers
- 12/060107
- B657697
- Other

Test Machine
- Test Mark SN# 11005
- Satec ID: 120HLVC1240
- Other

Cast Date: 11/14/2023

Sample ID	Age (days)	Capped Length (in.)	Avg. Dia. (in.)	Area (in.²)	Density (lb/ft³)	Max. Load (lbs.)	Compressive Strength (psi)	L/D	Fracture Type	Sample or Cap Defects
Mix 3-1 B	56	7.86	3.99	12.47	152.2	94,830	7,600	1.97	1	None

Modulus of Elasticity (psi)	5,550,000
Poisson's Ratio	

Comments:

ASTM C157-17 - Length Change of Hardened Hydraulic-Cement Mortar and Concrete

Project Number: 2023.4830 **Lab Coordinator:** Todd Nelson **Project Manager:** Tom Van Dam

Operator: L. ZEGLER **Date:** 11/9/2023

Checked by: K. Pattaje **Date:** 3/12/2024

Mix ID: 1-2

Date Cast: 11/8/2023

Type of Material: [x] Concrete [ ] Mortar [ ] ______

Specimen Size: [ ] 3 x 3 x 11.25 in [x] 4 x 4 x 11.25 in [ ] ______

Mix Temp. (°F): 74.6

Slump (in.): 6

Consolidation: [ ] Rodding [x] Vibration [ ] ______

Max. Size of Aggregate: [x] 3/4" [ ] 1/2" [ ] ______

Number of Specimens: 3

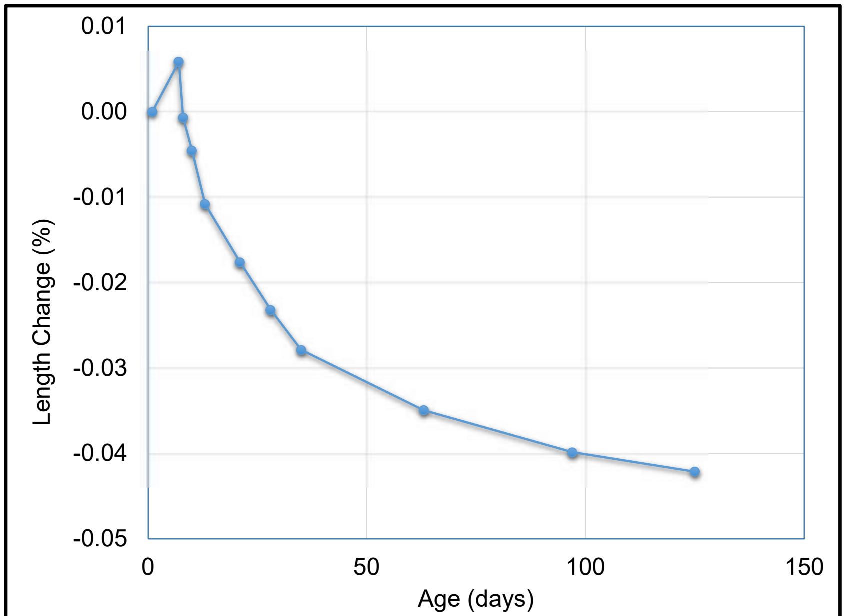
Curing Duration (days): 7

Storage Condition: [x] Water [ ] Air [ ] ______

Length Comparator: [x] SN: 11200975 [ ] SN: 12210636 [ ] ______

Dial Gage: [x] SN: 204402 [ ] ______

Reading #	Age (days)	Drying Time (days)	Average Length Change (%)
0	1	Before cure	0.000
1	7	0	0.006
2	8	1	-0.001
3	10	3	-0.005
4	13	6	-0.011
5	21	14	-0.018
6	28	21	-0.023
7	35	28	-0.028
8	63	56	-0.035
9	97	90	-0.040
10	125	118	-0.042
11			
12			



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ASTM C157-17 - Length Change of Hardened Hydraulic-Cement Mortar and Concrete

Project Number: 2023.483 **Lab Coordinator:** Todd Nelson **Project Manager:** Tom Van Dam

Operator: L. ZEGLER **Date:** 11/10/2023

Checked by: K. Pattaje **Date:** 3/13/2024

Mix ID: MIX 2-2 **Date Cast:** 11/9/2023

Type of Material: ☒ Concrete ☐ Mortar ☐ ______

Specimen Size: ☐ 3 x 3 x 11.25 in ☒ 4 x 4 x 11.25 in ☐ ______

Mix Temp. (°F): 73.7

Slump (in.): 7.75

Consolidation: ☐ Rodding ☒ Vibration ☐ ______

Max. Size of Aggregate: ☒ 3/4" ☐ 1/2" ☐ ______

Number of Specimens: 3

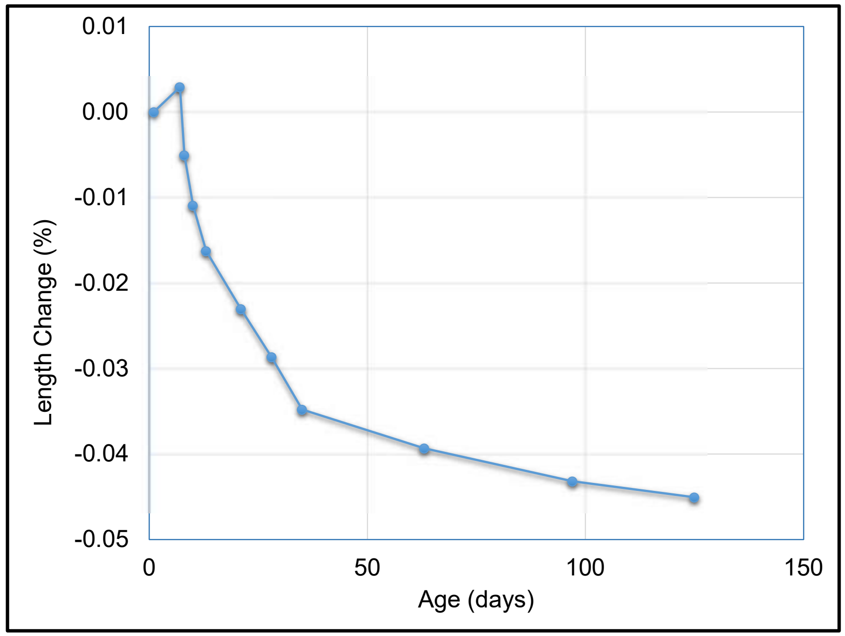
Curing Duration (days): 7

Storage Condition: ☒ Water ☐ Air ☐ ______

Length Comparator: ☒ SN: 11200975 ☐ SN: 12210636 ☐ ______

Dial Gage: ☒ SN: 204402 ☐ ______

Reading #	Age (days)	Time of Storage (days)	Average Length Change (%)
0	1	Before cure	0.000
1	7	0	0.003
2	8	1	-0.005
3	10	3	-0.011
4	13	6	-0.016
5	21	14	-0.023
6	28	21	-0.029
7	35	28	-0.035
8	63	56	-0.039
9	97	90	-0.043
10	125	118	-0.045
11			
12			



ASTM C157-17 - Length Change of Hardened Hydraulic-Cement Mortar and Concrete

Project Number: 2023.4830 **Lab Coordinator:** Todd Nelson **Project Manager:** Tom Van Dam

Operator: L. ZEGLER **Date:** 11/10/2023

Checked by: K. Pattaje **Date:** 3/19/2024

Mix ID: MIX 3-3

Date Cast: 11/15/2023

Type of Material: ☒ Concrete ☐ Mortar ☐ ______

Specimen Size: ☐ 3 x 3 x 11.25 in ☒ 4 x 4 x 11.25 in ☐ ______

Mix Temp. (°F): 77.5

Consolidation: ☐ Rodding ☒ Vibration ☐ ______

Max. Size of Aggregate: ☒ 3/4" ☐ 1/2" ☐ ______

Number of Specimens: 3

Slump (in.): 9.5

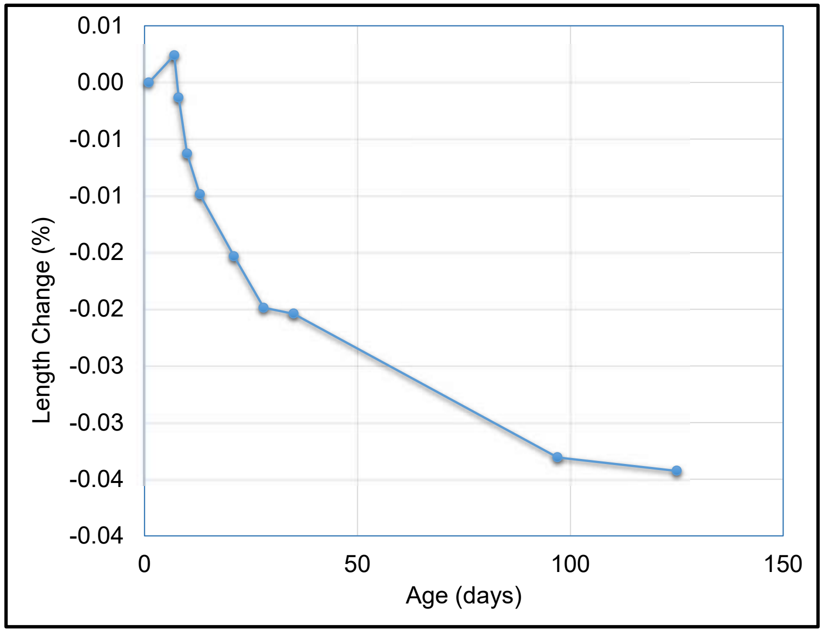
Curing Duration (days): 7

Storage Condition: ☒ Water ☐ Air ☐ ______

Length Comparator: ☒ SN: 11200975 ☐ SN: 12210636 ☐ ______

Dial Gage: ☒ SN: 204402 ☐ ______

Reading #	Age (days)	Drying Time (days)	Average Length Change (%)
0	1	Before cure	0.000
1	7	0	0.002
2	8	1	-0.001
3	10	3	-0.006
4	13	6	-0.010
5	21	14	-0.015
6	28	21	-0.020
7	35	28	-0.020
8	97	90	-0.033
9	125	118	-0.034
10			
11			
12			



AASHTO T336 - Coefficient of Thermal Expansion of Hyrdraulic Cement Concrete

Project Number: 2023.4830.0 **Project Coordinator:** L.Pham

Operator: R. Schulman **Test Date:** 12/8/2023

Checked by: L. Pham **Review Date:** 12/8/2023

Mix ID: 1

Date Cast: 11/8/2023

Curing Duration (days): 28

Curing Condition ■ Saturated □

Specimen Type: ■ Cast □ Cored □

Specimen Age (days): 28

Specimen Dia. (in): 4

Calibration Sample Material: SS 304
Calibration Sample CTE (10^{-6}/°C): 16.20

Verification Sample Material: SS 440C
Verification Sample CTE (10^{-6}/°C): 10.40

Specimen ID	Length (in)	Correction Factor (10-6/°C)	Segment	Start Temperature (°C)	Start LVDT Reading (in.)	End Temperature (°C)	End LVDT Reading (in.)	Measured Length Change, ΔLm (in.)	Length Change of Frame, ΔLf (in.)	Actual Length Change, ΔLa (in.)	Concrete CTE (10-6/°C)	Concrete CTE (10-6/°F)
1-2-A	7.009	2.77	Cooling	50.3	0.002301	10.0	0.000861	-0.001440	-7.82E-04	-2.22E-03	**7.87**	**4.37**
			Heating	10.0	0.000861	50.2	0.002344	0.001483	7.80E-04	2.26E-03	**8.03**	**4.46**
			Sample 1 CTE (Avergage of two segments)								**7.95**	**4.42**
1-2-B	6.996	0.22	Cooling	50.2	0.000152	10.0	-0.002045	-0.002197	-6.19E-05	-2.26E-03	**8.03**	**4.46**
			Heating	10.0	-0.002045	50.3	0.000204	0.002249	6.20E-05	2.31E-03	**8.19**	**4.55**
			Sample 2 CTE (Avergage of two segments)								**8.11**	**4.51**

Concrete Mixture CTE (10-6/°C and 10-6/°F, respectively)	8.0	4.5

AASHTO T336 - Coefficient of Thermal Expansion of Hyrdraulic Cement Concrete

Project Number: 2023.4830.0
Project Coordinator: L.Pham

Operator: R. Schulman
Test Date: 1/25/2024
Checked by: L. Pham
Review Date: 1/30/2024

Mix ID: 1
Date Cast: 11/8/2023
Curing Duration (days): 78
Curing Condition ■ Saturated ☐

Specimen Type: ■ Cast ☐ Cored ☐
Specimen Age (days): 78
Specimen Dia. (in): 4

Calibration Sample Material: SS 304
Calibration Sample CTE (10^{-6}/°C): 16.20
Verification Sample Material: SS 440C
Verification Sample CTE (10^{-6}/°C): 10.40

Specimen ID	Length (in)	Correction Factor (10-6/°C)	Segment	Start Temperature (°C)	Start LVDT Reading (in.)	End Temperature (°C)	End LVDT Reading (in.)	Measured Length Change, ΔLm (in.)	Length Change of Frame, ΔLf (in.)	Actual Length Change, ΔLa (in.)	Concrete CTE (10-6/°C)	Concrete CTE (10-6/°F)
1-2-A	7.009	3.20	Heating	9.5	-0.001370	50.1	-0.000123	0.001247	9.13E-04	2.16E-03	**7.57**	**4.21**
			Cooling	50.1	-0.000123	9.5	-0.001378	-0.001255	-9.11E-04	-2.17E-03	**7.61**	**4.23**
			Sample 1 CTE (Avergage of two segments)								**7.59**	**4.22**
1-2-B	6.996	-0.09	Heating	9.5	0.001066	50.2	0.003238	0.002172	-2.56E-05	2.15E-03	**7.54**	**4.19**
			Cooling	50.2	0.003238	9.5	0.001107	-0.002131	2.56E-05	-2.11E-03	**7.39**	**4.11**
			Sample 2 CTE (Avergage of two segments)								**7.47**	**4.15**

Concrete Mixture CTE (10-6/°C and 10-6/°F, respectively)	**7.5**	**4.2**

AASHTO T336 - Coefficient of Thermal Expansion of Hyrdraulic Cement Concrete

Project Number: 2023.4830.0 **Project Coordinator:** L.Pham

Operator: L. Pham **Test Date:** 12/8/2023

Checked by: ______ **Review Date:** ______

Mix ID: 2

Date Cast: 11/9/2023

Specimen Type: ■ Cast ☐ Cored ☐ ______

Curing Duration (days): 29

Specimen Age (days): 29

Calibration Sample Material: SS 304
Calibration Sample CTE (10^{-6}/°C): 16.20

Curing Condition ■ Saturated ☐ ______

Specimen Dia. (in): 4

Verification Sample Material: SS 440C
Verification Sample CTE (10^{-6}/°C): 10.40

Specimen ID	Length (in)	Correction Factor (10-6/°C)	Segment	Start Temperature (°C)	Start LVDT Reading (in.)	End Temperature (°C)	End LVDT Reading (in.)	Measured Length Change, ΔLm (in.)	Length Change of Frame, ΔLf (in.)	Actual Length Change, ΔLa (in.)	Concrete CTE (10-6/°C)	Concrete CTE (10-6/°F)
2-2-A	7.004	2.77	Cooling	50.3	0.001345	9.9	-0.000171	-0.001516	-7.83E-04	-2.30E-03	**8.14**	**4.52**
			Heating	9.9	-0.000171	50.3	0.001348	0.001519	7.83E-04	2.30E-03	**8.14**	**4.52**
			Sample 1 CTE (Avergage of two segments)								**8.14**	**4.52**
2-2-B	6.969	0.22	Cooling	50.3	0.004128	9.9	0.001743	-0.002385	-6.18E-05	-2.45E-03	**8.70**	**4.84**
			Heating	9.9	0.001743	50.3	0.004161	0.002418	6.19E-05	2.48E-03	**8.81**	**4.90**
			Sample 2 CTE (Avergage of two segments)								**8.76**	**4.87**

Concrete Mixture CTE (10-6/°C and 10-6/°F, respectively)	**8.4**	**4.7**

AASHTO T336 - Coefficient of Thermal Expansion of Hyrdraulic Cement Concrete

Project Number: 2023.4830.0 **Project Coordinator:** L.Pham

Operator: R. Schulman **Test Date:** 1/27/2024

Checked by: L. Pham **Review Date:** 2/11/2024

Mix ID: 2

Date Cast: 11/9/2023

Specimen Type: ■ Cast ☐ Cored ☐ ____

Curing Duration (days): 79

Specimen Age (days): 79

Calibration Sample Material: SS 304

Calibration Sample CTE (10^{-6}/°C): 16.20

Curing Condition ■ Saturated ☐ ____

Specimen Dia. (in): 4

Verification Sample Material: SS 440C

Verification Sample CTE (10^{-6}/°C): 10.40

Specimen ID	Length (in)	Correction Factor (10-6/°C)	Segment	Start Temperature (°C)	Start LVDT Reading (in.)	End Temperature (°C)	End LVDT Reading (in.)	Measured Length Change, ΔLm (in.)	Length Change of Frame, ΔLf (in.)	Actual Length Change, ΔLa (in.)	Concrete CTE (10-6/°C)	Concrete CTE (10-6/°F)
2-2-A	7.004	3.20	Cooling	50.2	0.001946	9.5	0.000698	-0.001248	-9.11E-04	-2.16E-03	**7.58**	**4.21**
			Heating	9.5	0.000698	50.2	0.001919	0.001221	9.11E-04	2.13E-03	**7.49**	**4.16**
			Sample 1 CTE (Avergage of two segments)								**7.53**	**4.19**
2-2-B	6.969	-0.09	Cooling	50.1	0.001184	9.3	-0.001133	-0.002317	2.56E-05	-2.29E-03	**8.05**	**4.47**
			Heating	9.3	-0.001133	50.0	0.001172	0.002305	-2.56E-05	2.28E-03	**8.03**	**4.46**
			Sample 2 CTE (Avergage of two segments)								**8.04**	**4.47**

Concrete Mixture CTE (10-6/°C and 10-6/°F, respectively)	7.8	4.3

AASHTO T336 - Coefficient of Thermal Expansion of Hyrdraulic Cement Concrete

Project Number: 2023.4830.0 **Project Coordinator:** L.Pham

Operator: L. Pham **Test Date:** 12/8/2023

Checked by: ______ **Review Date:** ______

Mix ID: 3

Date Cast: 11/14/2023

Curing Duration (days): 28

Curing Condition ■ Saturated ☐ ______

Specimen Type: ■ Cast ☐ Cored ☐ ______

Specimen Age (days): 28

Specimen Dia. (in): 4

Calibration Sample Material: SS 304
Calibration Sample CTE (10^{-6}/°C): 16.20

Verification Sample Material: SS 440C
Verification Sample CTE (10^{-6}/°C): 10.40

Specimen ID	Length (in)	Correction Factor (10-6/°C)	Segment	Start Temperature (°C)	Start LVDT Reading (in.)	End Temperature (°C)	End LVDT Reading (in.)	Measured Length Change, ΔLm (in.)	Length Change of Frame, ΔLf (in.)	Actual Length Change, ΔLa (in.)	Concrete CTE (10-6/°C)	Concrete CTE (10-6/°F)
3-1-B	6.984	2.77	Cooling	50.3	0.007269	9.9	0.005161	-0.002108	-7.83E-04	-2.89E-03	**10.23**	**5.68**
			Heating	9.9	0.005161	50.4	0.007254	0.002093	7.84E-04	2.88E-03	**10.16**	**5.64**
			Sample 1 CTE (Avergage of two segments)								**10.19**	**5.66**
3-1-A	6.962	0.22	Cooling	50.2	-0.004613	10.0	-0.007463	-0.002850	-6.16E-05	-2.91E-03	**10.40**	**5.78**
			Heating	10.0	-0.007463	50.5	-0.004553	0.002910	6.20E-05	2.97E-03	**10.55**	**5.86**
			Sample 2 CTE (Avergage of two segments)								**10.47**	**5.82**

Concrete Mixture CTE (10-6/°C and 10-6/°F, respectively)	**10.3**	**5.7**

AASHTO T336 - Coefficient of Thermal Expansion of Hyrdraulic Cement Concrete

Project Number: 2023.4830.0 **Project Coordinator:** L.Pham

Operator: R. Schulman **Test Date:** 1/30/2024

Checked by: L. Pham **Review Date:** 2/11/2024

Mix ID: 3

Date Cast: 11/14/2023

Curing Duration (days): 77

Curing Condition ■ Saturated ☐

Specimen Type: ■ Cast ☐ Cored ☐

Specimen Age (days): 77

Specimen Dia. (in): 4

Calibration Sample Material: SS 304
Calibration Sample CTE (10^{-6}/°C): 16.20

Verification Sample Material: SS 440C
Verification Sample CTE (10^{-6}/°C): 10.40

Specimen ID	Length (in)	Correction Factor (10-6/°C)	Segment	Start Temperature (°C)	Start LVDT Reading (in.)	End Temperature (°C)	End LVDT Reading (in.)	Measured Length Change, ΔLm (in.)	Length Change of Frame, ΔLf (in.)	Actual Length Change, ΔLa (in.)	Concrete CTE (10-6/°C)	Concrete CTE (10-6/°F)
3-1-A	6.962	3.20	Cooling	50.2	0.003192	9.5	0.001440	-0.001752	-9.06E-04	-2.66E-03	**9.39**	**5.22**
			Heating	9.5	0.001440	50.1	0.003195	0.001755	9.05E-04	2.66E-03	**9.40**	**5.22**
			Sample 1 CTE (Avergage of two segments)								**9.40**	**5.22**
3-1-B	6.984	-0.09	Cooling	50.1	0.001380	9.4	-0.001411	-0.002791	2.55E-05	-2.77E-03	**9.75**	**5.41**
			Heating	9.4	-0.001411	50.1	0.001348	0.002759	-2.56E-05	2.73E-03	**9.62**	**5.34**
			Sample 2 CTE (Avergage of two segments)								**9.68**	**5.38**

Concrete Mixture CTE (10-6/°C and 10-6/°F, respectively)	**9.5**	**5.3**

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ASTM C1876/AASHTO T 402 - Bulk Electrical Resistivity or Bulk Conductivity of Concrete

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: Karthik Pattaje **Initials:** KP **Date:** 12/6/2023
Checked by: Corrie Piehowski **Initials:** CP **Date:** 12/21/2023

Sample ID: Mix 1
Cast Date: 11/8/2023
Age of Sample (days): 28

Resistance Meter:
- ☐ Miller 400A
- ☐ Resipod #970
- ☐ Resipod #4691
- ☒ Resipod #8948

Specimen:
- ☒ Cast
- ☐ Core

Conditioning:
- ☒ Moist room
- ☐ Lime tank
- ☐ Simulated Pore Solution
- ☐ Other:

Sample	Diameter (m)	Length (m)	Area (m^2)	Temp. (°C)	$R_{Cylinder}$ (Ohm)	Uniaxial Resistivity (Ohm-m)	Pore Solution Resistivity (Ohm-m)	Formation Factor
A	0.102	0.198	0.00817	20.2	1600	66.0		
B	0.102	0.198	0.00812	20.2	1600	65.6		
C	0.103	0.198	0.00834	20.2	1500	63.1		
					Set average:	64.9	--	

Comments:

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ASTM C1876/AASHTO T 402 - Bulk Electrical Resistivity or Bulk Conductivity of Concrete

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: Karthik Pattaje **Initials:** KP **Date:** 12/13/2023
Checked by: Corrie Piehowski **Initials:** CP **Date:** 12/21/2023

Sample ID: Mix 1
Cast Date: 11/8/2023
Age of Sample (days): 35

Resistance Meter:
- ☐ Miller 400A
- ☐ Resipod #970
- ☐ Resipod #4691
- ☒ Resipod #8948

Specimen:
- ☒ Cast
- ☐ Core

Conditioning:
- ☒ Moist room
- ☐ Lime tank
- ☒ Simulated Pore Solution
- ☐ Other:

Sample	Diameter (m)	Length (m)	Area (m^2)	Temp. (°C)	$R_{Cylinder}$ (Ohm)	Uniaxial Resistivity (Ohm-m)	Pore Solution Resistivity (Ohm-m)	Formation Factor
A	0.102	0.198	0.00817	21.6	1300	53.6		
B	0.102	0.198	0.00812	21.6	1300	53.3		
C	0.103	0.198	0.00834	21.6	1200	50.5		
					Set average:	52.4	--	

Comments: Conditioned in simulated pore solution for 7 days after 28 days of moist curing

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ASTM C1876/AASHTO T 402 - Bulk Electrical Resistivity or Bulk Conductivity of Concrete

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: Karthik Pattaje **Initials:** KP **Date:** 1/3/2024
Checked by: Corrie Piehowski **Initials:** CP **Date:** 1/3/2024

Sample ID: Mix 1
Cast Date: 11/8/2023
Age of Sample (days): 56

Resistance Meter:
- ☐ Miller 400A
- ☐ Resipod #970
- ☐ Resipod #4691
- ☒ Resipod #8948

Specimen:
- ☒ Cast
- ☐ Core

Conditioning:
- ☒ Moist room
- ☐ Lime tank
- ☒ Simulated Pore Solution
- ☐ Other:

Sample	Diameter (m)	Length (m)	Area (m^2)	Temp. (°C)	$R_{Cylinder}$ (Ohm)	Uniaxial Resistivity (Ohm-m)	Pore Solution Resistivity (Ohm-m)	Formation Factor
A	0.102	0.198	0.00817	20.5	1300	53.6		
B	0.102	0.198	0.00812	20.5	1300	53.3		
C	0.103	0.198	0.00834	20.5	1300	54.7		
					Set average:	53.8	--	

Comments: Conditioned in simulated pore solution after 28 days of moist curing

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ASTM C1876/AASHTO T 402 - Bulk Electrical Resistivity or Bulk Conductivity of Concrete

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: Corrie Piehowski **Initials:** CP **Date:** 2/1/2024
Checked by: Karthik Pattaje **Initials:** KP **Date:** 2/2/2024

Sample ID: Mix 1
Cast Date: 11/8/2023
Age of Sample (days): 90

Resistance Meter:
- ☐ Miller 400A
- ☐ Resipod #970
- ☐ Resipod #4691
- ☒ Resipod #8948

Specimen:
- ☒ Cast
- ☐ Core

Conditioning:
- ☒ Moist room
- ☐ Lime tank
- ☒ Simulated Pore Solution
- ☐ Other:

Sample	Diameter (m)	Length (m)	Area (m^2)	Temp. (°C)	$R_{Cylinder}$ (Ohm)	Uniaxial Resistivity (Ohm-m)	Pore Solution Resistivity (Ohm-m)	Formation Factor
A	0.102	0.198	0.00817	23.1	1400	57.7		
B	0.102	0.198	0.00812	23.1	1300	53.3		
C	0.103	0.198	0.00834	23.1	1300	54.7		
					Set average:	55.2	--	

Comments: Conditioned in simulated pore solution after 28 days of moist curing

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ASTM C1876/AASHTO T 402 - Bulk Electrical Resistivity or Bulk Conductivity of Concrete

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: Karthik Pattaje **Initials:** KP **Date:** 12/7/2023
Checked by: Corrie Piehowski **Initials:** CP **Date:** 12/21/2023

Sample ID: Mix 2
Cast Date: 11/9/2023
Age of Sample (days): 28

Resistance Meter:
- ☐ Miller 400A
- ☐ Resipod #970
- ☐ Resipod #4691
- ☒ Resipod #8948

Specimen:
- ☒ Cast
- ☐ Core

Conditioning:
- ☒ Moist room
- ☐ Lime tank
- ☐ Simulated Pore Solution
- ☐ Other:

Sample	Diameter (m)	Length (m)	Area (m^2)	Temp. (°C)	$R_{Cylinder}$ (Ohm)	Uniaxial Resistivity (Ohm-m)	Pore Solution Resistivity (Ohm-m)	Formation Factor
A	0.103	0.201	0.00828	20.2	2400	98.9		
B	0.102	0.201	0.00825	20.2	2500	102.6		
C	0.103	0.200	0.00828	20.2	2600	107.7		
					Set average:	103.1	--	

Comments:

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ASTM C1876/AASHTO T 402 - Bulk Electrical Resistivity or Bulk Conductivity of Concrete

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: Karthik Pattaje/Corrie Piehowsk **Initials:** KP/CP **Date:** 12/7/2023
Checked by: Corrie Piehowski **Initials:** CP **Date:** 12/21/2023

Sample ID: Mix 2
Cast Date: 11/9/2023
Age of Sample (days): 28+7

Resistance Meter:
- ☐ Miller 400A
- ☐ Resipod #970
- ☐ Resipod #4691
- ☒ Resipod #8948

Specimen:
- ☒ Cast
- ☐ Core

Conditioning:
- ☒ Moist room
- ☐ Lime tank
- ☒ Simulated Pore Solution
- ☐ Other:

Sample	Diameter (m)	Length (m)	Area (m^2)	Temp. (°C)	$R_{Cylinder}$ (Ohm)	Uniaxial Resistivity (Ohm-m)	Pore Solution Resistivity (Ohm-m)	Formation Factor
A	0.103	0.201	0.00828	21.6	2100	86.6		
B	0.102	0.201	0.00825	21.6	2100	86.2		
C	0.103	0.200	0.00828	21.6	2100	87.0		
					Set average:	86.6	--	

Comments: Conditioned in simulated pore solution for 7 days after 28 days of moist curing

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ASTM C1876/AASHTO T 402 - Bulk Electrical Resistivity or Bulk Conductivity of Concrete

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: Karthik Pattaje **Initials:** KP **Date:** 1/4/2024
Checked by: Corrie Piehowski **Initials:** CP **Date:** 1/5/2024

Sample ID: Mix 2
Cast Date: 11/9/2023
Age of Sample (days): 56

Resistance Meter:
- ☐ Miller 400A
- ☐ Resipod #970
- ☐ Resipod #4691
- ☒ Resipod #8948

Specimen:
- ☒ Cast
- ☐ Core

Conditioning:
- ☒ Moist room
- ☐ Lime tank
- ☒ Simulated Pore Solution
- ☐ Other:

Sample	Diameter (m)	Length (m)	Area (m^2)	Temp. (°C)	$R_{Cylinder}$ (Ohm)	Uniaxial Resistivity (Ohm-m)	Pore Solution Resistivity (Ohm-m)	Formation Factor
A	0.103	0.201	0.00828	20.8	2200	90.7		
B	0.102	0.201	0.00825	20.8	2200	90.3		
C	0.103	0.200	0.00828	20.8	2300	95.3		
					Set average:	92.1	--	

Comments: Conditioned in simulated pore solution after 28 days of moist curing

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ASTM C1876/AASHTO T 402 - Bulk Electrical Resistivity or Bulk Conductivity of Concrete

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: Corrie Piehowski **Initials:** CP **Date:** 2/1/2024
Checked by: Karthik Pattaje **Initials:** KP **Date:** 2/2/2024

Sample ID: Mix 2
Cast Date: 11/9/2023
Age of Sample (days): 90

Resistance Meter:
- ☐ Miller 400A
- ☐ Resipod #970
- ☐ Resipod #4691
- ☒ Resipod #8948

Specimen:
- ☒ Cast
- ☐ Core

Conditioning:
- ☒ Moist room
- ☐ Lime tank
- ☒ Simulated Pore Solution
- ☐ Other:

Sample	Diameter (m)	Length (m)	Area (m^2)	Temp. (°C)	$R_{Cylinder}$ (Ohm)	Uniaxial Resistivity (Ohm-m)	Pore Solution Resistivity (Ohm-m)	Formation Factor
A	0.103	0.201	0.00828	23.1	2500	103.0		
B	0.102	0.201	0.00825	23.1	2500	102.6		
C	0.103	0.200	0.00828	23.1	2700	111.9		
					Set average:	105.8	--	

Comments: Conditioned in simulated pore solution after 28 days of moist curing

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ASTM C1876/AASHTO T 402 - Bulk Electrical Resistivity or Bulk Conductivity of Concrete

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: Karthik Pattaje **Initials:** KP **Date:** 12/12/2023
Checked by: Corrie Piehowski **Initials:** CP **Date:** 12/21/2023

Sample ID: Mix 3
Cast Date: 11/14/2023
Age of Sample (days): 28

Resistance Meter:
- ☐ Miller 400A
- ☐ Resipod #970
- ☐ Resipod #4691
- ☒ Resipod #8948

Specimen:
- ☒ Cast
- ☐ Core

Conditioning:
- ☒ Moist room
- ☐ Lime tank
- ☐ Simulated Pore Solution
- ☐ Other:

Sample	Diameter (m)	Length (m)	Area (m^2)	Temp. (°C)	$R_{Cylinder}$ (Ohm)	Uniaxial Resistivity (Ohm-m)	Pore Solution Resistivity (Ohm-m)	Formation Factor
A	0.101	0.199	0.00807	20.2	23200	940.7		
B	0.101	0.198	0.00805	20.2	25700	1042.3		
C	0.101	0.199	0.00807	20.2	24500	993.9		
					Set average:	992.3	--	

Comments:

WJE | ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

Wiss, Janney, Elstner Associates, Inc.
330 Pfingsten Road
Northbrook, Illinois 60062
847.272.7400 tel | 847.291.5189 fax
www.wje.com

ASTM C1876/AASHTO T 402 - Bulk Electrical Resistivity or Bulk Conductivity of Concrete

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: Corrie Piehowski **Initials:** CP **Date:** 12/19/2023
Checked by: Karthik Pattaje **Initials:** KP **Date:** 12/20/2023

Sample ID: Mix 3
Cast Date: 11/14/2023
Age of Sample (days): 28+7

Resistance Meter:
- ☐ Miller 400A
- ☐ Resipod #970
- ☐ Resipod #4691
- ☒ Resipod #8948

Specimen:
- ☒ Cast
- ☐ Core

Conditioning:
- ☒ Moist room
- ☐ Lime tank
- ☒ Simulated Pore Solution
- ☐ Other:

Sample	Diameter (m)	Length (m)	Area (m^2)	Temp. (°C)	$R_{Cylinder}$ (Ohm)	Uniaxial Resistivity (Ohm-m)	Pore Solution Resistivity (Ohm-m)	Formation Factor
A	0.101	0.199	0.00807	21.6	16600	673.1		
B	0.101	0.198	0.00805	21.6	18200	738.2		
C	0.101	0.199	0.00807	21.6	20600	835.7		
					Set average:	749.0	--	

Comments: Conditioned in simulated pore solution for 7 days after 28 days of moist curing

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330 Pfingsten Road
Northbrook, Illinois 60062
847.272.7400 tel | 847.291.5189 fax
www.wje.com

ASTM C1876/AASHTO T 402 - Bulk Electrical Resistivity or Bulk Conductivity of Concrete

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: Corrie Piehowski **Initials:** CP **Date:** 1/9/2024
Checked by: Karthik Pattaje **Initials:** KP **Date:** 1/9/2024

Sample ID: Mix 3
Cast Date: 11/14/2023
Age of Sample (days): 56

Resistance Meter:
- ☐ Miller 400A
- ☐ Resipod #970
- ☐ Resipod #4691
- ☒ Resipod #8948

Specimen:
- ☒ Cast
- ☐ Core

Conditioning:
- ☒ Moist room
- ☐ Lime tank
- ☒ Simulated Pore Solution
- ☐ Other:

Sample	Diameter (m)	Length (m)	Area (m^2)	Temp. (°C)	$R_{Cylinder}$ (Ohm)	Uniaxial Resistivity (Ohm-m)	Pore Solution Resistivity (Ohm-m)	Formation Factor
A	0.101	0.199	0.00807	20.7	22700	920.7		
B	0.101	0.198	0.00805	20.7	22700	920.8		
C	0.101	0.199	0.00809	20.7	22600	919.0		
					Set average:	920.2	--	

Comments: Conditioned in simulated pore solution after 28 days of moist curing

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

Wiss, Janney, Elstner Associates, Inc.
330 Pfingsten Road
Northbrook, Illinois 60062
847.272.7400 tel | 847.291.5189 fax
www.wje.com

ASTM C1876/AASHTO T 402 - Bulk Electrical Resistivity or Bulk Conductivity of Concrete

Project Number: 2023.4830.0 **Project Coordinator:** T. Nelson

Operator: Corrie Piehowski **Initials:** CP **Date:** 2/6/2024
Checked by: Karthik Pattaje **Initials:** KP **Date:** 2/12/2024

Sample ID: Mix 3
Cast Date: 11/14/2023
Age of Sample (days): 90

Resistance Meter:
- ☐ Miller 400A
- ☐ Resipod #970
- ☐ Resipod #4691
- ☒ Resipod #8948

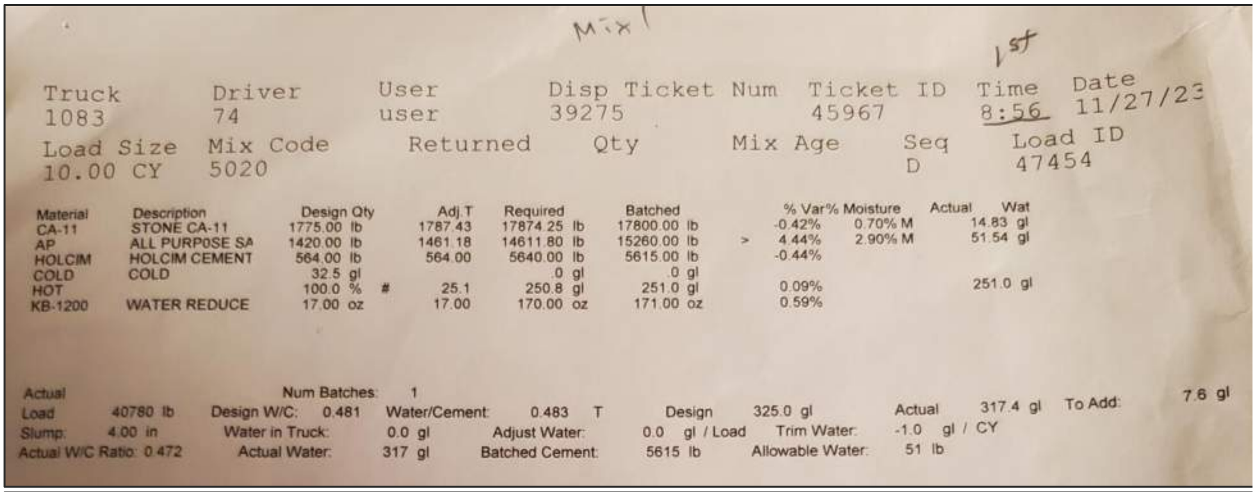
Specimen:
- ☒ Cast
- ☐ Core

Conditioning:
- ☒ Moist room
- ☐ Lime tank
- ☒ Simulated Pore Solution
- ☐ Other:

Sample	Diameter (m)	Length (m)	Area (m^2)	Temp. (°C)	$R_{Cylinder}$ (Ohm)	Uniaxial Resistivity (Ohm-m)	Pore Solution Resistivity (Ohm-m)	Formation Factor
A	0.101	0.199	0.00807	23.1	22400	908.6		
B	0.101	0.198	0.00805	23.1	25000	1014.1		
C	0.101	0.199	0.00809	23.1	24500	996.2		
					Set average:	973.0	--	

Comments: Conditioned in simulated pore solution after 28 days of moist curing

APPENDIX. Batch Tickets



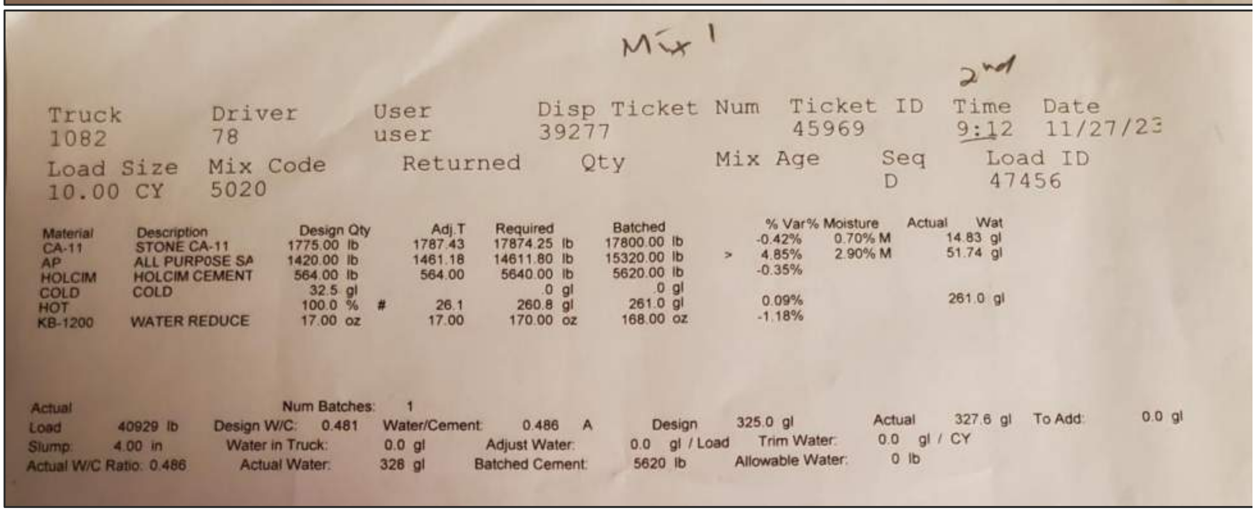
Mix 1 — 1st

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
1083	74	user	39275	45967	8:56	11/27/23

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CY	5020				D	47454

Material	Description	Design Qty		Adj.T	Required	Batched		% Var	% Moisture	Actual Wat
CA-11	STONE CA-11	1775.00 lb		1787.43	17874.25 lb	17800.00 lb		-0.42%	0.70% M	14.83 gl
AP	ALL PURPOSE SA	1420.00 lb		1461.18	14611.80 lb	15260.00 lb	>	4.44%	2.90% M	51.54 gl
HOLCIM	HOLCIM CEMENT	564.00 lb		564.00	5640.00 lb	5615.00 lb		-0.44%		
COLD	COLD	32.5 gl			.0 gl	.0 gl				
HOT		100.0 %	#	25.1	250.8 gl	251.0 gl		0.09%		251.0 gl
KB-1200	WATER REDUCE	17.00 oz		17.00	170.00 oz	171.00 oz		0.59%		

Actual Load: 40780 lb | Num Batches: 1 | Design W/C: 0.481 | Water/Cement: 0.483 T | Design 325.0 gl | Actual 317.4 gl | To Add: 7.6 gl
Slump: 4.00 in | Water in Truck: 0.0 gl | Adjust Water: 0.0 gl / Load | Trim Water: -1.0 gl / CY
Actual W/C Ratio: 0.472 | Actual Water: 317 gl | Batched Cement: 5615 lb | Allowable Water: 51 lb



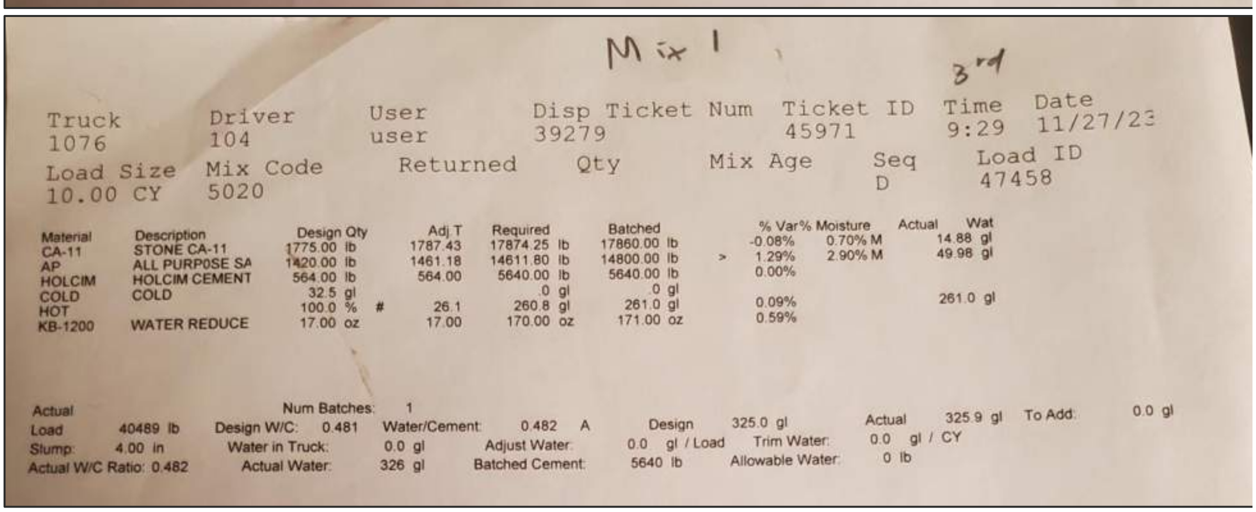
Mix 1 — 2nd

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
1082	78	user	39277	45969	9:12	11/27/23

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CY	5020				D	47456

Material	Description	Design Qty		Adj.T	Required	Batched		% Var	% Moisture	Actual Wat
CA-11	STONE CA-11	1775.00 lb		1787.43	17874.25 lb	17800.00 lb		-0.42%	0.70% M	14.83 gl
AP	ALL PURPOSE SA	1420.00 lb		1461.18	14611.80 lb	15320.00 lb	>	4.85%	2.90% M	51.74 gl
HOLCIM	HOLCIM CEMENT	564.00 lb		564.00	5640.00 lb	5620.00 lb		-0.35%		
COLD	COLD	32.5 gl			.0 gl	.0 gl				
HOT		100.0 %	#	26.1	260.8 gl	261.0 gl		0.09%		261.0 gl
KB-1200	WATER REDUCE	17.00 oz		17.00	170.00 oz	168.00 oz		-1.18%		

Actual Load: 40929 lb | Num Batches: 1 | Design W/C: 0.481 | Water/Cement: 0.486 A | Design 325.0 gl | Actual 327.6 gl | To Add: 0.0 gl
Slump: 4.00 in | Water in Truck: 0.0 gl | Adjust Water: 0.0 gl / Load | Trim Water: 0.0 gl / CY
Actual W/C Ratio: 0.486 | Actual Water: 328 gl | Batched Cement: 5620 lb | Allowable Water: 0 lb



Mix 1 — 3rd

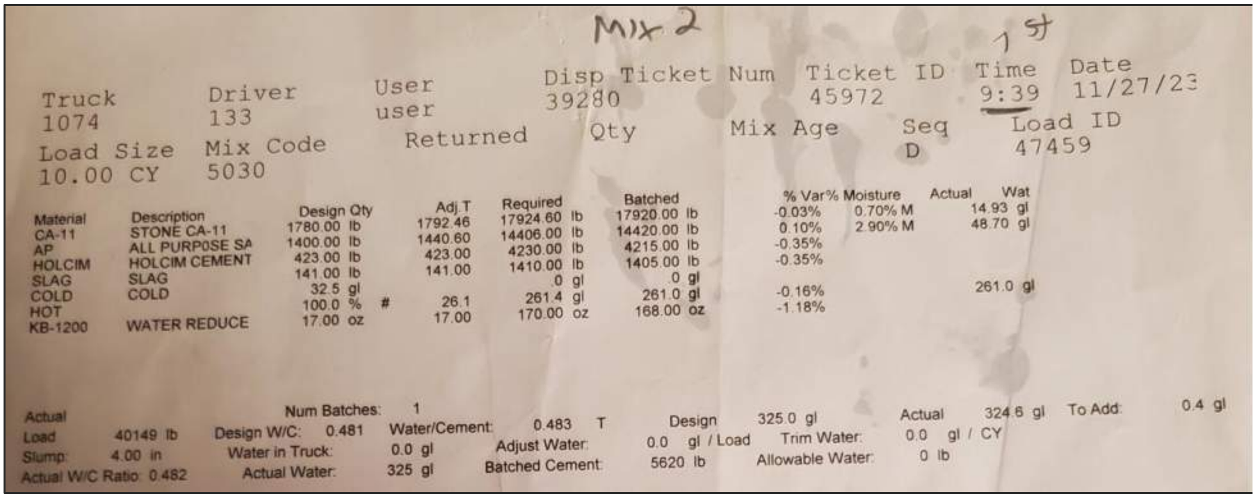
Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
1076	104	user	39279	45971	9:29	11/27/23

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CY	5020				D	47458

Material	Description	Design Qty		Adj.T	Required	Batched		% Var	% Moisture	Actual Wat
CA-11	STONE CA-11	1775.00 lb		1787.43	17874.25 lb	17860.00 lb		-0.08%	0.70% M	14.88 gl
AP	ALL PURPOSE SA	1420.00 lb		1461.18	14611.80 lb	14800.00 lb	>	1.29%	2.90% M	49.98 gl
HOLCIM	HOLCIM CEMENT	564.00 lb		564.00	5640.00 lb	5640.00 lb		0.00%		
COLD	COLD	32.5 gl			.0 gl	.0 gl				
HOT		100.0 %	#	26.1	260.8 gl	261.0 gl		0.09%		261.0 gl
KB-1200	WATER REDUCE	17.00 oz		17.00	170.00 oz	171.00 oz		0.59%		

Actual Load: 40489 lb | Num Batches: 1 | Design W/C: 0.481 | Water/Cement: 0.482 A | Design 325.0 gl | Actual 325.9 gl | To Add: 0.0 gl
Slump: 4.00 in | Water in Truck: 0.0 gl | Adjust Water: 0.0 gl / Load | Trim Water: 0.0 gl / CY
Actual W/C Ratio: 0.482 | Actual Water: 326 gl | Batched Cement: 5640 lb | Allowable Water: 0 lb

Figure A. Batch tickets for Mix 1 - Control



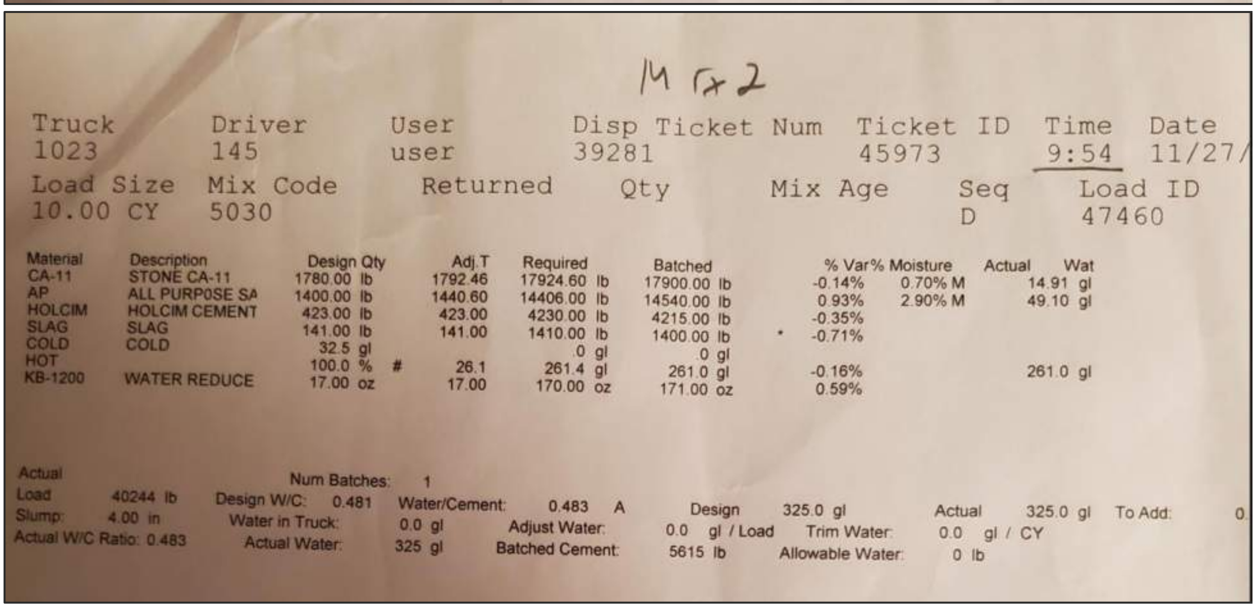
Mix 2 1st

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
1074	133	user	39280	45972	9:39	11/27/23

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CY	5030				D	47459

Material	Description	Design Qty	Adj.T	Required	Batched	% Var%	Moisture	Actual Wat
CA-11	STONE CA-11	1780.00 lb	1792.46	17924.60 lb	17920.00 lb	-0.03%	0.70% M	14.93 gl
AP	ALL PURPOSE SA	1400.00 lb	1440.60	14406.00 lb	14420.00 lb	0.10%	2.90% M	48.70 gl
HOLCIM	HOLCIM CEMENT	423.00 lb	423.00	4230.00 lb	4215.00 lb	-0.35%		
SLAG	SLAG	141.00 lb	141.00	1410.00 lb	1405.00 lb	-0.35%		
COLD	COLD	32.5 gl		.0 gl	.0 gl			
HOT		100.0 % #	26.1	261.4 gl	261.0 gl	-0.16%		261.0 gl
KB-1200	WATER REDUCE	17.00 oz	17.00	170.00 oz	168.00 oz	-1.18%		

Actual Load 40149 lb
Slump: 4.00 in
Actual W/C Ratio: 0.482
Num Batches: 1
Design W/C: 0.481
Water in Truck: 0.0 gl
Actual Water: 325 gl
Water/Cement: 0.483 T
Adjust Water: 0.0 gl / Load
Batched Cement: 5620 lb
Design 325.0 gl
Trim Water: 0.0 gl / CY
Allowable Water: 0 lb
Actual 324.6 gl
To Add: 0.4 gl



Mix 2

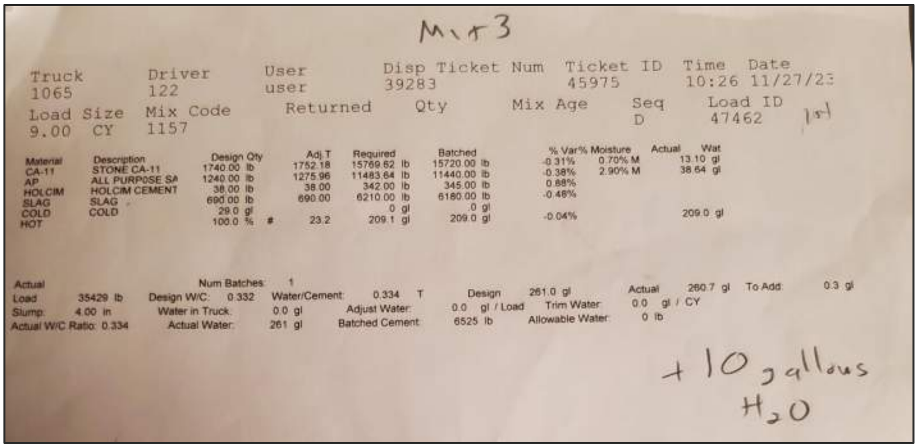
Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
1023	145	user	39281	45973	9:54	11/27/

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CY	5030				D	47460

Material	Description	Design Qty	Adj.T	Required	Batched	% Var%	Moisture	Actual Wat
CA-11	STONE CA-11	1780.00 lb	1792.46	17924.60 lb	17900.00 lb	-0.14%	0.70% M	14.91 gl
AP	ALL PURPOSE SA	1400.00 lb	1440.60	14406.00 lb	14540.00 lb	0.93%	2.90% M	49.10 gl
HOLCIM	HOLCIM CEMENT	423.00 lb	423.00	4230.00 lb	4215.00 lb	-0.35%		
SLAG	SLAG	141.00 lb	141.00	1410.00 lb	1400.00 lb	-0.71%		
COLD	COLD	32.5 gl		.0 gl	.0 gl			
HOT		100.0 % #	26.1	261.4 gl	261.0 gl	-0.16%		261.0 gl
KB-1200	WATER REDUCE	17.00 oz	17.00	170.00 oz	171.00 oz	0.59%		

Actual Load 40244 lb
Slump: 4.00 in
Actual W/C Ratio: 0.483
Num Batches: 1
Design W/C: 0.481
Water in Truck: 0.0 gl
Actual Water: 325 gl
Water/Cement: 0.483 A
Adjust Water: 0.0 gl / Load
Batched Cement: 5615 lb
Design 325.0 gl
Trim Water: 0.0 gl / CY
Allowable Water: 0 lb
Actual 325.0 gl
To Add: 0.

Figure B. Batch tickets for Mix 2 - 25% SC



Mix 3

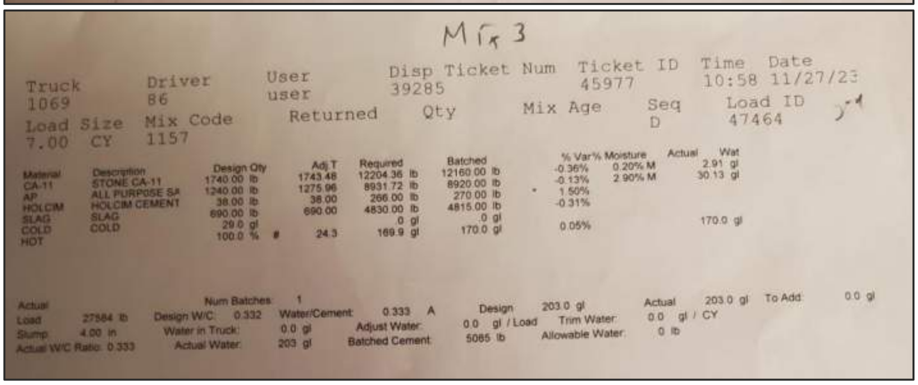
Truck 1065 | Driver 122 | User user | Disp Ticket Num 39283 | Ticket ID 45975 | Time 10:26 | Date 11/27/23

Load Size 9.00 CY | Mix Code 1157 | Returned | Qty | Mix Age | Seq D | Load ID 47462 | 1st

Material	Description	Design Qty		Adj.T	Required	Batched	% Var	% Moisture	Actual Wat
CA-11	STONE CA-11	1740.00 lb		1752.18	15769.62 lb	15720.00 lb	-0.31%	0.70% M	13.10 gl
AP	ALL PURPOSE SA	1240.00 lb		1275.96	11483.64 lb	11440.00 lb	-0.38%	2.90% M	38.64 gl
HOLCIM	HOLCIM CEMENT	38.00 lb		38.00	342.00 lb	345.00 lb	0.88%		
SLAG	SLAG	690.00 lb		690.00	6210.00 lb	6180.00 lb	-0.48%		
COLD	COLD	29.0 gl			0 gl	0 gl			209.0 gl
HOT		100.0 %	#	23.2	209.1 gl	209.0 gl	-0.04%		

Actual Load 35429 lb | Slump 4.00 in | Actual W/C Ratio 0.334
Num Batches: 1 | Design W/C: 0.332 | Water in Truck: 0.0 gl | Actual Water: 261 gl
Water/Cement: 0.334 T | Adjust Water: 0.0 gl / Load | Batched Cement: 6525 lb
Design 261.0 gl | Trim Water: 0.0 gl / CY | Allowable Water: 0 lb
Actual 260.7 gl | To Add: 0.3 gl

+10 gallons H_2O



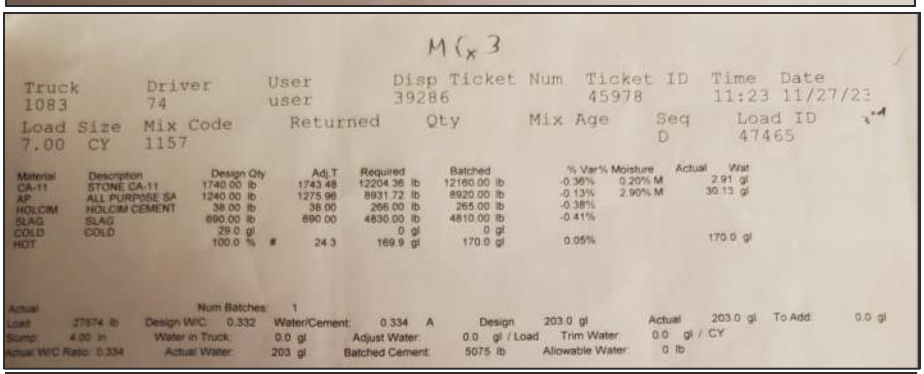
Mix 3

Truck 1069 | Driver 86 | User user | Disp Ticket Num 39285 | Ticket ID 45977 | Time 10:58 | Date 11/27/23

Load Size 7.00 CY | Mix Code 1157 | Returned | Qty | Mix Age | Seq D | Load ID 47464 | 2nd

Material	Description	Design Qty		Adj.T	Required	Batched	% Var	% Moisture	Actual Wat
CA-11	STONE CA-11	1740.00 lb		1743.48	12204.36 lb	12160.00 lb	-0.36%	0.20% M	2.91 gl
AP	ALL PURPOSE SA	1240.00 lb		1275.96	8931.72 lb	8920.00 lb	-0.13%	2.90% M	30.13 gl
HOLCIM	HOLCIM CEMENT	38.00 lb		38.00	266.00 lb	270.00 lb	1.50%		
SLAG	SLAG	690.00 lb		690.00	4830.00 lb	4815.00 lb	-0.31%		
COLD	COLD	29.0 gl			0 gl	0 gl			170.0 gl
HOT		100.0 %	#	24.3	169.9 gl	170.0 gl	0.05%		

Actual Load 27584 lb | Slump 4.00 in | Actual W/C Ratio 0.333
Num Batches: 1 | Design W/C: 0.332 | Water in Truck: 0.0 gl | Actual Water: 203 gl
Water/Cement: 0.333 A | Adjust Water: 0.0 gl / Load | Batched Cement: 5065 lb
Design 203.0 gl | Trim Water: 0.0 gl / CY | Allowable Water: 0 lb
Actual 203.0 gl | To Add: 0.0 gl



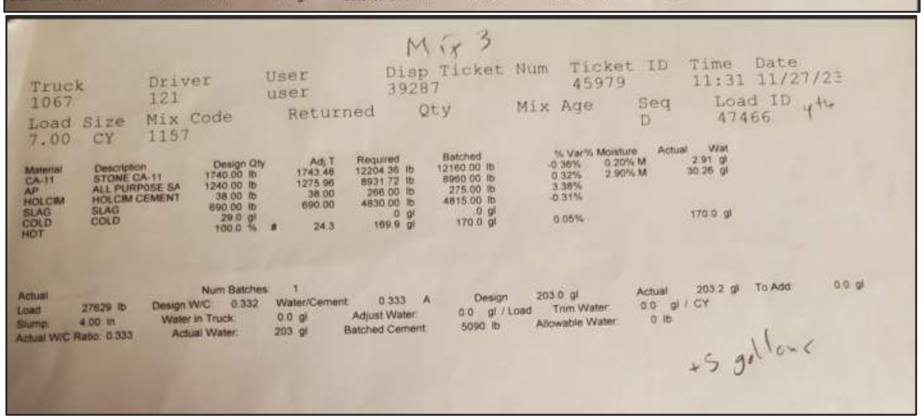
Mix 3

Truck 1083 | Driver 74 | User user | Disp Ticket Num 39286 | Ticket ID 45978 | Time 11:23 | Date 11/27/23

Load Size 7.00 CY | Mix Code 1157 | Returned | Qty | Mix Age | Seq D | Load ID 47465 | 3rd

Material	Description	Design Qty		Adj.T	Required	Batched	% Var	% Moisture	Actual Wat
CA-11	STONE CA-11	1740.00 lb		1743.48	12204.36 lb	12160.00 lb	-0.36%	0.20% M	2.91 gl
AP	ALL PURPOSE SA	1240.00 lb		1275.96	8931.72 lb	8920.00 lb	-0.13%	2.90% M	30.13 gl
HOLCIM	HOLCIM CEMENT	38.00 lb		38.00	266.00 lb	265.00 lb	-0.38%		
SLAG	SLAG	690.00 lb		690.00	4830.00 lb	4810.00 lb	-0.41%		
COLD	COLD	29.0 gl			0 gl	0 gl			170.0 gl
HOT		100.0 %	#	24.3	169.9 gl	170.0 gl	0.05%		

Actual Load 27574 lb | Slump 4.00 in | Actual W/C Ratio 0.334
Num Batches: 1 | Design W/C: 0.332 | Water in Truck: 0.0 gl | Actual Water: 203 gl
Water/Cement: 0.334 A | Adjust Water: 0.0 gl / Load | Batched Cement: 5075 lb
Design 203.0 gl | Trim Water: 0.0 gl / CY | Allowable Water: 0 lb
Actual 203.0 gl | To Add: 0.0 gl



Mix 3

Truck 1067 | Driver 121 | User user | Disp Ticket Num 39287 | Ticket ID 45979 | Time 11:31 | Date 11/27/23

Load Size 7.00 CY | Mix Code 1157 | Returned | Qty | Mix Age | Seq D | Load ID 47466 | 4th

Material	Description	Design Qty		Adj.T	Required	Batched	% Var	% Moisture	Actual Wat
CA-11	STONE CA-11	1740.00 lb		1743.48	12204.36 lb	12160.00 lb	-0.36%	0.20% M	2.91 gl
AP	ALL PURPOSE SA	1240.00 lb		1275.96	8931.72 lb	8960.00 lb	0.32%	2.90% M	30.26 gl
HOLCIM	HOLCIM CEMENT	38.00 lb		38.00	266.00 lb	275.00 lb	3.38%		
SLAG	SLAG	690.00 lb		690.00	4830.00 lb	4815.00 lb	-0.31%		
COLD	COLD	29.0 gl			0 gl	0 gl			170.0 gl
HOT		100.0 %	#	24.3	169.9 gl	170.0 gl	0.05%		

Actual Load 27629 lb | Slump 4.00 in | Actual W/C Ratio 0.333
Num Batches: 1 | Design W/C: 0.332 | Water in Truck: 0.0 gl | Actual Water: 203 gl
Water/Cement: 0.333 A | Adjust Water: 0.0 gl / Load | Batched Cement: 5090 lb
Design 203.0 gl | Trim Water: 0.0 gl / CY | Allowable Water: 0 lb
Actual 203.2 gl | To Add: 0.0 gl

+5 gallons

Figure C. Batch tickets for Mix 3 - C1157

APPENDIX. Quality Control Test Reports

Compressive Strength of Concrete

Test Method: ASTM C 39

Report Date: 01/30/2024
Sample: 7357

St. Charles
130 Point West Boulevard
St. Charles, MO 63301
Phone: 636-949-8200
Fax: 636-949-8269

Client:
Concrete Strategies, LLC.
2199 Innerbelt Business Center Drive
St. Louis, MO 63114

Project:
20210575.01
Trial Batching - AWS Test Panels
7400 N Broadway
St. Louis, MO 63147

Sample Details

Set #:	1	**Technician:**	Drazen Gonzalez Tirado	**Batched:**	
Specimen Size:	4" X 8" Cylinder	**Cast By:**	Drazen Gonzalez Tirado	**Sampled:**	09:45 CST
Specimens In Set:	20	**Date Cast:**	11/27/23	**Cast:**	09:45 CST
Truck / Ticket #:	108 / 39275	**Sampled From:**	Pump Discharge	**Truck Empty:**	
Contractor:	Concrete Strategies	**Placement Method:**	Pump	**Placement Time:**	

Location

Placement Location: Building - Wall
Location Details: Test panel 1
Sample Location / Notes: Panel 1

Batch Log

Supplier:	Kienstra	**Mix Design:**	5020
Plant:	Woodriver		
Sampling Method:	ASTM C172 (AASHTO R60) - Sampling Concrete		Mix 1 - Control
Sample Condition:	Good		
On-Site Admixtures:	None		

Specifications

Strength: 5000 (psi)

Field Measurements

Weather:		**Slump (in):**	3-1/2 (ASTM C143)	**Plastic Unit Weight:**	148.0 (lb/ft³) (ASTM C138)
Air Temperature (F):	34	**Concrete Temp (F):**	79 (ASTM C1064)	**Air Content:**	2.3 (ASTM C231)
				Load Volume:	10.00 (yd³)

Standard Cure | **Field Cure**

Lab Test Results

Specimen Number	Test Age Days	Test Date	Field / Lab Cure Days	Average Cylinder Diameter (in)	Cylinder Area (in²)	Max Load (lbs)	Strength (psi)	Fracture Type	Break Remark	Capping Method
1-1	2 FC	11/29/23	2 / 0	4.00	12.57	64,889	5,160	2		U
1-2	2 FC	11/29/23	2 / 0	4.00	12.57	63,993	5,090	2		U
1-3	2 FC	11/29/23	2 / 0	4.00	12.57	64,541	5,140	2		U
1-4	2 FC	11/29/23	2 / 0	4.00	12.57	62,290	4,960	2		U
1-5	7	12/04/23	1 / 6	4.00	12.57	69,370	5,520	2		U
1-6	7	12/04/23	1 / 6	4.00	12.57	68,788	5,470	2		U
1-7	4 FC	12/01/23	3 / 1	4.00	12.57	68,768	5,470	2		U
1-8	3 FC	11/30/23	3 / 0	4.00	12.57	65,712	5,230	2		U
1-9	14 FC	12/11/23	4 / 10	4.00	12.57	75,689	6,020	2		U
1-10	14 FC	12/11/23	4 / 10	4.00	12.57	76,262	6,070	2		U
1-11	29	12/26/23	1 / 28	4.00	12.57	78,385	6,240	2	C1	U
1-12	29	12/26/23	1 / 28	4.00	12.57	79,562	6,330	2	C1	U
1-13	29	12/26/23	1 / 28	4.00	12.57	79,811	6,350	2	C1	U
1-14	29 FC	12/26/23	4 / 25	4.00	12.57	82,152	6,540	3	C1	U
1-15	29 FC	12/26/23	4 / 25	4.00	12.57	83,090	6,610	2	C1	U
1-16	29 FC	12/26/23	4 / 25	4.00	12.57	84,343	6,710	3	C1	U
1-17	56 H FC	01/22/24	1 / 55							
1-18	56 H FC	01/22/24	1 / 55							
1-19	56 H FC	01/22/24	1 / 55							
1-20	56 H FC	01/22/24	1 / 55							

Test Age Average Strengths (psi): 2 Day FC - **5090**, 7 Day - **5500**, 4 Day FC - **5470**, 3 Day FC - **5230**, 14 Day FC - **6040**, 29 Day - **6310**, 29 Day FC - **6620**

Compressive Strength of Concrete
Test Method: ASTM C 39

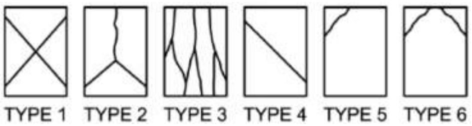
Report Date: 01/30/2024
Sample: 7357

St. Charles
130 Point West Boulevard
St. Charles, MO 63301
Phone: 636-949-8200
Fax: 636-949-8269

Client:
Concrete Strategies, LLC.
2199 Innerbelt Business Center Drive
St. Louis, MO 63114

Project:
20210575.01
Trial Batching - AWS Test Panels
7400 N Broadway
St. Louis, MO 63147

	Capping Methods
C1: Test results meet or exceed the specified strength **Tested By:** Reginald Nichols (1,2,7,8,9,10), Drew Hemphill (17,18,19,20)	**U:** Unbonded Cap (ASTM C1231)
Checked In : 11/29/2023 (1,2), 11/29/2023 (3,4), 11/28/2023 (5,6,11,12,13,17,18,19,20), 11/30/2023 (7,8), 12/01/2023 (9,10,14,15,16)	



This Report has been reviewed and approved by:

Dale Hendrickson

Field Manager II

Compressive Strength of Concrete

Test Method: ASTM C 39

Report Date: 01/30/2024
Sample: 7359

St. Charles
130 Point West Boulevard
St. Charles, MO 63301
Phone: 636-949-8200
Fax: 636-949-8269

Client:
Concrete Strategies, LLC.
2199 Innerbelt Business Center Drive
St. Louis, MO 63114

Project:
20210575.01
Trial Batching - AWS Test Panels
7400 N Broadway
St. Louis, MO 63147

Sample Details

Set #:	2	**Technician:**	Drazen Gonzalez Tirado	**Batched:**	10:07 CST
Specimen Size:	4" X 8" Cylinder	**Cast By:**	Drazen Gonzalez Tirado	**Sampled:**	10:50 CST
Specimens In Set:	20	**Date Cast:**	11/27/23	**Cast:**	11:00 CST
Truck / Ticket #:	1023 / 39281	**Sampled From:**	Pump Discharge	**Truck Empty:**	
Contractor:	Concrete Strategies	**Placement Method:**	Pump	**Placement Time:**	

Location

Placement Location: Building - Wall
Location Details: Panel 2
Sample Location / Notes: Panel 2

Batch Log

Supplier: Kienstra
Plant: Woodriver
Sampling Method: ASTM C172 (AASHTO R60) - Sampling Concrete
Sample Condition: Good
On-Site Admixtures: None
Mix Design: 5030

Mix 2 - 25% SC

Specifications

Strength: 5000 (psi)

Field Measurements

Weather:		**Slump (in):**	4-1/4 (ASTM C143)	**Plastic Unit Weight:**	148.2 (lb/ft³) (ASTM C138)
Air Temperature (F):	37	**Concrete Temp (F):**	80 (ASTM C1064)	**Air Content:**	2.3 (ASTM C231)
				Load Volume:	10.00 (yd³)

Standard Cure | Field Cure

Lab Test Results

Specimen Number	Test Age Days	Test Date	Field / Lab Cure Days	Average Cylinder Diameter (in)	Cylinder Area (in²)	Max Load (lbs)	Strength (psi)	Fracture Type	Break Remark	Capping Method
2-1	2 FC	11/29/23	2 / 0	4.00	12.57	45,485	3,620	2		U
2-2	2 FC	11/29/23	2 / 0	4.00	12.57	46,132	3,670	2		U
2-3	2 FC	11/29/23	2 / 0	4.00	12.57	48,570	3,860	2		U
2-4	2 FC	11/29/23	2 / 0	4.00	12.57	46,554	3,700	2		U
2-5	7	12/04/23	1 / 6	4.00	12.57	67,062	5,340	2		U
2-6	7	12/04/23	1 / 6	4.00	12.57	65,782	5,230	2		U
2-7	4 FC	12/01/23	3 / 1	4.00	12.57	55,508	4,420	5		U
2-8	3 FC	11/30/23	3 / 0	4.00	12.57	54,004	4,300	2		U
2-9	14 FC	12/11/23	4 / 10	4.00	12.57	76,446	6,080	2		U
2-10	14 FC	12/11/23	4 / 10	4.00	12.57	76,675	6,100	2		U
2-11	29	12/26/23	1 / 28	4.00	12.57	88,138	7,010	2	C1	U
2-12	29	12/26/23	1 / 28	4.00	12.57	82,749	6,580	2	C1	U
2-13	29	12/26/23	1 / 28	4.00	12.57	87,364	6,950	2	C1	U
2-14	29 FC	12/26/23	4 / 25	4.00	12.57	87,255	6,940	2	C1	U
2-15	29 FC	12/26/23	4 / 25	4.00	12.57	88,727	7,060	3	C1	U
2-16	29 FC	12/26/23	4 / 25	4.00	12.57	85,639	6,810	2	C1	U
2-17	56 H FC	01/22/24	1 / 55							
2-18	56 H FC	01/22/24	1 / 55							
2-19	56 H FC	01/22/24	1 / 55							
2-20	56 H FC	01/22/24	1 / 55							

Test Age Average Strengths (psi): 2 Day FC - **3710**, 7 Day - **5280**, 4 Day FC - **4420**, 3 Day FC - **4300**, 14 Day FC - **6090**, 29 Day - **6850**, 29 Day FC - **6940**

Compressive Strength of Concrete
Test Method: ASTM C 39

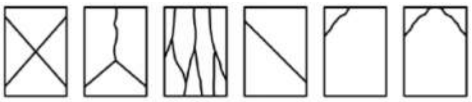
Report Date: 01/30/2024
Sample: 7359

St. Charles
130 Point West Boulevard
St. Charles, MO 63301
Phone: 636-949-8200
Fax: 636-949-8269

Client:
Concrete Strategies, LLC.
2199 Innerbelt Business Center Drive
St. Louis, MO 63114

Project:
20210575.01
Trial Batching - AWS Test Panels
7400 N Broadway
St. Louis, MO 63147

	Capping Methods
C1: Test results meet or exceed the specified strength **Tested By:** Reginald Nichols (1,2,7,8,9,10), Drew Hemphill (17,18,19,20)	**U:** Unbonded Cap (ASTM C1231)
Checked In : 11/29/2023 (1,2), 11/29/2023 (3,4), 11/28/2023 (5,6,11,12,13,17,18,19,20), 11/30/2023 (7,8), 12/01/2023 (9,10,14,15,16)	



TYPE 1 TYPE 2 TYPE 3 TYPE 4 TYPE 5 TYPE 6

This Report has been reviewed and approved by:
Dale Hendrickson
Field Manager II

Compressive Strength of Concrete

Test Method: ASTM C 39

Revised-20240202
Report Date: 02/02/2024
Sample: 7361

St. Charles
130 Point West Boulevard
St. Charles, MO 63301
Phone: 636-949-8200
Fax: 636-949-8269

Client:
Concrete Strategies, LLC.
2199 Innerbelt Business Center Drive
St. Louis, MO 63114

Project:
20210575.01
Trial Batching - AWS Test Panels
7400 N Broadway
St. Louis, MO 63147

Sample Details

Set #:	3	**Technician:**	Drazen Gonzalez Tirado	**Batched:**	12:08 CST
Specimen Size:	4" X 8" Cylinder	**Cast By:**	Drazen Gonzalez Tirado	**Sampled:**	12:35 CST
Specimens In Set:	20	**Date Cast:**	11/27/23	**Cast:**	12:45 CST
Truck / Ticket #:	1083 / 39286	**Sampled From:**	Pump Discharge	**Truck Empty:**	
Contractor:	Concrete Strategies	**Placement Method:**	Pump	**Placement Time:**	

Location

Placement Location: Building - Wall
Location Details: Panel 3
Sample Location / Notes: Panel 3

Batch Log

Supplier: Kienstra
Plant: Woodriver
Sampling Method: ASTM C172 (AASHTO R60) - Sampling Concrete
Sample Condition: Good
On-Site Admixtures: None
Mix Design: 1157

Mix 3 - C1157

Specifications

Strength: 5000 (psi)

Field Measurements

Weather:		**Slump (in):**	9 (ASTM C143)	**Plastic Unit Weight:**	142.8 (lb/ft³) (ASTM C138)
Air Temperature (F):	43	**Concrete Temp (F):**	73 (ASTM C1064)	**Air Content:**	3.5 (ASTM C231)
				Load Volume:	7.00 (yd³)

Standard Cure | Field Cure

Lab Test Results

Specimen Number	Test Age Days	Test Date	Field / Lab Cure Days	Average Cylinder Diameter (in)	Cylinder Area (in²)	Max Load (lbs)	Strength (psi)	Fracture Type	Break Remark	Capping Method
3-1	2 FC	11/29/23	2 / 0	4.00	12.57	1,019	80	3		U
3-2	2 FC	11/29/23	2 / 0	4.00	12.57	849	70	3		U
3-3	2 FC	11/29/23	2 / 0	4.00	12.57	969	80	3		U
3-4	2 FC	11/29/23	2 / 0	4.00	12.57	1,314	110	3		U
3-5	3	11/30/23	1 / 2	4.00	12.57	5,203	410	3		U
3-6	7	12/04/23	1 / 6	4.00	12.57	8,683	690	2		U
3-7	3 FC	11/30/23	3 / 0	4.00	12.57	5,520	440	3		U
3-8	4 FC	12/01/23	3 / 1	4.00	12.57	4,890	390	2		U
3-9	5 FC	12/02/23	5 / 0	4.00	12.57	11,301	900	5		U
3-10	5 FC	12/02/23	5 / 0	4.00	12.57	12,427	990	5		U
3-11	29	12/26/23	1 / 28	4.00	12.57	62,888	5,000	2	C1	U
3-12	29	12/26/23	1 / 28	4.00	12.57	63,435	5,050	2	C1	U
3-13	7	12/04/23	1 / 6	4.00	12.57	12,196	970	2		U
3-14	7 FC	12/04/23	7 / 0	4.00	12.57	22,110	1,760	2		U
3-15	29 FC	12/26/23	29 / 0	4.00	12.57	74,810	5,950	2	C1	U
3-16	29 FC	12/26/23	29 / 0	4.00	12.57	72,762	5,790	2	C1	U
3-17	56 H FC	01/22/24	1 / 55							
3-18	56 H FC	01/22/24	1 / 55							
3-19	56 H FC	01/22/24	1 / 55							
3-20	56 H FC	01/22/24	1 / 55							

Test Age Average Strengths (psi): 2 Day FC - **80**, 3 Day - **410**, 7 Day - **830**, 3 Day FC - **440**, 4 Day FC - **390**, 5 Day FC - **940**, 29 Day - **5030**, 7 Day FC - **1760**, 29 Day FC - **5870**

St. Charles
130 Point West Boulevard
St. Charles, MO 63301
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Compressive Strength of Concrete

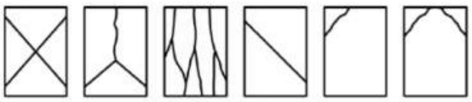
Test Method: ASTM C 39

Revised-20240202
Report Date: 02/02/2024
Sample: 7361

Client:
Concrete Strategies, LLC.
2199 Innerbelt Business Center Drive
St. Louis, MO 63114

Project:
20210575.01
Trial Batching - AWS Test Panels
7400 N Broadway
St. Louis, MO 63147

	Capping Methods
C1: Test results meet or exceed the specified strength **Tested By:** Reginald Nichols (1,2,8,11,12,13,14,15,16), Drew Hemphill (17,18,19,20)	**U:** Unbonded Cap (ASTM C1231)
Checked In : 11/29/2023 (1,2), 11/29/2023 (3,4), 11/28/2023 (5,6,11,12,13,17,18,19,20), 11/30/2023 (7,8), 12/02/2023 (9,10), 12/04/2023 (14), 12/26/2023 (15,16)	



TYPE 1 TYPE 2 TYPE 3 TYPE 4 TYPE 5 TYPE 6

This Report has been reviewed and approved by:

Dale Hendrickson

Field Manager II

*Specimens are in conformance with applicable standards unless otherwise noted. Results only relate to items tested. Results may not be reproduced except in full without prior written approval.

St. Charles
130 Point West Boulevard
St. Charles, MO 63301
Phone: 636-949-8200
Fax: 636-949-8269

Concrete Modulus of Rupture

Test Method: ASTM C 293

Report Date: 01/30/2024
Sample: 7356

Client:
Concrete Strategies, LLC.
2199 Innerbelt Business Center Drive
St. Louis, MO 63114

Project:
20210575.01
Trial Batching - AWS Test Panels
7400 N Broadway
St. Louis, MO 63147

Sample Details

Set #:	1	**Technician:**	Drazen Gonzalez Tirado	**Batched:**	
Specimen Size:	6" X 21" X 6" Prism	**Cast By:**	Drazen Gonzalez Tirado	**Sampled:**	09:45 CST
Specimens In Set:	7	**Date Cast:**	11/27/23	**Cast:**	09:55 CST
Truck / Ticket #:		**Sampled From:**	Pump Discharge	**Truck Empty:**	
Contractor:		**Placement Method:**	Pump	**Placement Time:**	

Location

Placement Location: Building - Wall
Location Details: Test panel 1
Sample Location / Notes: Test panel 1

Batch Log

Supplier: Kienstra
Plant: Woodriver
Sampling Method: ASTM C172 (AASHTO R60) - Sampling Concrete
Sample Condition: Good
Mix Design: 5020

Mix 1 - Control

Beam Fabrication Method: Vibrated (ASTM C31)
On-Site Admixtures: None

Specifications

Mod. of Rupture: 500 (psi)
Air: 0 - 3 (%)
Slump: 3 - 8 (in)

Field Measurements

Weather:		**Slump (in):**	3-1/2 (ASTM C143)	**Plastic Unit Weight:**	148.0 (lb/ft³) (ASTM C138)
Air Temperature (F):		**Concrete Temp (F):**	79 (ASTM C1064)	**Air Content:**	2.3 (ASTM C231)
				Load Volume:	

Standard Cure | **Field Cure**

Lab Test Results

Specimen Number	Test Age Days	Test Date	Field / Lab Cure Days	Average Width (in)	Average Depth (in)	Span (in)	Load (lbs)	Modulus of Rupture (psi)	Fracture Location	Wet / Dry	Break Remark
1-1	2 FC	11/29/23	2 / 0	6.00	6.00	18	7,510	625	Middle	Wet	
1-2	2 FC	11/29/23	2 / 0	6.00	6.00	18	8,415	700	Middle	Wet	
1-3	3 FC	11/30/23	3 / 0	6.00	6.00	18	8,415	700	Middle	Wet	
1-4	7 FC	12/04/23	4 / 3	6.00	6.00	18	9,575	800	Middle	Wet	
1-5	7 FC	12/04/23	4 / 3	6.00	6.00	18	10,115	845	Middle	Wet	
1-6	29 FC	12/26/23	4 / 25	5.95	6.00	18	10,070	845	Middle	Wet	
1-7	29 FC	12/26/23	4 / 25	6.00	6.00	18	10,585	880	Middle	Wet	

Test Age Average Strengths (psi): 2 Day FC - **665**, 3 Day FC - **700**, 7 Day FC - **820**, 29 Day FC - **865**

Specimen 1-1: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 1-2: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 1-3: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 1-4: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 1-5: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 1-6: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 1-7: **Testing Method -** Leather Shims, **Forming Method -** Molded

Break Remarks

Tested By: Reginald Nichols (1,2,3,4,5,6,7)
Checked In : 11/29/2023 (1), 11/29/2023 (2), 11/30/2023 (3), 12/01/2023 (4,5,6,7)

This Report has been reviewed and approved by:
Dale Hendrickson
Field Manager II

Concrete Modulus of Rupture

Test Method: ASTM C 293

Report Date: 01/30/2024
Sample: 7358

St. Charles
130 Point West Boulevard
St. Charles, MO 63301
Phone: 636-949-8200
Fax: 636-949-8269

Client:

Concrete Strategies, LLC.
2199 Innerbelt Business Center Drive
St. Louis, MO 63114

Project:

20210575.01
Trial Batching - AWS Test Panels
7400 N Broadway
St. Louis, MO 63147

Sample Details

Set #:	2	**Technician:**	Drazen Gonzalez Tirado	**Batched:**	10:07 CST
Specimen Size:	6" X 21" X 6" Prism	**Cast By:**	Drazen Gonzalez Tirado	**Sampled:**	10:50 CST
Specimens In Set:	7	**Date Cast:**	11/27/23	**Cast:**	11:00 CST
Truck / Ticket #:	1023 / 39281	**Sampled From:**	Pump Discharge	**Truck Empty:**	
Contractor:	Concrete Strategies	**Placement Method:**	Pump	**Placement Time:**	

Location

Placement Location: Building - Wall
Location Details: Panel 2
Sample Location / Notes: Panel 2

Batch Log

Supplier: Kienstra
Plant: Woodriver
Sampling Method: ASTM C172 (AASHTO R60) - Sampling Concrete
Sample Condition: Good
Mix Design: 5030

Mix 2 - 25% SC

Beam Fabrication Method: Vibrated (ASTM C31)
On-Site Admixtures: None

Specifications

Mod. of Rupture: 500 (psi)
Air: 0 - 3 (%)
Slump: 3 - 8 (in)

Field Measurements

Weather:		**Slump (in):**	4-1/4 (ASTM C143)	**Plastic Unit Weight:**	148.2 (lb/ft³) (ASTM C138)
Air Temperature (F):	37	**Concrete Temp (F):**	80 (ASTM C1064)	**Air Content:**	2.3 (ASTM C231)
				Load Volume:	10.00 (yd³)

Standard Cure

Field Cure

Lab Test Results

Specimen Number	Test Age Days	Test Date	Field / Lab Cure Days	Average Width (in)	Average Depth (in)	Span (in)	Load (lbs)	Modulus of Rupture (psi)	Fracture Location	Wet / Dry	Break Remark
2-1	2 FC	11/29/23	2 / 0	6.00	6.00	18	6,825	570	Middle	Wet	
2-2	2 FC	11/29/23	2 / 0	6.00	6.00	18	7,540	630	Middle	Wet	
2-3	3 FC	11/30/23	3 / 0	6.00	6.00	18	8,630	720	Middle	Wet	
2-4	7 FC	12/04/23	4 / 3	6.00	6.00	18	9,285	775	Middle	Wet	
2-5	7 FC	12/04/23	4 / 3	6.00	6.00	18	9,785	815	Middle	Wet	
2-6	29 FC	12/26/23	4 / 25	6.00	6.00	18	11,230	935	Middle	Wet	
2-7	29 FC	12/26/23	4 / 25	6.00	6.00	18	10,915	910	Middle	Wet	

Test Age Average Strengths (psi): 2 Day FC - **600**, 3 Day FC - **720**, 7 Day FC - **795**, 29 Day FC - **925**

Specimen 2-1: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 2-2: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 2-3: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 2-4: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 2-5: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 2-6: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 2-7: **Testing Method -** Leather Shims, **Forming Method -** Molded

Break Remarks

Tested By: Reginald Nichols (1,2,3,4,5,6,7)

Checked In : 11/29/2023 (1), 11/29/2023 (2), 11/30/2023 (3), 12/01/2023 (4,5,6,7)

This Report has been reviewed and approved by:

Dale Hendrickson

Field Manager II

Concrete Modulus of Rupture

Test Method: ASTM C 293

Revised-20240202
Report Date: 02/02/2024
Sample: 7360

St. Charles
130 Point West Boulevard
St. Charles, MO 63301
Phone: 636-949-8200
Fax: 636-949-8269

Client:
Concrete Strategies, LLC.
2199 Innerbelt Business Center Drive
St. Louis, MO 63114

Project:
20210575.01
Trial Batching - AWS Test Panels
7400 N Broadway
St. Louis, MO 63147

Sample Details

Set #:	3	**Technician:**	Drazen Gonzalez Tirado	**Batched:**	12:08 CST
Specimen Size:	6" X 21" X 6" Prism	**Cast By:**	Drazen Gonzalez Tirado	**Sampled:**	12:35 CST
Specimens In Set:	7	**Date Cast:**	11/27/23	**Cast:**	12:45 CST
Truck / Ticket #:	1087 / 39286	**Sampled From:**	Pump Discharge	**Truck Empty:**	
Contractor:	Concrete Strategies	**Placement Method:**	Pump	**Placement Time:**	

Location

Placement Location: Building - Wall
Location Details: Panel 3
Sample Location / Notes: Panel 3

Batch Log

Supplier: Kienstra
Plant: Woodriver
Sampling Method: ASTM C172 (AASHTO R60) - Sampling Concrete
Sample Condition: Good
Mix Design: 1157

Mix 3 - C1157

Beam Fabrication Method: Vibrated (ASTM C31)
On-Site Admixtures: None

Specifications

Mod. of Rupture: 500 (psi)
Air: 0 - 3 (%)
Slump: 3 - 8 (in)

Field Measurements

Weather:		**Slump (in):**	9 (ASTM C143)	**Plastic Unit Weight:**	142.8 (lb/ft³) (ASTM C138)
Air Temperature (F):	43	**Concrete Temp (F):**	73 (ASTM C1064)	**Air Content:**	3.5 (ASTM C231)
				Load Volume:	7.00 (yd³)

Standard Cure | **Field Cure**

Lab Test Results

Specimen Number	Test Age Days	Test Date	Field / Lab Cure Days	Average Width (in)	Average Depth (in)	Span (in)	Load (lbs)	Modulus of Rupture (psi)	Fracture Location	Wet / Dry	Break Remark
3-1	2 FC	11/29/23	2 / 0	5.90	6.00	18	550	45	Middle	Wet	
3-2	2 FC	11/29/23	2 / 0	6.00	6.00	18	950	80	Middle	Wet	
3-3	3 FC	11/30/23	3 / 0	6.00	6.00	18	2,715	225	Middle	Wet	
3-4	5 FC	12/02/23	5 / 0	6.05	6.00	18	5,370	445	Middle	Dry	
3-5	7 FC	12/04/23	7 / 0	6.00	6.00	18	6,940	580	Middle	Wet	
3-6	29 FC	12/26/23	29 / 0	6.00	6.00	18	10,085	840	Middle	Wet	
3-7	29 FC	12/26/23	29 / 0	6.00	6.00	18	8,885	740	Middle	Wet	

Test Age Average Strengths (psi): 2 Day FC - **65**, 3 Day FC - **225**, 5 Day FC - **445**, 7 Day FC - **580**, 29 Day FC - **790**

Specimen 3-1: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 3-2: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 3-3: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 3-4: **Testing Method -** Ground and Leather Shims, **Forming Method -** Molded
Specimen 3-5: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 3-6: **Testing Method -** Leather Shims, **Forming Method -** Molded
Specimen 3-7: **Testing Method -** Leather Shims, **Forming Method -** Molded

Break Remarks

Tested By: Reginald Nichols (1,2,3,4,5,6,7)

Checked In : 11/29/2023 (1), 11/29/2023 (2), 11/30/2023 (3), 12/02/2023 (4), 12/04/2023 (5), 12/26/2023 (6,7)

This Report has been reviewed and approved by:
Dale Hendrickson
Field Manager II