

BURNS COOLEY DENNIS, INC.

GEOTECHNICAL AND MATERIALS ENGINEERING CONSULTANTS

**LABORATORY DATA TO DETERMINE
IMPACT OF COARSE AGGREGATE
TYPE AND CEMENTITIOUS
MATERIALS ON DESIGN THICKNESS
OF PCC PAVEMENTS**

Project No. SP-9999-09(110)/106812-101000

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Abstract

This study was requested by the Mississippi Department of Transportation (MDOT) to develop mechanical and volume change properties for typical portland cement concrete (PCC) pavements that are useful for the implementation of the Mechanistic-Empirical Pavement Design Guide (MEPDG). These properties include compressive strength, flexural strength, modulus of elasticity, Poisson's ratio, coefficient of thermal expansion, and length change.

A total of twenty laboratory mixtures were used to develop data provided in this report. These mixtures were proportioned from five coarse aggregate sources and three supplementary cementitious materials (SCM). The mixtures represent typical concrete pavement materials used in Mississippi. Constituent materials included water, portland cement, fly ash, slag cement, Mississippi gravel, crushed limestone, along with air entraining and water reducing admixtures. Two sources of crushed limestone and three sources of Mississippi gravel were utilized in these mixtures. The sources of gravel were selected to represent typical aggregate properties found throughout the state of Mississippi.

The concrete properties included in this report are useful for level 1 and 2 inputs of the MEPDG. Results for compressive strength, flexural strength, modulus of elasticity and Poisson's ratio are reported for 7, 14, 28, and 90 days. Results for coefficient of thermal expansion were reported for 28 days. Length change measurements were reported from the end the initial 7-day moist curing period generally for 0, 5, 7, 14, 28, 35, 56, 112, 224, 448, 812, 813, 815, 819, 826, 840, 847, 868, and 981 days.

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CHAPTER 1 - INTRODUCTION

BACKGROUND

The Mississippi Department of Transportation (MDOT) has been active in the implementation of the Mechanistic-Empirical Pavement Design Guide (MEPDG) procedure for determining thickness of flexible and rigid pavements. Mechanical and volume change properties of portland cement concrete (PCC) pavement are critical inputs for thickness design procedures of this guide. MDOT needed these concrete properties determined for typical concrete pavement mixtures used in Mississippi. Data included in this report were developed from testing twenty mixtures that represent typical concrete materials and proportions used in PCC pavements in Mississippi. These data are being used to assist MDOT in the implementation of MEPDG. More information on the implementation of the MEPDG for concrete pavements can be found in “Guidelines for PCC Inputs to AASHTOWare Pavement ME” (Rao, 2014).

OBJECTIVE

The objective of this study was to develop concrete material properties useful in the implementation of the MEPDG for PCC pavements constructed in Mississippi. Results include mechanical and volume change properties. The following properties are included in this report:

- Mechanical Properties
 - Compressive Strength (f'_c), psi
 - Flexural Strength or Modulus of Rupture (MOR), psi
 - Modulus of Elasticity (MOE), psi
 - Poisson's Ratio (μ)
- Volume Change Properties
 - Coefficient of Thermal Expansion (CTE), in./in./°F
 - Length Change, % or negative strain $\times 10^{-6}$

APPROACH

Testing was performed on hardened concrete to determine mechanical and volume change properties. The test methods used to determine these properties are listed below:

- Compressive strength - AASHTO T 22 / ASTM C 39 “Standard Test method for Compressive Strength of Cylindrical Concrete Specimens.”

- Flexural strength - AASHTO T 97 / ASTM C 78 “Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading.)”
- Modulus of Elasticity and Poisson’s Ratio - ASTM C 469 “Standard Test Method for Static Modulus of Elasticity and Poisson’s Ratio of Concrete.”
- Coefficient of Thermal Expansion - AASHTO T 336 “Coefficient of Thermal Expansion of Hydraulic Cement Concrete.”
- Length change - AASHTO T 160 / ASTM C 157 “Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.”

Results for compressive strength, modulus of elasticity and Poisson’s ratio were reported for 7, 14, 28, and 90 days. Length change measurements were reported from end of initial 7-day moist curing period for 0, 5, 7, 14, 28, 35, 56, 112, 224, 448, 812, 813, 815, 819, 826, 840, 847, 868, and 981 days. Burns Cooley Dennis, Inc. (BCD) conducted all of the laboratory testing except for the Coefficient of Thermal Expansion (CTE) which was conducted by American Engineering Testing (AET). Limited comparison testing was conducted by Federal Highway Administration (FHWA) Mobile Concrete Laboratory for Modulus of Elasticity, Poisson’s ratio, and CTE.

Table 1 presents a description of experimental mixtures. One source of fine aggregate was used in all twenty mixtures. Five sources of coarse aggregate were used including two sources of crushed limestone and three sources of Mississippi gravel. Gravel sources were selected to represent typical aggregate properties found throughout the state of Mississippi and the selection was based on the nominal maximum aggregate size or the absorption. One source was selected to provide a No. 67 (small maximum size) gravel aggregate. The other two gravel aggregate sources were selected based on the absorption of the aggregate. The approximate average absorption of Mississippi gravel aggregates is 2.60 percent based on the Author’s experience from testing forty-four sources. This study utilized one gravel source with a high absorption (above average) and one source with a low absorption (below average). The values of the high and low absorptions were 3.37 percent and 1.42 percent, respectively.

One source of Class C fly ash, one source of Class F fly ash, and one source of slag cement was selected and blended with one source of portland cement. Fly ash was utilized to replace portland cement at a rate of 25 percent by weight. Slag cement was utilized to replace

portland cement at a rate of 50 percent by weight. Mixtures proportioned with 100 percent portland cement were also utilized. Four cementitious blends were used in combination with five sources of coarse aggregate to make up the twenty mixtures used for test data included herein.

Table 1. Experimental Mixtures

Mix Number	Coarse Aggregate Type	Cementitious Materials
1	No. 57 High ¹ Absorption Gravel	Cement Type I-II
2		Cement Type I-II + FA Class F
3		Cement Type I-II + FA Class C
4		Cement Type I-II + Slag Cement
5	No 57 Crushed Limestone (Missouri)	Cement Type I-II
6		Cement Type I-II + FA Class F
7		Cement Type I-II + FA Class C
8		Cement Type I-II + Slag Cement
9	No 57 Crushed Limestone (Alabama)	Cement Type I-II
10		Cement Type I-II + FA Class F
11		Cement Type I-II + FA Class C
12		Cement Type I-II + Slag Cement
13	No 57 Low ¹ Absorption Gravel	Cement Type I-II
14		Cement Type I-II + FA Class F
15		Cement Type I-II + FA Class C
16		Cement Type I-II + Slag Cement
17	No 67 Small Maximum Size Gravel	Cement Type I-II
18		Cement Type I-II + FA Class F
19		Cement Type I-II + FA Class C
20		Cement Type I-II + Slag Cement

Note 1: High absorption referred to herein indicates an absorption above 2.60. Low absorption referred to herein indicates an absorption below 2.60.

CHAPTER 2 - MATERIALS

PORTLAND CEMENT

Portland cement is hydraulic cement and is the primary cementing material in portland cement concrete. Portland cement meeting requirements of ASTM C 150 / AASHTO M 85, “Standard Specification for Portland Cement”, is hydraulic cement made to conform to specific chemical and physical property limits according to these specifications. These specifications provide for eight types of portland cement meeting various set time and exposure criteria. Portland cement meeting requirements of both Type I and Type II was used in this study as the primary cementing material. Only one source of portland cement was used.

Hydraulic cements react with water to produce calcium silicate hydrate and other cementing compounds that cause concrete to set and gain strength. A byproduct of this reaction is calcium hydroxide which remains suspended in the concrete matrix and may be available to react with pozzolans such as Class C fly ash, Class F fly ash, or slag cement to create more cementing compounds.

Chemical and physical properties of the portland cement used in this project were provided by the supplier and are presented in Table 2. The cement is from a source that is approved for use on MDOT projects.

SUPPLEMENTARY CEMENTITIOUS MATERIALS (SCMs)

Supplementary Cementitious Materials (SCMs) are included in concrete mixtures as part of the overall cementitious system. Concrete produced in Mississippi incorporates SCMs in the mixture, particularly Class C fly ash and Class F fly ash. SCMs are often added to concrete in order to improve plastic and hardened properties. SCMs included in this study are Class C fly ash, Class F fly ash, and slag cement. SCMs have both hydraulic and pozzolanic value in concrete. Pozzolans are materials that have little cementing value by themselves, but will react with calcium hydroxide to provide additional cementing compounds within portland cement concrete.

Fly Ash

Fly ash is finely divided residue of burned ground coal, captured from the flue gases of a coal combustion device, usually at a coal-burning electric power plant. The combustion

byproduct is usually harvested with electrostatic precipitators, conveyed to storage and shipping, and is commonly used as a cementitious component of concrete without further processing. Class C fly ash and Class F fly ash conform to the provisions of AASHTO M 295 / ASTM C 618 “Standard Specification for Coal Fly Ash and Calcined Natural Pozzolan for Use in Concrete.” The distinction between the two classes is usually related to the type of coal burned in production of the ash. Class C fly ash can contain a total calcium content (expressed as CaO) higher than 10 percent, but MDOT projects require a CaO content of Class C fly ash greater than or equal to 8 percent. MDOT projects require a CaO content of less than 6 percent for Class F fly ash. Both classes of fly ash are predominately pozzolanic. MDOT specifications allow Class C fly ash and Class F fly ash to be used to replace up to 25 percent of the portland cement when used to replace Type I or II portland cement in concrete pavements. Mixtures for this study were proportioned with one source of Class C fly ash and one source of Class F fly ash. Each fly ash source is approved for use on MDOT projects. Chemical and physical properties of the Class C fly ash and Class F fly ash used in this study were provided by the supplier and are presented in Tables 3 and 4, respectfully.

Slag Cement

Slag cement is produced from water-quenched molten slag from an iron-making blast furnace according to AASHTO M 302 / ASTM C 989 “Slag Cement for Use in Concrete and Mortars.” Slag cement is hydraulic cement with additional pozzolanic properties. Slag cement is the molten mineralogical byproduct of iron ore from the blast furnace, but must be processed through "granulation" (rapid water quenching), drying, and grinding in a ball mill or roller press to produce slag cement. MDOT concrete specifications allow up to 50 percent replacement of portland cement with slag cement. Restrictive controls of the iron-making process lessen the variations in chemical composition from an individual plant, but the composition may vary between sources. When molten slag is rapidly water-cooled, it forms a glassy, sand-like, granulated material that when dried and ground into a fine powder, has cementitious properties. Slag that is allowed to cool slowly in air will form crystalline products that have no cementitious properties. Slag cement in the presence of water and activators supplied by the presence of portland cement will hydrate and set in a manner similar to portland cement. Slag cement is graded along a three-tiered activity index based on 7-day and 28-day strength results. This study

utilized one source of slag cement and this source is approved for use on MDOT projects. Chemical and physical properties of the slag cement used in this study were provided by the supplier and are presented in Table 5.

Table 2. Portland Cement Properties

Chemical Properties	Results
Silicon Dioxide (SiO ₂), %	19.5
Aluminum Oxide (Al ₂ O ₃), %	4.8
Ferric Oxide (Fe ₂ O ₃), %	3.2
Calcium Oxide (CaO), %	64.4
Magnesium Oxide (MgO), %	1.0
Sulfur Trioxide (SO ₃), %	3.5
Loss of Ignition (LOI), %	2.6
Insoluble Residue, %	0.25
Carbon Dioxide (CO ₂), %	1.7
Limestone, %	4.2
CaCO ₃ in limestone, %	93
Tricalcium Silicate (C ₃ S), %	60
Dicalcium Silicate (C ₂ S), %	10
Tricalcium Aluminate (C ₃ A), %	7
Tetracalcium Aluminoferrite (C ₄ AF), %	10
C ₃ S + 4.75C ₃ A, %	93.3
Alkalies (Na ₂ O equivalent), %	0.46
Physical Properties	Results
Air Content, %	6
Blaine Fineness, m ² /kg	404
Autoclave Expansion, %	0.00
Compressive Strength, 3 day (psi)	3,950
Compressive Strength, 7 day (psi)	4,910
Time of setting (Vicat) Initial Set, minutes	110
Mortar Bar Expansion C1038, %	-0.012
Heat of Hydration (cal/g)	80

Table 3. Class C Fly Ash Properties

Chemical Properties	Results
Silicon Dioxide (SiO ₂), %	39.61
Aluminum Oxide (Al ₂ O ₃), %	20.19
Iron Oxide (Fe ₂ O ₃), %	6.47
Sum of Constituents, %	66.27
Sulfur Trioxide (SO ₃), %	1.61
Calcium Oxide (CaO), %	21.15
Magnesium Oxide (MgO), %	4.94
Sodium Oxide (Na ₂ O), %	1.58
Potassium Oxide (K ₂ O), %	0.76
Moisture Content, %	0.07
Loss on Ignition, %	0.41
Available Alkalies, as Na ₂ O, %	1.42
Physical Properties	Results
Fineness, % retained on No. 325	19.68
Strength Activity Index 7 day, % of control	89
Strength Activity Index 28 day, % of control	93
Water Requirement, % control	94
Autoclave Soundness	0.02
Density	2.61

Table 4. Class F Fly Ash Properties

Chemical Properties	Results
Silicon Dioxide (SiO ₂), %	50.96
Aluminum Oxide (Al ₂ O ₃), %	25.88
Iron Oxide (Fe ₂ O ₃), %	8.70
Sum of Silicon Dioxide, Iron Oxide & Aluminum Oxide, %	85.54
Calcium Oxide (CaO), %	2.67
Magnesium Oxide (MgO), %	1.16
Sulfur Trioxide (SO ₃), %	2.22
Loss on Ignition, %	2.93
Moisture Content, %	1.47
Available Alkalies, as Na ₂ O, %	1.05
Sodium Oxide (Na ₂ O), %	0.27
Potassium Oxide (K ₂ O), %	1.18
Physical Properties	Results
Fineness, % retained on No. 325	20.1
Strength Activity Index 7 day, % of control	81
Strength Activity Index 28 day, % of control	78
Water Requirement, % control	98
Autoclave Soundness	-0.03
Density Mg/m ³	2.18

Table 5. Slag Cement Properties

Chemical Properties	Results
Sulfide S, %	1.06
Sulfate Ion (SO ₃), %	0.29
Physical Properties	Results
+45 μ m (No. 325) Sieve, %	0.43
Blaine Fineness (m ² /kg)	672
Air Content, %	3.7
Slag Activity 7 Day Index, %	80
Slag Activity 28 Day Index, %	124
Compressive Strength Slag + Ref, 7 day (psi)	3,720
Compressive Strength Slag + Ref, 28 day (psi)	7,390
Reference Cement	
Compressive Strength MPa, 7 day (psi)	4,630
Compressive Strength MPa, 28 day (psi)	5,950
Reference Cement Qualification Data	
Chemical Properties	Results
Total Alkalies as Na ₂ O, %	0.84
Tricalcium Silicate (C ₃ S), %	55.3
Dicalcium Silicate (C ₂ S), %	16.6
Tricalcium Aluminate (C ₃ A), %	7.9
Tetracalcium Aluminoferrite (C ₄ AF), %	8.8
Physical Properties	Results
Blaine Fineness (m ² /kg)	368
Compressive Strength MPa, 7 day (psi)	4,390
Compressive Strength MPa, 28 day (psi)	5,640

AGGREGATES

The aggregates for this study consisted of five coarse aggregate sources and one fine aggregate source. The fine aggregate came from the same source used to represent high absorption gravel. Multiple tests were performed on separate samples of each aggregate source to determine representative gradations, gravities, and absorption. To simplify reporting, the coarse aggregate sources were assigned identification numbers. Table 6 provides a list of identification numbers and descriptions of coarse aggregate sources. Average properties of aggregates used in this study are presented in Tables 7 through 13. All aggregates are from sources that are approved for MDOT projects.

Table 6. Coarse Aggregate Identification Number

Coarse Aggregate Identification Number	Coarse Aggregate Description
CA_ID1	No. 57 High Absorption Gravel
CA_ID2	No. 57 Crushed Limestone (Missouri)
CA_ID3	No. 57 Crushed Limestone (Alabama)
CA_ID4	No. 57 Low Absorption Gravel
CA_ID5	No. 67 Small Maximum Size Gravel

Table 7. Coarse Aggregate Properties: High Absorption No. 57 Gravel (CA_ID1)

Sieve Size	Individual % Retained	Total % Passing
1 in.	1.5	98
¾ in.	14.5	84
½ in.	44.6	39
3/8 in.	27.1	12
No. 4	10.4	2
No. 8	0.7	1
No. 16	0.3	1
No. 30	0.1	1
No. 50	0.1	1
No. 100	0.1	1
% Finer Than No. 200	0.1	
FM	6.98	
Bulk Gravity (DRY)	2.394	
Bulk Gravity (SSD)	2.475	
Absorption, %	3.37	
Unit Weight, pcf	96	
Void Content, %	35.8	

Table 8. Coarse Aggregate Properties: No. 57 Crushed Limestone (CA_ID2)

Sieve Size	Individual % Retained	Total % Passing
1 in.	1.6	98
¾ in.	12.6	86
½ in.	38.3	47
3/8 in.	24.6	23
No. 4	16.5	6
No. 8	2.6	4
No. 16	0.6	3
No. 30	0.4	3
No. 50	0.3	3
No. 100	0.2	2
% Finer Than No. 200	2.1	
FM	6.70	
Bulk Gravity (DRY)	2.597	
Bulk Gravity (SSD)	2.636	
Absorption, %	1.49	
Unit Weight, pcf	101	
Void Content, %	37.9	

Table 9. Coarse Aggregate Properties: No. 57 Crushed Limestone (CA_ID3)

Sieve Size	Individual % Retained	Total % Passing
1 in.	2.7	97
¾ in.	24.0	73
½ in.	37.5	36
3/8 in.	18.2	18
No. 4	15.0	3
No. 8	0.9	2
No. 16	0.3	1
No. 30	0.1	1
No. 50	0.1	1
No. 100	0.1	1
% Finer Than No. 200	0.9	
FM	7.00	
Bulk Gravity (DRY)	2.740	
Bulk Gravity (SSD)	2.750	
Absorption, %	0.35	
Unit Weight, pcf	104	
Void Content, %	38.8	

Table 10. Coarse Aggregate Properties: No. 57 Low Absorption Gravel (CA_ID4)

Sieve Size	Individual % Retained	Total % Passing
1 in.	19.8	80
¾ in.	24.8	55
½ in.	29.3	26
3/8 in.	14.2	12
No. 4	10.0	2
No. 8	1.5	0
No. 16	0.1	0
No. 30	0.0	0
No. 50	0.1	0
No. 100	0.0	0
% Finer Than No. 200	0.0	
FM	7.30	
Bulk Gravity (DRY)	2.536	
Bulk Gravity (SSD)	2.572	
Absorption, %	1.42	
Unit Weight, pcf	103	
Void Content, %	34.7	

Table 11. Coarse Aggregate Properties: No. 67 Small Maximum Size Gravel (CA_ID 5)

Sieve Size	Individual % Retained	Total % Passing
1 in.	0.0	100
¾ in.	2.2	98
½ in.	32.6	65
3/8 in.	23.1	42
No. 4	37.3	5
No. 8	4.4	
No. 16	0.2	0
No. 30	0.0	0
No. 50	0.0	0
No. 100	0.0	0
% Finer Than No. 200	0.1	
FM	6.54	
Bulk Gravity (DRY)	2.453	
Bulk Gravity (SSD)	2.513	
Absorption, %	2.45	
Unit Weight, pcf	101	
Void Content, %	33.9	

Table 12. Summary of Coarse Aggregate Properties

	CA ID1	CA ID2	CA ID3	CA ID4	CA ID5
% Finer Than No. 200	0.1	2.1	0.9	0.0	0.1
FM	6.98	6.70	7.00	7.30	6.54
Bulk Gravity (DRY)	2.394	2.597	2.740	2.536	2.453
Bulk Gravity (SSD)	2.475	2.636	2.750	2.572	2.513
Absorption, %	3.37	1.49	0.35	1.42	2.45
DRUW (pcf)	96	101	104	103	101
Void Content, %	35.8	37.9	38.8	34.7	33.9

Table 13. Fine Aggregate Properties

Sieve Size	Individual % Retained	Total % Passing
1 in.	0.0	100
¾ in.	0.0	100
½ in.	0.0	100
3/8 in.	0.0	100
No. 4	0.4	100
No. 8	4.5	95
No. 16	8.4	87
No. 30	17.0	70
No. 50	57.8	12
No. 100	11.3	1
% Finer Than No. 200	0.5	
FM	2.36	
Bulk Gravity (DRY)	2.622	
Bulk Gravity (SSD)	2.636	
Absorption (%)	0.52	

Sampling Aggregates

A large quantity of material was required for this study due to the size and number of test specimens required to produce the data needed by MDOT. Figures 1 and 2 demonstrate this amount of material for one coarse aggregate source sample and the fine aggregate sample, respectfully. Technicians that sampled and tested the aggregates were certified as ACI Aggregate Testing Technician Level 1 (MDOT Class 2).

This study emphasized the influence of coarse aggregate properties such as absorption on concrete pavement. Therefore, the selection of coarse aggregates was based on a combination of knowledge and experience, and preliminary investigation of potential sources. Once a suitable source was identified, technicians obtained a large enough sample so that a single

sample from each source was used for testing. A representative sample was secured and protected for moisture content testing during sampling from the source.

Our sampling procedures included the use of on-site power equipment, when available, and inspection of the stockpile for any discernible area of variation. A scale was used to pre-weigh the source material into 50 pound increments and secure the samples in five gallon buckets with tight-fitting lids. This exercise minimized handling of the aggregates and allowed the use of a consistent, representative moisture content for the entire sample. The sampling practices and procedures guarded against critical variations and bias in the material.

The fine aggregate sample was delivered to our laboratory in a dump truck. Samples of fine aggregate used for each mixture were collected from the stockpile in a similar manner as previously described for the coarse aggregate. The fine aggregate was pre-weighed in 50 pound increments and placed in five gallon buckets with sealed lids. This sample was stored in our laboratory for a minimum of 24 hours to condition the sample to laboratory temperature. Representative samples were taken for moisture content determination as the buckets were being filled.



Figure 1. Coarse Aggregate Sample from One Source



Figure 2. Fine Aggregate Sample

ADMIXTURES

Water Reducer

All mixes included a single Type A water reducing admixture meeting requirements of AASHTO M 194 / ASTM C 494 “Standard Specifications for Chemical Admixtures for Concrete.” Water reducers can be used to provide a higher slump without increasing the water cementitious ratio or lower water cement ratio without reducing the slump. In addition, higher strengths can be achieved through the increased dispersion of cementitious particles which promotes increased hydration. Dosage rates ranged from 27.40 ounces per cubic yard to 33.25 pounces per cubic yard. The typical dosage rate was 27.40 ounces per cubic yard but was increased as needed to achieve the desired slump range of 1 $\frac{3}{4}$ in. to 2 $\frac{3}{4}$ in. The dosage rate for each mix is presented in Table 18 of Chapter 5.

Air Entrainment

Entrained air is chemically induced in concrete to reduce surface delamination caused by repeated freezing and thawing cycles on moist concrete. Moisture expands when it freezes and this expansion can cause cracking and scaling of the concrete surface. Entrained air provides microscopic air voids in the cementitious paste and these voids provide relief from stresses

caused by expansion of water. The admixture used in this study met requirements of ASTM C 260 / AASHTO M 154 “Standard Specifications for Air-Entraining Admixture.” The dosage rate was selected to provide a target air content within a range of 4 percent to 6 percent. Dosage rates ranged from 2.05 ounces per cubic yard to 13.70 ounces per cubic yard. The actual dosage rate for each mix is provided in Appendix A and is presented in Table 18 of Chapter 5.

CHAPTER 3 – CONCRETE MIXTURES

MIXTURE DEVELOPMENT

Twenty laboratory mixtures were used to determine mechanical and length change properties of typical PCC pavements in Mississippi. Compressive strength, flexural strength, modulus of elasticity, Poisson's ratio, coefficient of thermal expansion, and length change are properties that were tested. Mixtures were generally proportioned in two 6.25 cubic feet batches to produce enough material to fabricate the test specimens. The specimen sizes and number of replicates are presented in Table 14.

Table 14. Number of Replicates and Size of Test Specimens

Test	Replicates	Standard	Specimen Size (in.)	Specimen Age (days)
Compressive Strength	5	AASHTO T 22	6 x 12	7,14,28,90
Flexural Strength	3	AASHTO T 97	6 x 6 x ±20	7,14,28,90
Modulus of Elasticity and Poisson's Ratio	3	ASTM C 469	6 x 12	7,14,28,90
Coefficient of Thermal Expansion	2	AASHTO T 336	4 x 8	28
Length Change	4	AASHTO T 160	4 x 4 x 11 ¼	1,7,12,14,21,35,,63,119, 231,455, 819, 820, 822, 826, 833, 847, 854, 875, 988 ¹

Notes:

1. The specimen age of the last measurement ranged from 911 to 988 days.

The mixture proportions were based on criteria established by the MDOT Technical Advisory Committee and the author of this report. These criteria were as follows: 1) slump range of 1 ¾ to 2 ¾ in., 2) air content range of 4 percent to 6 percent, 3) total cementitious content of 548 pounds per cubic yard (pcy). The cementitious quantity was based on previously submitted concrete paving mixtures for MDOT projects. Absolute volume calculations for mixture proportioning were based on an air content of 4.5 percent.

COARSE AGGREGATE CONTENT

The total weight of coarse aggregate utilized in the mixtures was based on MDOT's minimum requirements for coarse aggregate content for concrete paving mixtures. Section 501 "Portland Cement Concrete Pavement" of MDOT's Specifications for Road and Bridge Construction requires a minimum coarse aggregate content of 72 percent of the volume of a cubic yard of concrete. The minimum dry weight of coarse aggregate per pcy of concrete is then calculated using Equation 1.

$$W_{CA} = 0.72 \times 27 \times DRUW \quad (1)$$

Where:

W_{CA} = Dry Weight of Coarse Aggregate, lbs

$DRUW$ = Dry Rodded Unit Weight, pcf

This dry coarse aggregate weight was then increased by the absorption percentage to provide the saturated surface dry weight. The saturated surface dry (SSD) weight of coarse aggregate for the mixes ranged from 1929 pcy to 2031 pcy. The absolute volume of cement, water, coarse aggregate, and air was then calculated and the sum of these subtracted from 27 cubic feet to determine the volume and weight of fine aggregate needed to yield one cubic yard of concrete. The coarse aggregate content for each source is presented in Table 15.

Table 15. Coarse Aggregate Content

Coarse Aggregate Source	Dry Rodded Unit Weight (pcf)	Absorption (Percent)	Coarse Aggregate Content, SSD (pcy)
CA_ID1	96	3.37	1929
CA_ID2	101	1.49	1993
CA_ID3	104	0.35	2029
CA_ID4	103	1.42	2031
CA_ID5	101	2.45	2012

CEMENTITIOUS MATERIAL IDENTIFICATION

Four cementitious blends were used to proportion mixtures for each of the five coarse aggregate sources. Identification numbers were assigned to each of these four combinations of cementitious materials to simplify reporting. Table 16 presents a list of identification numbers for blends of cementitious materials. A summary of mixture proportions is provided in Table 17.

Table 16. Identification Numbers for Blends of Cementitious Materials

Identification Number	Percent Portland Cement	Percent Class C Fly Ash	Percent Class F Fly Ash	Percent Slag Cement
CM_ID1	100	0	0	0
CM_ID2	75	0	25	0
CM_ID3	75	25	0	0
CM_ID4	50	0	0	50

Final Report

Table 17. Summary of Mixture Proportions

Mix No.	CM_ID	CA_ID	Portland Cement (pcy)	Fly Ash (pcy)	Slag Cement (pcy)	Total Cementitious (pcy)	Water (pcy)	Water (Gallons/pcy)	w/cm Ratio	Coarse Aggregate SSD (pcy)	Fine Aggregate SSD (pcy)	Fine/Coarse (by weight)
1	CM_ID1	CA_ID1	548	0	0	548	229.19	27.50	0.418	1929	1135	0.588
2	CM_ID2	CA_ID1	411	137	0	548	222.92	26.75	0.407	1929	1090	0.565
3	CM_ID3	CA_ID1	411	137	0	548	210.40	25.25	0.384	1929	1149	0.596
4	CM_ID4	CA_ID1	274	0	274	548	229.19	27.50	0.418	1929	1103	0.572
5	CM_ID1	CA_ID2	548	0	0	548	231.25	27.75	0.422	1993	1180	0.592
6	CM_ID2	CA_ID2	411	137	0	548	233.34	28.00	0.426	1993	1146	0.575
7	CM_ID3	CA_ID2	411	137	0	548	225.00	27.00	0.411	1993	1194	0.599
8	CM_ID4	CA_ID2	274	0	274	548	237.50	28.50	0.433	1993	1160	0.582
9	CM_ID1	CA_ID3	548	0	0	548	231.25	27.75	0.422	2029	1228	0.605
10	CM_ID2	CA_ID3	411	137	0	548	233.33	28.00	0.426	2029	1172	0.577
11	CM_ID3	CA_ID3	411	137	0	548	220.83	26.50	0.403	2029	1231	0.607
12	CM_ID4	CA_ID3	274	0	274	548	237.50	28.50	0.433	2029	1191	0.587
13	CM_ID1	CA_ID4	548	0	0	548	208.33	25.00	0.380	2031	1152	0.567
14	CM_ID2	CA_ID4	411	137	0	548	208.33	25.00	0.380	2031	1117	0.550
15	CM_ID3	CA_ID4	411	137	0	548	195.83	23.50	0.357	2031	1161	0.571
16	CM_ID4	CA_ID4	274	0	274	548	216.67	26.00	0.395	2031	1131	0.557
17	CM_ID1	CA_ID5	548	0	0	548	229.16	27.50	0.418	2012	1090	0.542
18	CM_ID2	CA_ID5	411	137	0	548	233.33	28.00	0.426	2012	1028	0.511
19	CM_ID3	CA_ID5	411	137	0	548	216.67	26.00	0.395	2012	1077	0.535
20	CM_ID4	CA_ID5	274	0	274	548	229.16	27.50	0.418	2012	1048	0.521

CHAPTER 4 – LABORATORY TESTING

AGGREGATE TESTING

Typical aggregate testing was conducted on each aggregate. These tests include; 1) AASHTO T 85 / ASTM C 127 “Specific Gravity and Absorption of Coarse Aggregate”, 2) AASHTO T 84 / ASTM C 128 “Specific Gravity and Absorption of Fine Aggregate” 3) AASHTO T 27 / ASTM C 136 “Sieve Analysis of Fine and Coarse Aggregates”, and 4) AASHTO T 19 / ASTM C 29 “Bulk Density (“Unit Weight”) and Voids in Aggregate” for the coarse aggregate.

MIXING

Mixing was generally conducted in 6.25 cubic feet batches using a revolving drum mixer in accordance with AASHTO R 39 / ASTM C 192 “Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory”. The individual batch sizes are presented in Table 18 of Chapter 5. Chapter 3 gives a detailed description of the laboratory mixture designs.

The inside of the revolving-drum mixer received a thin layer of fresh mortar to prevent loss of mortar from the batch. To add consistency to the process, a masonry brush was used to spread the fresh layer of mortar uniformly around the interior of the drum. The drum was inverted for a two-minute time waiting period to allow any free water to exit from the drum before continuing. The mixer was then charged with the aggregates, approximately half the mixing water, and the admixtures. Several revolutions of the mixer drum were used to mix the aggregates and initial water. The cementitious materials and remaining mix water were then added to the mixer. A three-minute mixing, three-minute rest, two-minute final mixing pattern was performed taking steps to guard against moisture loss during the rest period.

Approximately 12.5 cubic feet of concrete was required to fabricate specimens for each mixture. This was accomplished by mixing two separate 6.25 cubic feet batches and combining the batches to fabricate test specimens. Each individual batch was placed into a wooden box where the combined material was used to make specimens for testing. The first batch was covered by plastic sheets to prevent loss of moisture while the second batch was mixing. See Figure 3 for an example of the mixer and wooden box used for batching. The gas-powered mixer required all mixing be accomplished outside of the laboratory. In order to maintain

consistent material temperature, all materials were stored in the laboratory for a minimum of 24 hours before use. See Figure 4 for conditioning of materials in the laboratory.



Figure 3. Batching Example



Figure 4. Conditioning of Materials in Laboratory

PLASTIC PROPERTIES

Each individual batch was tested for unit weight, yield, slump, air content (pressure method), and temperature. Additional air testing was conducted on a representative sample of combined materials using the volumetric method. This additional air testing was performed on mixes 2 through 20 to check the stability of entrained air during the batching process. This additional testing was implemented after the completion of mix 1. All testing was performed by a certified ACI Grade 1 Field-Testing Technicians in accordance with the following standards:

- **Density and Yield** – AASHTO T 121 / ASTM C 138 “Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete” (Figure 5)
- **Slump** – AASHTO T 119 / ASTM C 143 “Standard Test Method for Slump of Hydraulic-Cement Concrete” (Figure 6)
- **Air Content (Volumetric Method)** – AASHTO T 196 / ASTM C 173 “Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method” (Figure 7)
- **Air Content (Pressure Meter)** – AASHTO T 152 / ASTM C 231 “Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method” (Figure 5)
- **Making and Curing Cylinder and Prisms** – AASHTO R 39 / ASTM C 192 “Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.” (Figure 8 through 12)
- **Temperature** – ASTM C 1064 “Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete”



Figure 5. Density and Air Content (Pressure Method) Testing



Figure 6. Slump Testing



Figure 7. Air Content Testing (Volumetric Method)



Figure 8. Fabricating Compressive Strength and Modulus of Elasticity Specimens



Figure 9. Fabricating Flexural Strength Specimens



Figure 10. Fabricating Coefficient of Thermal Expansion Specimens



Figure 11. Fabricating Length Change Specimens



Figure 12. Curing Specimens

MECHANICAL PROPERTIES

Compressive Strength

Compressive strength specimens were cast immediately following testing of plastic properties. Technicians made the 6 in. x 12 in. specimens and used internal vibration as the method of consolidation. Upon completion of consolidation, strike-off, and finishing of the top surface, strength specimens were moved to a temperature controlled moisture room for curing until time of testing. These specimens were tested in accordance with AASHTO T 22 / ASTM C 39 “Standard Test method for Compressive Strength of Cylindrical Concrete Specimens.” Twenty specimens were tested for each mixture as follows: 5 specimens at 7 days, 5 at 14 days, 5 at 28 days, and 5 at 90 days. Each specimen was capped with sulfur mortar in accordance with ASTM C 617 / AASHTO T 231 “Standard Practice for Capping Cylindrical Concrete Specimens.” Three specimens for each test age were first tested for modulus of elasticity and Poisson’s ratio in accordance ASTM C 469 “Standard Test Method for Static Modulus of Elasticity and Poisson’s Ratio of Concrete.” After this testing, the MOE apparatus was removed and the specimens were loaded to failure to determine compressive strength. See Figure 13 for a photograph of compressive strength testing.

Flexural Strength

Flexural strength specimens were also fabricated and tested. Technicians made the 6 in. x 6 in. x ± 21 in. specimens and used internal vibration as the method of consolidation. Upon completion of consolidation, strike-off, and finishing of the surface, flexural strength specimens were moved to a temperature controlled moisture room for curing until time of soaking. These specimens were then soaked in a water bath saturated with calcium hydroxide for a minimum of 20 hours prior to testing. Specimens were tested in accordance with AASHTO T 97 / ASTM C 78 “Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).” Twelve specimens were tested for each mixture as follows: 3 specimens at 7 days, 3 at 14 days, 3 at 28 days, and 3 at 90 days. See Figure 14 for a photograph of flexural strength testing.

Modulus of Elasticity and Poisson’s Ratio

Modulus of elasticity specimens were fabricated for each mixture. Technicians made the 6 in. x 12 in. specimens and used internal vibration as the method of consolidation. Upon

completion of consolidation and strike-off finishing of the top surface, MOE specimens were moved to a temperature controlled moisture room for curing until time of testing. Specimens were tested in accordance with ASTM C 469 “Standard Test Method for Static Modulus of Elasticity and Poisson’s Ratio of Concrete.” Twelve specimens were tested for each mixture as follows: 3 specimens at 7 days, 3 at 14 days, 3 at 28 days, and 3 at 90 days. These specimens were additionally tested for compressive strength in accordance with AASHTO T 22 / ASTM C 39 “Standard Test method for Compressive Strength of Cylindrical Concrete Specimens.” See Figure 15 for a photograph of modulus of elasticity testing.

The MOE was calculated using Equation No. 2 provided in ASTM C 469.

$$E = \frac{(S_2 - S_1)}{(\epsilon_2 - 0.000050)} \quad (2)$$

Where:

E = chord modulus of elasticity, psi

S₂ = stress corresponding to 40% of ultimate load

S₁ = stress corresponding to a longitudinal strain of 50 millionths, psi

ε₂ = longitudinal strain produced by stress, S₂

Poisson’s ratio was calculated using Equation No. 3 provided in ASTM C 469.

$$\mu = \frac{(\epsilon_{t2} - \epsilon_{t1})}{(\epsilon_2 - 0.000050)} \quad (3)$$

Where:

μ = Poisson’s ratio

ε_{t2} = transverse strain at mid-height of the specimen produced by stress, S₂, and

ε_{t1} = transverse strain at mid-height of the specimen produced by stress S₁.



Figure 13. Compressive Strength Testing



Figure 14. Flexural Strength Testing



Figure 15. Modulus of Elasticity and Poisson's Ratio Testing

VOLUME CHANGE PROPERTIES

Coefficient of Thermal Expansion (CTE)

Specimens were also made for coefficient of thermal expansion (CTE) testing. Technicians fabricated the 4 in. x 8 in. cylindrical specimens and used internal vibration as the method of consolidation. The specimens were stored in BCD's moist curing room for approximately three days before being shipped to American Engineering Testing, Inc. for CTE testing. These specimens were tested in accordance with AASHTO T 336 "Coefficient of Thermal Expansion of Hydraulic Cement Concrete." Two specimens were tested at a specimen age of 28 days. See Figure 16 for a photograph of CTE testing.



Figure 16. Coefficient of Thermal Expansion Testing (Photograph Courtesy of American Engineering Testing, Inc.)

Length Change of Hardened Concrete

Length change properties needed for thickness determination of PCC pavements include: 1) ultimate shrinkage strain (microstrain units), 2) time required to develop 50 percent of ultimate shrinkage strain (days), 3) anticipated amount of reversible shrinkage (%), and 4) mean monthly ambient relative humidity for the project site (ARA, 2004). Ultimate shrinkage strain is achieved when dimensions of the concrete specimen become time stable (ARA, 2004). The specimens tested for this study were not dried or soaked long enough to show volume stability. However, the specimens were dried for 812 days and rewetted for a minimum of 92 days in an effort to estimate ultimate shrinkage strain and to estimate reversible shrinkage for mixtures of this study. Figure 17 presents a graph showing typical behavior of PCC. A similar figure was presented by Mindness and Young (1981).

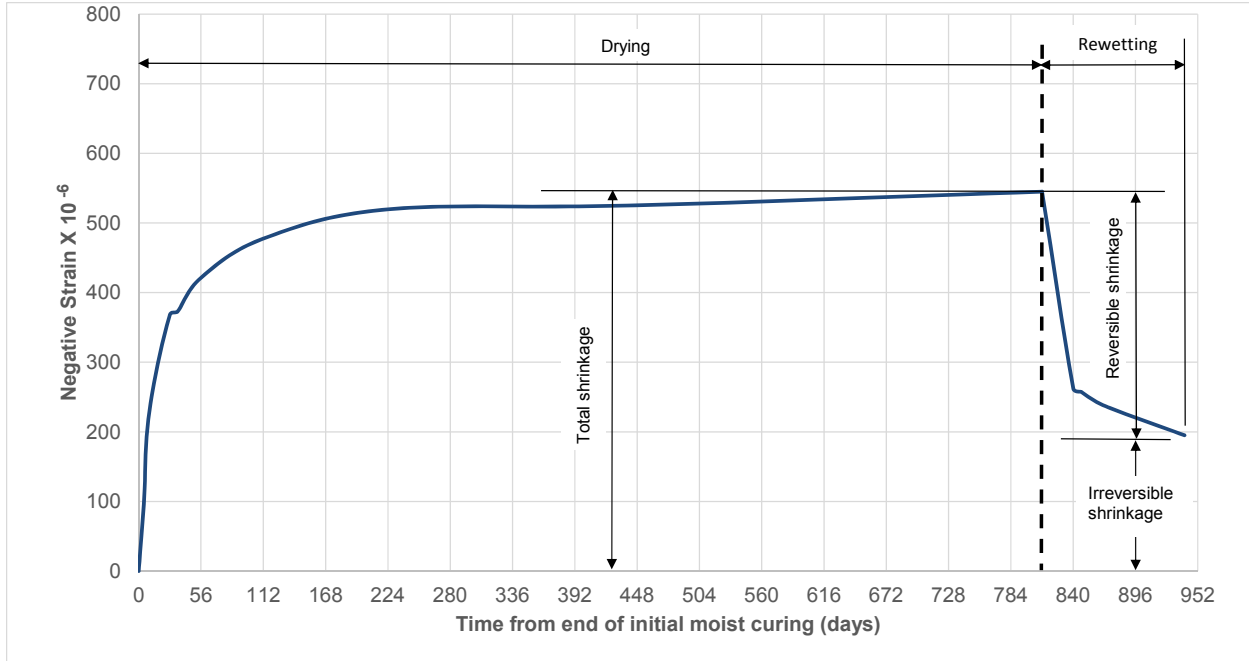


Figure 17. Typical behavior of PCC upon drying and rewetting

Length change was measured in general accordance with AASHTO T 160 / ASTM C 157 “Length Change of Hardened Hydraulic-Cement Mortar and Concrete” and AASHTO M 210 / ASTM C 490 “Standard Practice for use of Apparatus for the Determination of Length Change of Hardened Cement Paste, Mortar, and Concrete.” Specimens were cast according to AASHTO R 39 / ASTM C 192 utilizing prisms of 4 in. square cross sections and approximately 11 ¼ in. long. AASHTO T 160 requires that three specimens be tested for each test condition. However, four specimens were fabricated and tested for the mixtures in this study. Consolidation was accomplished by the use of internal vibration.

Sample Preparation

Specimens were immediately placed in a moist curing room for a 24-hour initial curing period immediately after the specimens were fabricated. Specimens were then de-molded at an age of 23.5 ± 0.5 hours and labeled with identifying information. Specimens were then placed into a water curing bath saturated with calcium hydroxide and maintained at 73 ± 1 degree Fahrenheit for 30 minutes before further processing (Figure 18).

Initial Testing

Specimens were removed from the curing bath and towel dried, leaving only a small amount of free water. Specimens were then placed in a comparator measuring to the nearest

0.0001 in. where initial measurements were taken and compared to a standard reference bar (Figure 19). Specimens were removed from the comparator and returned to the curing bath where they remained for the remainder of the 7-day moist curing period. AASHTO T 160 / ASTM C 157 states that after the initial comparator reading that the specimens are to be stored in a water bath at 73.4 ± 3.0 ° F until they have reached an age of 28 days. In this study, a 7-day moist curing period was used in lieu of a 28-day moist curing period to comply with standard conditions presented in Table 2.2.2 of ACI 209R-92 (ACI, 1992) referenced in the MEPDG (ARA, 2004). All specimens received a second comparator reading at the end of the initial moist curing period (Figure 20) prior to drying.

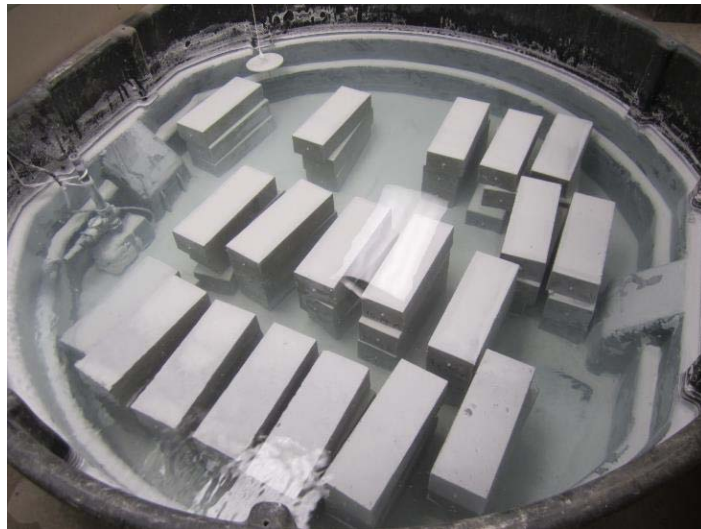


Figure 18. Lime-Saturated Water Bath

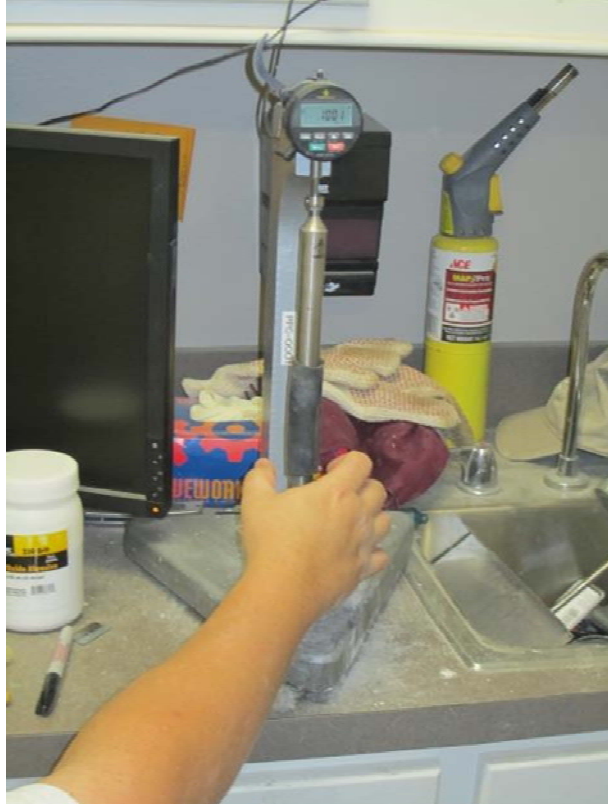


Figure 19. Comparator Reading of Standard Bar



Figure 20. Comparator Reading of Specimen

Specimen Dry Storage, Rewetting, and Testing

Specimens were stored after the second reading in a temperature and humidity controlled environment of 50 ± 4 percent relative humidity (RH) and 73 ± 3 ° F complying with requirements of AASHTO T 160 (Figure 21). The prism specimens were stacked on shelves with a clearance of at least 1 inch on all sides. Comparator readings were taken 1-day after casting, at the conclusion of the initial 7-day moist curing period, and at drying days 0, 5, 7, 14, 28, 56, 112, 224, 448, and 812. The specimens were then returned to the water bath for rewetting. Comparator readings were taken at 1, 3, 7, 14, 28, 35, 56 days of rewetting. The last measure for rewetting was taken within a range of 92 days to 169 days. Tables and figures shown in this report will indicate length change (% shrinkage) and negative micro strains ($\times 10^{-6}$) from the end of the initial 7-day moist curing period.



Figure 21. Temperature and Humidity Controlled Room

Calculations

Length Change

Length change properties were calculated and reported as a positive number if expansion occurred and a negative number if shrinkage occurred from a baseline established at the initial comparator reading taken ± 24 hours after fabrication of the specimens. AASHTO T 160 states that the percent shrinkage or expansion is to be reported to the nearest 0.001 percent. All shrinkage and expansion percentages reported herein are calculated and reported to the nearest 0.0001 percent in an effort to compare slight changes in length change that occurred between similar mixtures. The equation for calculating length change of specimens at any age as a percent of the standard reference bar length (10 in.) is presented in Equation 4.

$$L = \frac{L_x - L_i}{G} * 100 \quad (4)$$

Where:

L = change in length at X age, %

L_x = comparator reading of specimen at X age minus comparator reading of reference bar at X age; in inches

L_i = initial comparator reading at a specimen age of $24 \pm \frac{1}{2}$ hour after the addition of water to the cement during the mixing operation minus comparator readings of reference bar at that same time; in inches

G = nominal gauge length; 10 inches. This nominal gauge length is the length between inside ends of gauge studs cast into the prism specimens and is 10 ± 0.1 in.

Shrinkage Strain

Shrinkage strain is the change in length due to shrinkage that occurs after the end of the initial moist curing period. This can be found in ACI 209-92 "Prediction of Creep, Shrinkage, and Temperature Effects in Concrete Structures." Shrinkage strain shown herein is calculated using the comparator readings taken at a baseline established at the end of the initial 7-day moist curing period. Results were multiplied by 1,000,000 and reported as negative strain $\times 10^{-6}$.

Equation No. 5 shown below was used to calculate strain.

$$L = \frac{L_x - L_e}{G} * 1,000,000 \quad (5)$$

Where:

L = shrinkage strain at X age, %

L_x = comparator reading of specimen at X age minus comparator reading of reference bar at X age; in inches

L_e = comparator reading at end of 7-day moist curing period minus comparator readings of reference bar at that same time; in inches

G = nominal gauge length; 10 inches. This nominal gauge length is the length between inside ends of gauge studs cast into the prism specimens and is 10 ± 0.1 in.

35-Day Length Change

Equation 2-9 of ACI 209R-92 indicates that 50 percent of ultimate shrinkage strain occurs on the 35th day of drying after an initial 7-day moist cured period. Comparators reading were not taken for the specimens at 35 days from the end of initial moist curing for this study. Length change percentages and shrinkage strains at 35 days for the start of drying shown herein are calculated values and not measured values. In order to calculate percent length change and shrinkage strain at 35 days of drying, the comparator readings taken at drying days of 14, 28, 56, and 112 were used to develop an equation representing the best fitting curve connecting these four comparator readings. The natural log equations developed from these curves were then used to calculate the 35-day length change and 35-day shrinkage strain for each individual specimen. See Figures 22 and 23 for examples of equations used to determine 35-day length change and shrinkage strains, respectively.

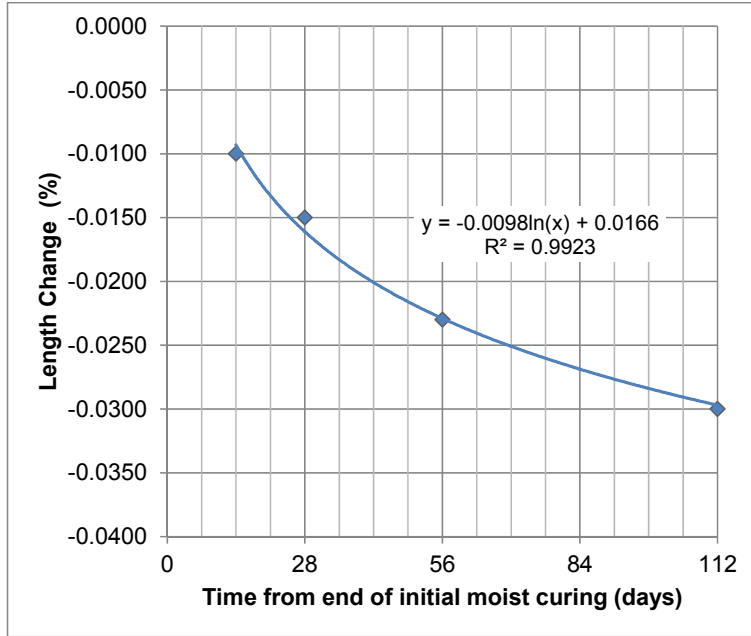


Figure 22. Best Fitting Curve Example for Determining Length Change at 35 Days of Drying

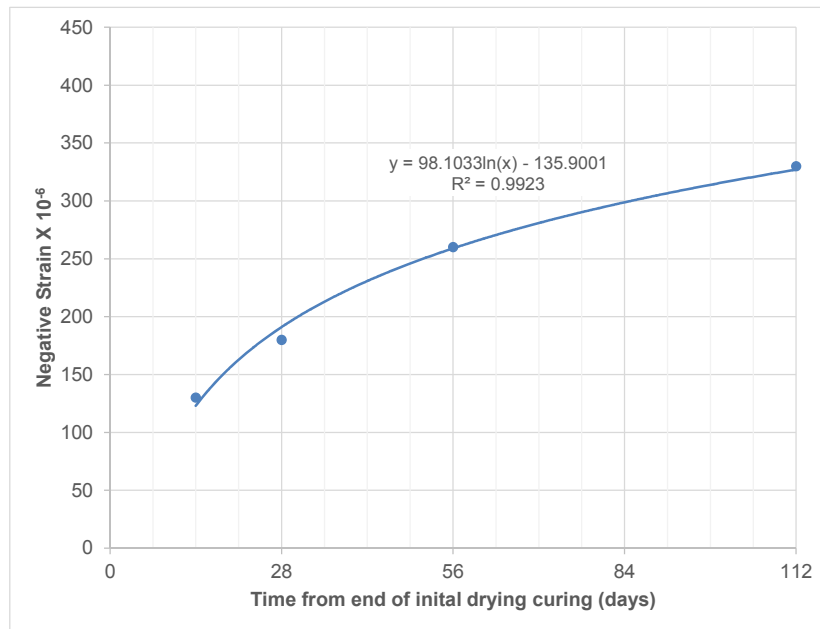


Figure 23. Best Fitting Curve Example Used For Determining Negative Strain at 35 Days Measured From Start of Drying

Relative Humidity – Converting from 50% RH to 40% RH

Specimens were stored in a temperature and humidity controlled environment of 50 ± 4 percent relative humidity (RH) and 73 ± 3 ° F after the initial 7-day moist curing period. This controlled environment complies with requirements of AASHTO T 160. However, 40 percent RH is presented in MEPDG (ARA, 2004) as the standard drying environment and this humidity is referenced in ACI 209R-92 (ACI, 1992). Therefore, tables presented in this report at 40 percent RH were developed based on calculated values. The calculations incorporate a correction factor from equation 2-15 of ACI 209R-92. Shrinkage percent and shrinkage strain were modified for RH using Equation 6.

$$Value_{40\% RH} = \frac{Value_{50\% RH}}{0.89} \quad (6)$$

CHAPTER 5 - RESULTS

PLASTIC PROPERTIES

Plastic properties of each individual batch are presented in Table 18. The slump ranged from 1 ¼ inches to 2 ¾ inches. The air content determined by pressure meter ranged from 4.4 percent to 6.3 percent. The temperature of the fresh concrete ranged from 69° F to 84° F. The density (unit weight) of the fresh concrete ranged from 139.8 pcf to 149.6 pcf.

Table 18. Plastic Properties and Admixture Dosage Rates of Individual Batches

Mix No.	Batch Size (ft ³)	Air (oz/yd ³)	Water Reducer (oz/yd ³)	Density (pcf)	Slump (in.)	% Air Pressure Method	% Air Roller Meter Method	Temp (°F)
1.1	6.00	4.11	27.40	142.6	1.25	5.8	ND ¹	69
1.2	6.00	2.74	27.40	141.8	1.50	4.7		71
1.3	1.00	4.11	27.40	143.6	1.25	5.0		69
1.4	1.50	2.74	27.40	142.8	2.50	5.0		77
2.1	6.25	8.22	27.40	142.6	1.50	4.9	5.50	71
2.2	6.25	8.22	27.40	139.8	1.75	5.5		73
2.3	1.50	13.70	30.41	141.8	1.25	5.1		73
3.1	6.75	2.74	27.40	143.2	2.75	4.7	5.00	77
3.2	6.25	2.74	27.40	144.4	2.00	4.6		77
4.1	6.25	3.12	27.40	143.8	2.50	4.5	4.50	79
4.2	6.25	3.12	33.25	143.0	2.25	4.5		79
5.1	6.50	2.74	27.40	145.4	2.50	5.3	6.25	80
5.2	6.25	2.74	27.40	143.4	2.75	6.3		78
6.1	6.25	6.85	27.40	143.4	2.25	6.0	5.25	74
6.2	6.25	6.25	27.40	145.6	2.50	5.0		74
7.1	6.25	3.01	27.40	145.8	2.00	4.9	5.00	81
7.2	6.25	3.01	31.78	145.6	2.00	5.4		81
8.1	6.25	4.27	27.40	146.0	1.50	4.6	5.00	72
8.2	6.25	6.47	31.07	146.2	2.00	4.5		73
9.1	6.25	2.19	27.40	149.0	2.25	5.5	5.50	79
9.2	6.25	2.05	27.40	149.6	2.75	4.8		78
10.1	6.25	4.38	27.40	148.6	2.75	4.8	4.25	78
10.2	6.25	4.38	27.40	148.6	2.75	4.5		80
11.1	6.50	4.30	27.40	147.8	2.75	5.2	5.25	84
11.2	6.25	3.01	27.40	147.6	2.75	5.6		79
12.1	6.25	3.51	27.40	147.4	2.25	5.2	5.75	80
12.2	6.25	3.51	27.40	146.7	2.75	5.4		77
13.1	6.25	2.74	27.40	146.2	1.50	4.9	4.50	84

Mix No.	Batch Size (ft ³)	Air (oz/yd ³)	Water Reducer (oz/yd ³)	Density (pcf)	Slump (in.)	% Air Pressure Method	% Air Roller Meter Method	Temp (°F)
13.2	6.25	2.74	27.40	146.6	1.25	4.5		79
14.1	6.25	4.93	27.40	145.0	2.75	4.5	3.75	79
14.2	6.25	4.38	27.40	143.6	2.75	4.5		80
15.1	6.25	2.74	27.40	145.4	2.25	5.1	4.25	82
15.2	6.25	2.74	27.40	145.8	2.50	5.0		80
16.1	6.25	3.07	27.40	145.0	2.00	4.6	3.75	80
16.2	6.25	3.07	27.40	146.3	2.00	4.4		79
17.1	6.25	2.74	27.40	143.8	1.25	5.0	5.00	79
17.2	6.25	2.74	27.40	142.2	2.25	5.5		78
18.1	6.25	5.48	27.40	141.4	2.50	5.0	4.75	80
18.2	6.25	5.48	27.40	140.6	2.75	4.9		80
19.1	6.25	2.74	27.40	145.0	1.25	4.5	4.50	82
19.2	6.25	2.74	27.40	144.0	1.25	5.0		79
20.1	6.25	3.07	27.40	144.0	1.25	4.4	4.00	78
20.2	6.25	3.36	27.40	144.8	1.25	4.4		79

Notes:

1. ND – Not determined.

MECHANICAL PROPERTIES

COMPRESSIVE STRENGTH

Results from testing for compressive strength are presented in this section. Individual test results shown in this report are calculated as the nearest 1 pound per square inch (psi). The average of each individual specimen was then calculated and rounded to the nearest 10 psi. Standard deviation of each set of compressive strength specimens was also calculated and reported. Compressive strength results for all mixes are presented in Table 19. Each mixture had an average compressive strength that exceeded MDOT's specified 28-day strength requirement of 3,500 psi for concrete pavement. The range of compressive strengths for each test age are as follows:

- 7-day - 4,370 psi (Mix 6) to 6,820 psi (Mix 19)
- 14-day - 4,770 psi (Mix 2) to 7,980 psi (Mix 19)
- 28-day - 5,760 psi (Mix 2) to 8,240 psi (Mix 19)
- 90-day - 7,030 psi (Mix 2) to 9,500 psi (Mix 19)

Figure 24 presents graphs of compressive strength versus age for all mixes. Figures 25 through 29 present graphs of compressive strength versus age for each coarse aggregate source. The coarse aggregate source and cementitious blend along with w/cm ratio are noted within each figure.

Table 19: Compressive Strengths, psi

Mix No.	Specimen	7-Day	14-Day	28-Day	90-Day
1	A	5310	6137	6210	7653
	B	5561	6028	6928	7199
	C	5533	6245	6879	7256
	D	5773	6286	6578	7529
	E	5901	6401	6647	7404
	Average	5620	6220	6650	7410
	STDEV	229	143	287	188
2	A	4587	4710	5757	7016
	B	4518	4852	5589	6920
	C	4229	4748	5670	7001
	D	4381	4636	5859	6855
	E	4356	4915	5903	7348
	Average	4410	4770	5760	7030
	STDEV	141	112	130	190
3	A	5153	6228	7193	7659
	B	5406	6367	7241	7944
	C	5960	6553	7376	8439
	D	5565	6501	7213	7867
	E	5605	6452	6644	7642
	Average	5540	6420	7130	7910
	STDEV	295	127	283	323
4	A	4470	6131	7199	8064
	B	3962	6378	6886	7563
	C	4429	6268	6258	7631
	D	4722	6649	7579	8048
	E	4482	6298	7180	7923
	Average	4410	6340	7020	7850
	STDEV	277	192	492	235
5	A	5589	5702	6362	6852
	B	5389	6111	5966	7093
	C	5326	5862	6627	7375
	D	5464	6179	6560	6877
	E	5505	5858	6312	6968
	Average	5450	5940	6370	7030
	STDEV	102	197	259	213

Final Report

Mix No.	Specimen	7-Day	14-Day	28-Day	90-Day
6	A	4109	4949	5995	7752
	B	4143	4735	6096	7285
	C	4563	5241	5724	6990
	D	4538	4926	5878	7621
	E	4483	4926	6145	7423
	Average	4370	4960	5970	7410
	STDEV	222	182	170	297
7	A	6011	7609	7954	8967
	B	6266	7380	7720	9911
	C	5749	7389	8146	9067
	D	6056	7155	8062	9156
	E	6598	7485	7984	9374
	Average	6140	7400	7970	9300
	STDEV	317	167	160	376
8	A	5710	7389	8069	8066
	B	5829	7403	7957	8971
	C	5848	7255	7853	8218
	D	5657	7721	8395	8718
	E	5356	7873	7931	7591
	Average	5680	7530	8040	8310
	STDEV	198	258	212	545
9	A	5837	7102	7205	8039
	B	6465	6867	7442	7717
	C	6138	6875	7326	7726
	D	6077	7168	7114	8118
	E	6184	7096	7491	8160
	Average	6140	7020	7320	7950
	STDEV	225	140	158	215
10	A	5456	5755	6577	9014
	B	5253	6093	6859	8419
	C	5437	6432	7074	9107
	D	5241	6353	6822	8663
	E	5233	5749	6729	9002
	Average	5320	6080	6810	8840
	STDEV	112	322	182	290
11	A	5631	6489	7313	8844
	B	5111	6437	7465	7754
	C	5766	6672	7160	8561
	D	5980	6800	7210	9074
	E	5614	6688	7334	8988
	Average	5620	6620	7300	8640
	STDEV	320	150	119	534

Final Report

Mix No.	Specimen	7-Day	14-Day	28-Day	90-Day
12	A	5048	6663	7538	8588
	B	5364	6721	7101	8251
	C	5413	7163	7613	8600
	D	4935	6679	7240	8593
	E	5213	6069	6850	8636
	Average	5190	6660	7270	8530
	STDEV	203	389	314	159
13	A	5647	6279	6999	7209
	B	5621	6267	7046	7289
	C	5542	6238	6935	6736
	D	5945	5902	6794	6926
	E	6132	6067	6618	7066
	Average	5780	6150	6880	7050
	STDEV	250	163	174	222
14	A	4739	5631	6818	8100
	B	4740	5689	6782	8180
	C	4842	5613	6776	8472
	D	4753	5973	6492	7913
	E	5015	5641	6706	8107
	Average	4820	5710	6710	8150
	STDEV	118	150	131	203
15	A	5828	6393	7877	8776
	B	6099	7311	6871	8532
	C	5821	6854	7790	8402
	D	6110	6515	7673	8738
	E	6097	6704	7874	8209
	Average	5990	6760	7620	8530
	STDEV	152	357	425	236
16	A	5137	6747	7159	7058
	B	5051	6598	7081	7609
	C	5417	6187	7337	7028
	D	5554	6535	7348	7096
	E	5411	6463	7427	8306
	Average	5310	6510	7270	7420
	STDEV	211	207	144	550
17	A	6159	6973	6628	8249
	B	5904	5964	7250	7851
	C	6083	7519	7388	8142
	D	6002	7398	7298	8438
	E	6361	6954	7522	7782
	Average	6100	6960	7220	8090
	STDEV	173	612	345	274

Final Report

Mix No.	Specimen	7-Day	14-Day	28-Day	90-Day
18	A	4954	5581	6633	8148
	B	4759	5604	6663	7991
	C	4961	5782	6595	7878
	D	4674	5933	6615	8353
	E	4852	5417	6647	7641
	Average	4840	5660	6630	8000
	STDEV	124	199	27	269
19	A	6750	7660	8444	9430
	B	6366	8031	7642	9343
	C	6943	8330	8027	9406
	D	7354	7836	8544	9773
	E	6697	8043	8527	9536
	Average	6820	7980	8240	9500
	STDEV	363	251	393	169
20	A	5690	7141	8026	8597
	B	5819	7447	8009	7941
	C	5597	7341	7915	8607
	D	5603	7465	7838	8722
	E	5911	7216	7750	8946
	Average	5720	7320	7910	8560
	STDEV	138	142	116	375

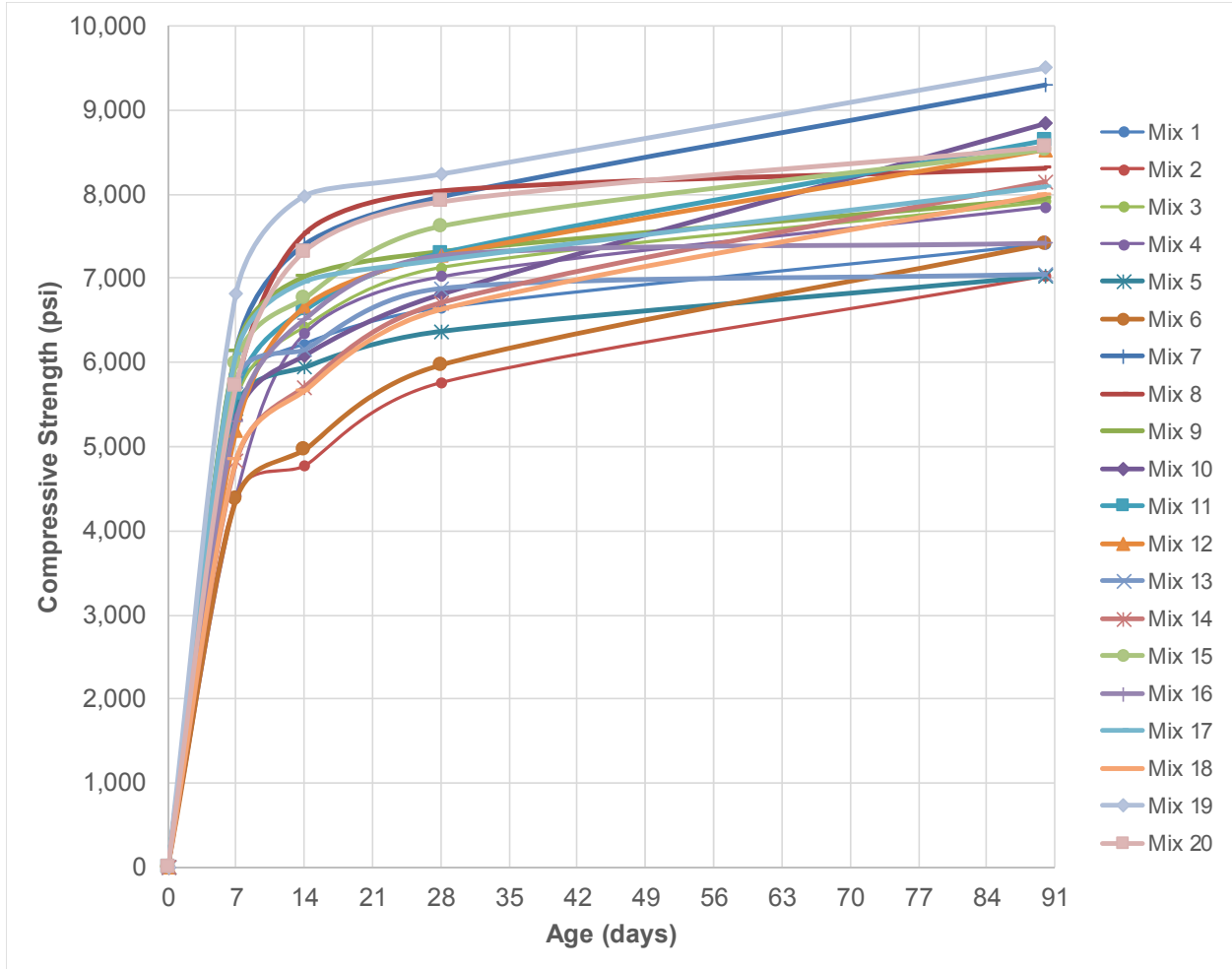


Figure 24. Compressive Strength VS Age - All Mixes

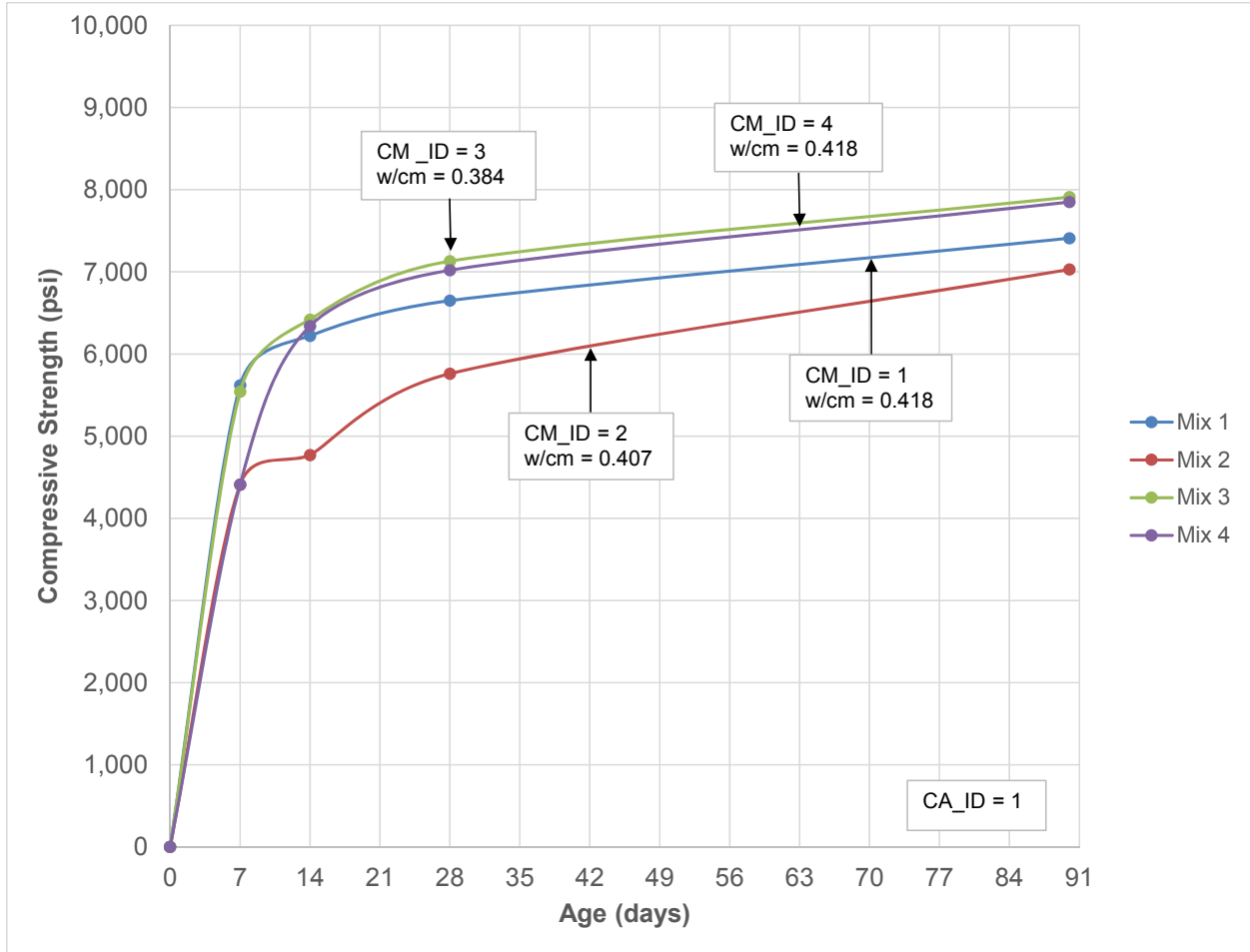


Figure 25. Compressive Strength VS Age - Mixes 1 Through 4 (CA_ID1)

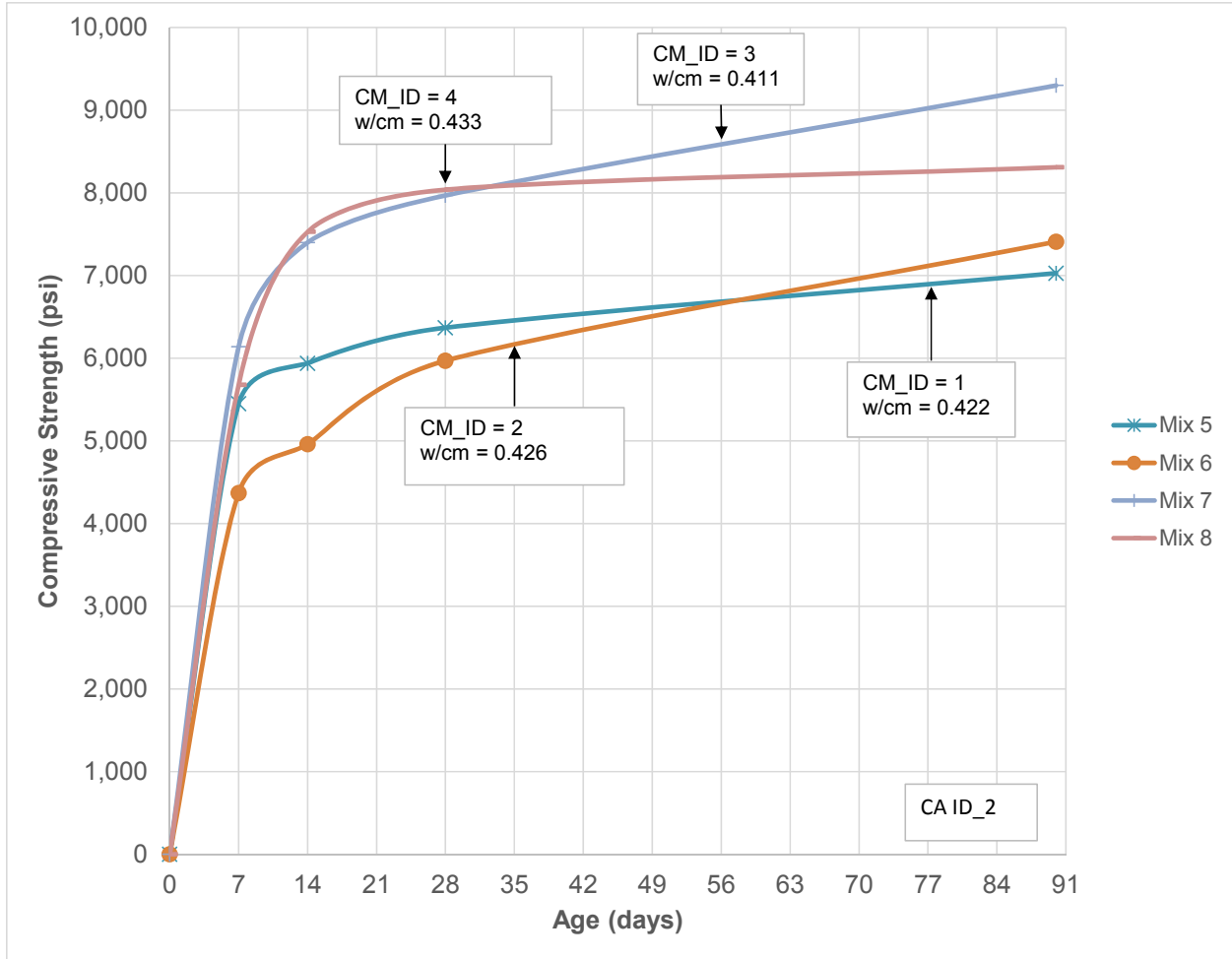


Figure 26. Compressive Strength VS Age - Mixes 5 Through 8 (CA_ID2)

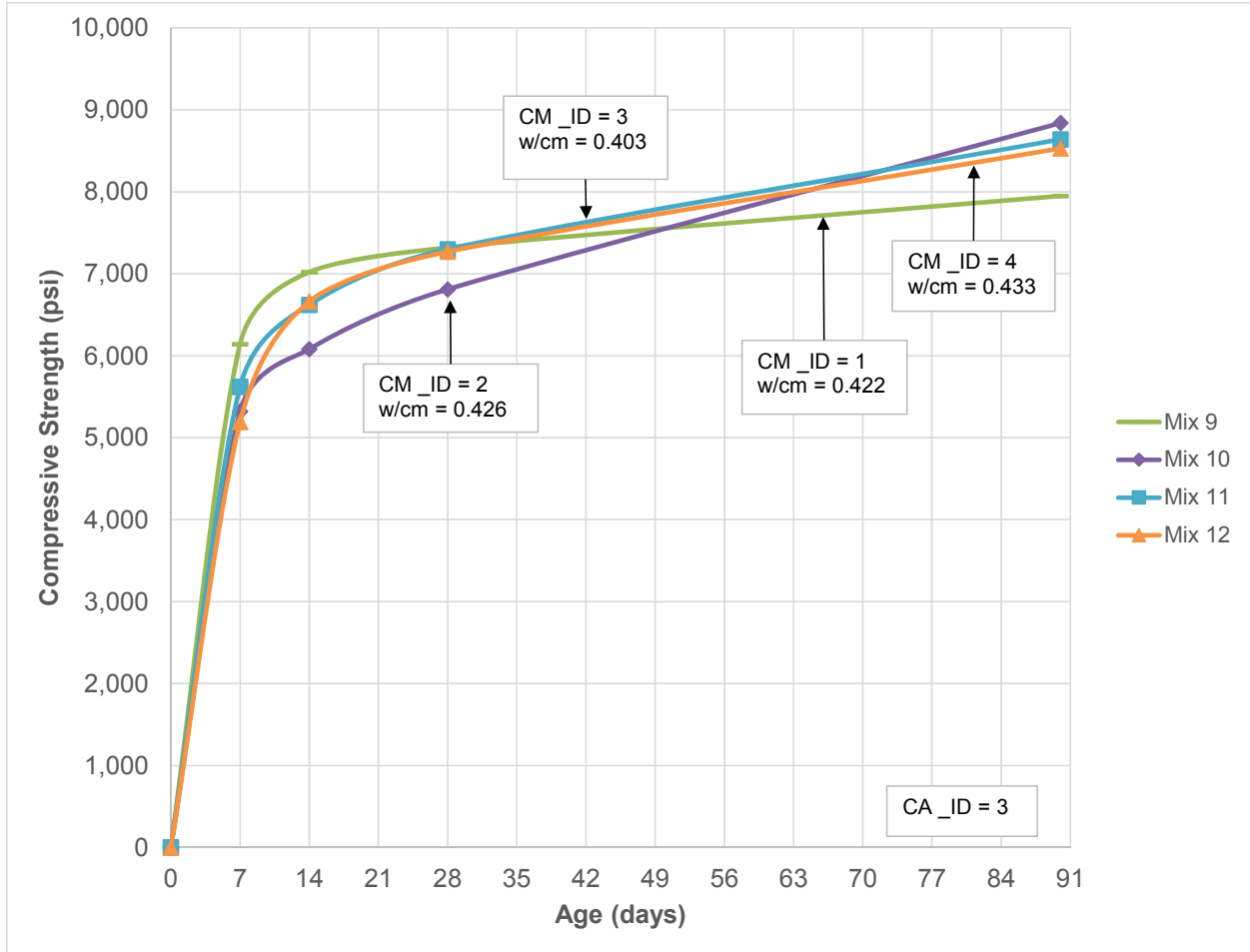


Figure 27. Compressive Strength VS Age - Mixes 9 Through 12 (CA_ID3)

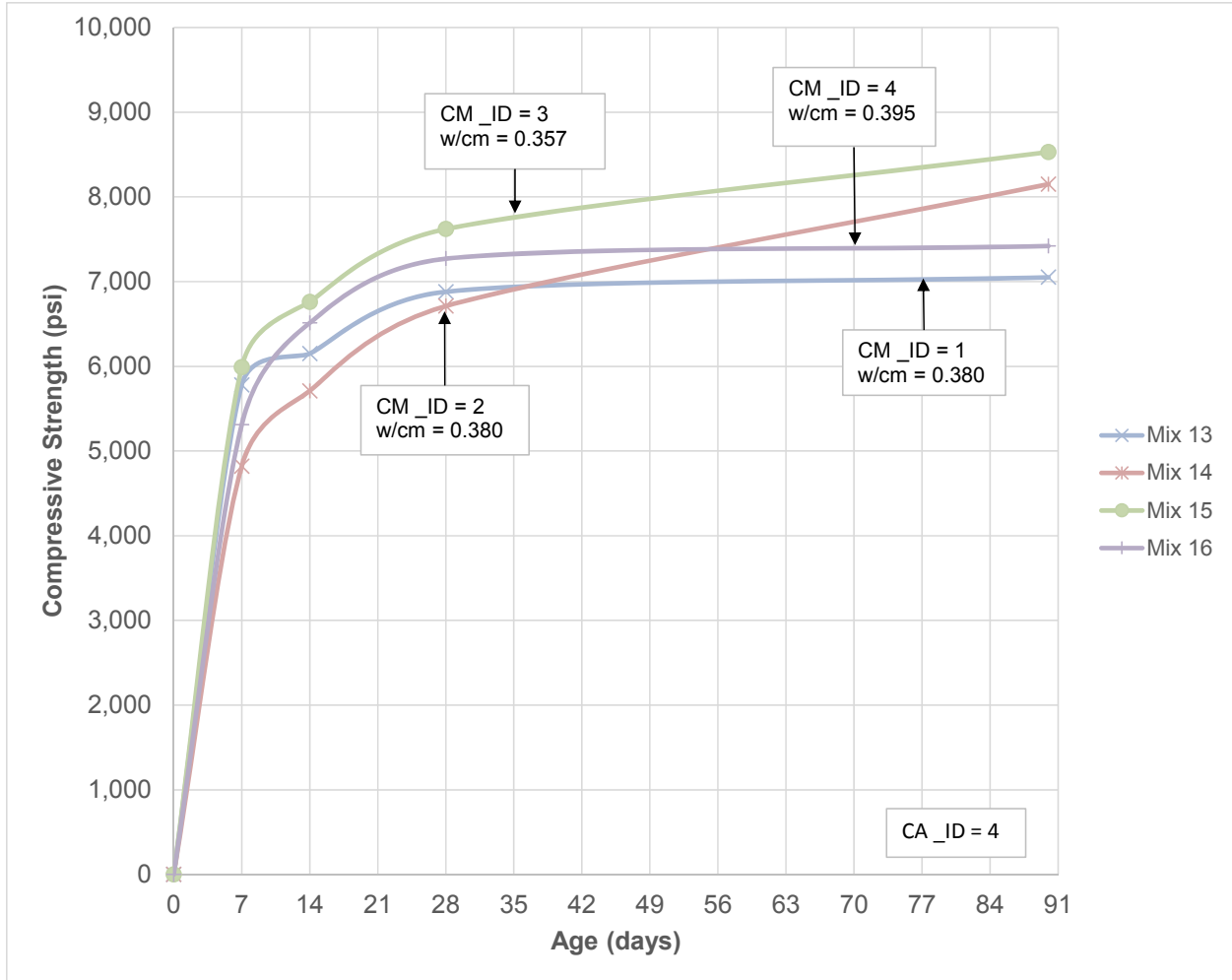


Figure 28. Compressive Strength VS Age - Mixes 13 Through 16 (CA_ID4)

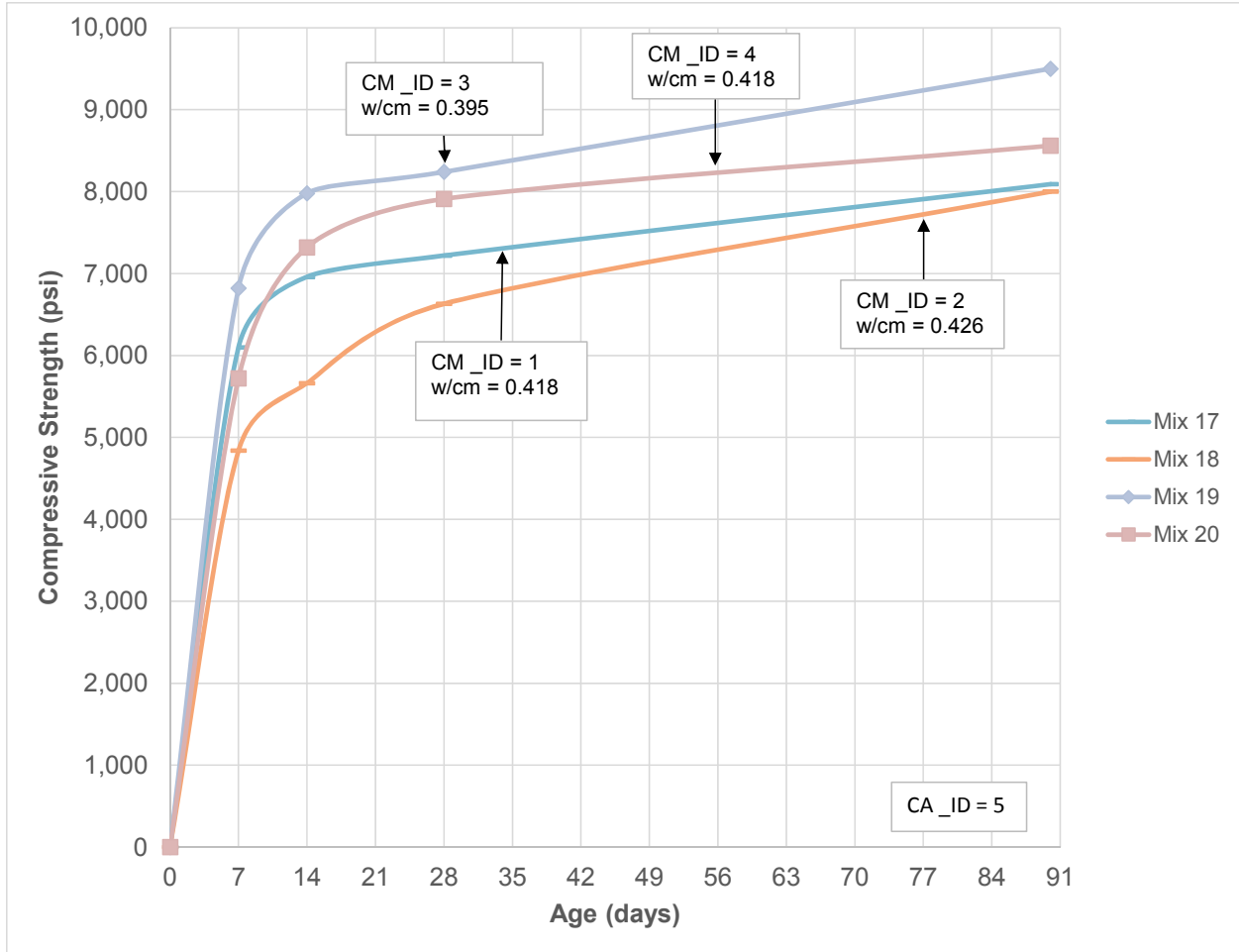


Figure 29. Compressive Strength VS Age - Mixes 17 Through 20 (CA_ID5)

FLEXURAL STRENGTH

Flexural strength test results are presented in this section. The result of each flexural strength specimen was calculated to the nearest 1 psi and the average of the test results from these individual specimens were rounded and reported to the nearest 5 psi. Standard deviation of each set of flexural strength specimen was also calculated and reported. MDOT does not specify a minimum flexural strength for PCC pavements. However, MDOT will consider eliminating the 72 percent coarse aggregate volume requirement if the flexural strength of the mixture equals or exceeds 650 psi. The 28-day flexural strength of all mixes in this study exceeded 650 psi.

The ranges of flexural strengths for each test age are as follows:

7-day – 595 psi (Mix 6) to 865 psi (Mix 9)

14-day – 680 psi (Mix 6) to 945 psi (Mix 12)

28-day – 720 psi (Mix 6) to 1,045 psi (Mix 12)

90-day – 725 psi (Mix 5) to 1,090 psi (Mix 16)

Figure 30 presents graphs of flexural strength versus age for all mixes. Figures 31 through 35 present graphs of flexural strength versus age for each coarse aggregate category. The coarse aggregate source and cementitious option along with w/cm ratio are noted in within the figures.

Table 20. Flexural Strengths, psi

Mix No.	Specimen No.	7-Day	14-Day	28-Day	90-Day
1	A	707	751	752	850
	B	676	726	787	933
	C	710	778	809	848
	Average	700	750	785	875
	STDEV	19	26	29	49
2	A	633	674	730	853
	B	610	682	745	867
	C	582	707	774	931
	Average	610	690	750	885
	STDEV	26	17	22	42
3	A	712	791	855	837
	B	729	735	724	875
	C	671	718	752	911
	Average	705	750	775	875
	STDEV	30	38	69	37
4	A	711	788	829	856
	B	637	817	795	866
	C	683	776	904	819
	Average	675	795	845	845
	STDEV	37	21	56	25
5	A	683	751	734	714
	B	709	689	754	734
	C	659	751	720	730
	Average	685	730	735	725
	STDEV	25	36	17	11

Final Report

Mix No.	Specimen No.	7-Day	14-Day	28-Day	90-Day
6	A	626	683	707	811
	B	624	675	762	810
	C	535	683	695	800
	Average	595	680	720	805
	STDEV	52	5	36	6
7	A	756	787	786	799
	B	683	799	861	830
	C	776	818	801	896
	Average	740	800	815	840
	STDEV	49	16	40	50
8	A	719	832	915	968
	B	752	837	853	910
	C	688	815	971	972
	Average	720	830	915	950
	STDEV	32	12	59	35
9	A	850	910	939	895
	B	862	928	914	987
	C	888	907	930	934
	Average	865	915	930	940
	STDEV	19	11	13	46
10	A	715	804	962	982
	B	733	902	940	1049
	C	720	842	896	997
	Average	725	850	935	1010
	STDEV	9	49	34	35
11	A	753	890	993	1059
	B	731	917	978	1010
	C	792	879	948	1088
	Average	760	895	975	1050
	STDEV	31	20	23	39
12	A	729	984	1019	1132
	B	704	928	1059	1067
	C	790	919	1064	1012
	Average	740	945	1045	1070
	STDEV	44	35	25	60
13	A	732	898	824	905
	B	838	894	852	932
	C	753	811	899	917
	Average	775	870	860	920
	STDEV	56	49	38	14

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Mix No.	Specimen No.	7-Day	14-Day	28-Day	90-Day
14	A	704	866	846	967
	B	676	776	820	1004
	C	690	809	885	957
	Average	690	815	850	975
	STDEV	14	46	33	25
15	A	806	810	905	967
	B	853	863	899	1064
	C	755	831	899	1032
	Average	805	835	900	1020
	STDEV	49	27	3	49
16	A	746	937	1008	1029
	B	745	930	992	1144
	C	692	866	1015	1093
	Average	730	910	1005	1090
	STDEV	31	39	12	58
17	A	718	841	832	877
	B	729	797	822	874
	C	741	796	778	852
	Average	730	810	810	870
	STDEV	12	26	29	14
18	A	691	722	794	942
	B	648	726	787	956
	C	667	703	710	831
	Average	670	715	765	910
	STDEV	22	12	47	68
19	A	785	842	846	874
	B	783	788	847	884
	C	811	838	838	911
	Average	795	825	845	890
	STDEV	16	30	5	19
20	A	755	871	891	961
	B	678	834	920	982
	C	746	891	972	985
	Average	725	865	930	975
	STDEV	42	29	41	13

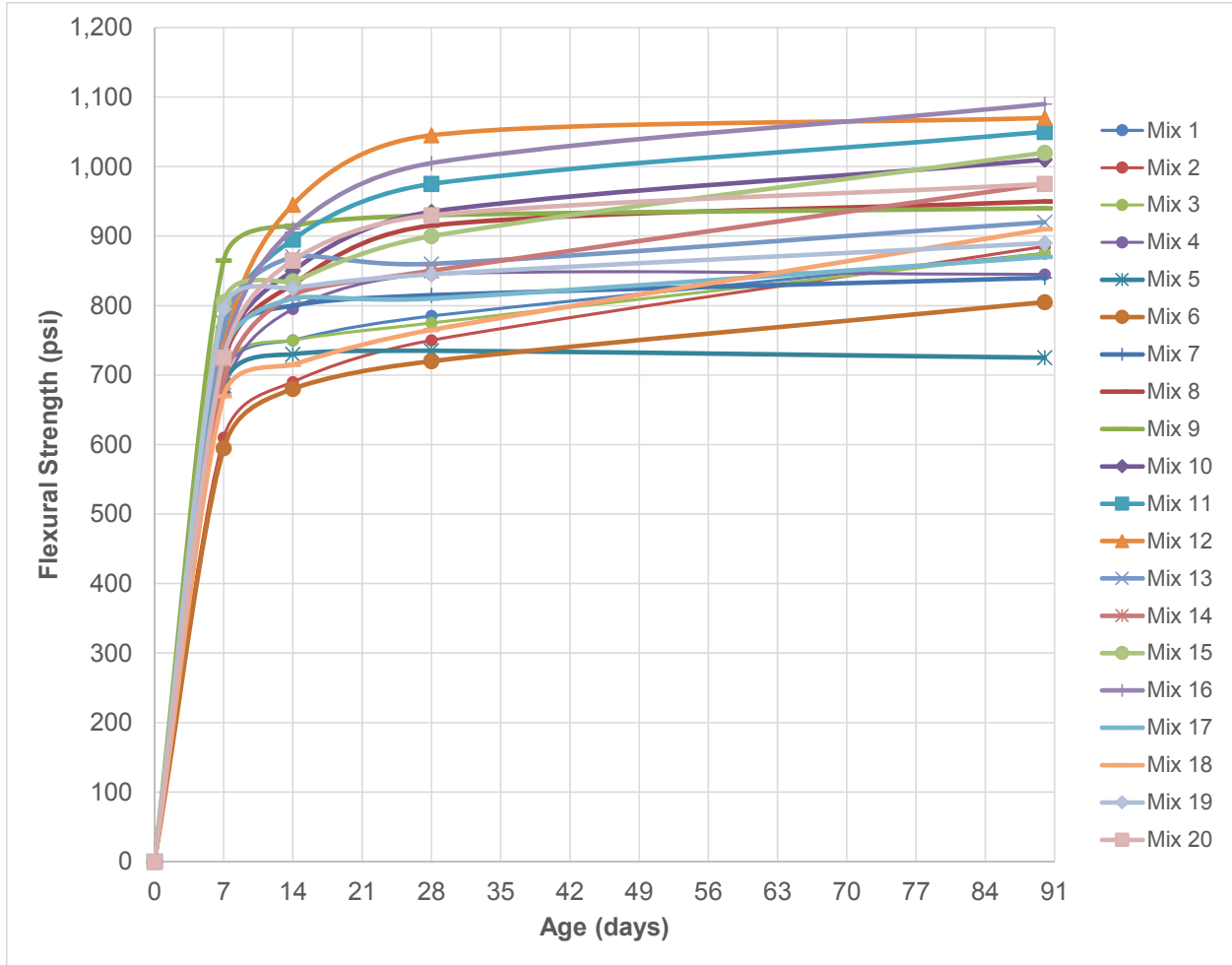


Figure 30. Flexural Strength VS Age - All Mixes

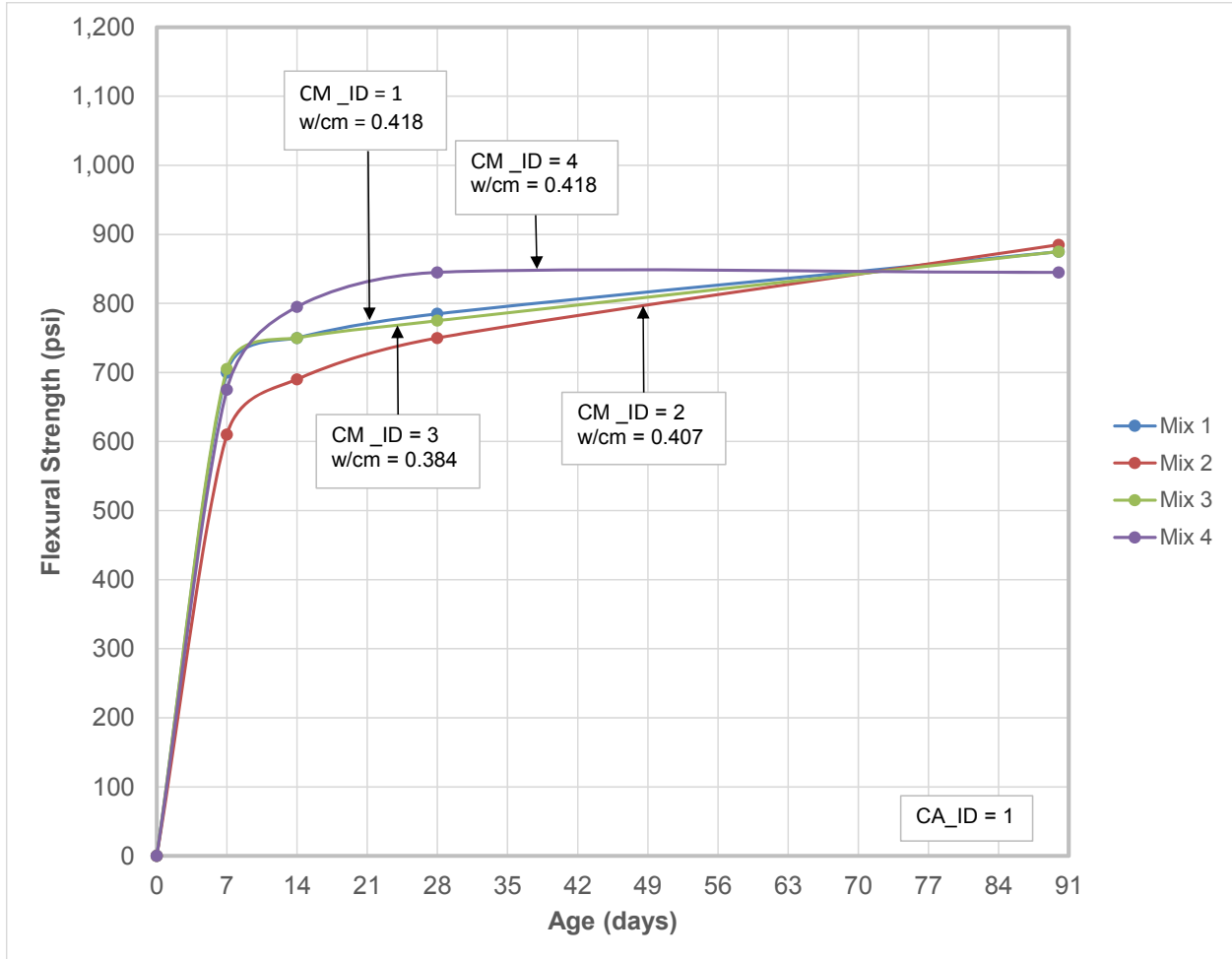


Figure 31. Flexural Strength VS Age - Mixes 1 Through 4 (CA_ID1)

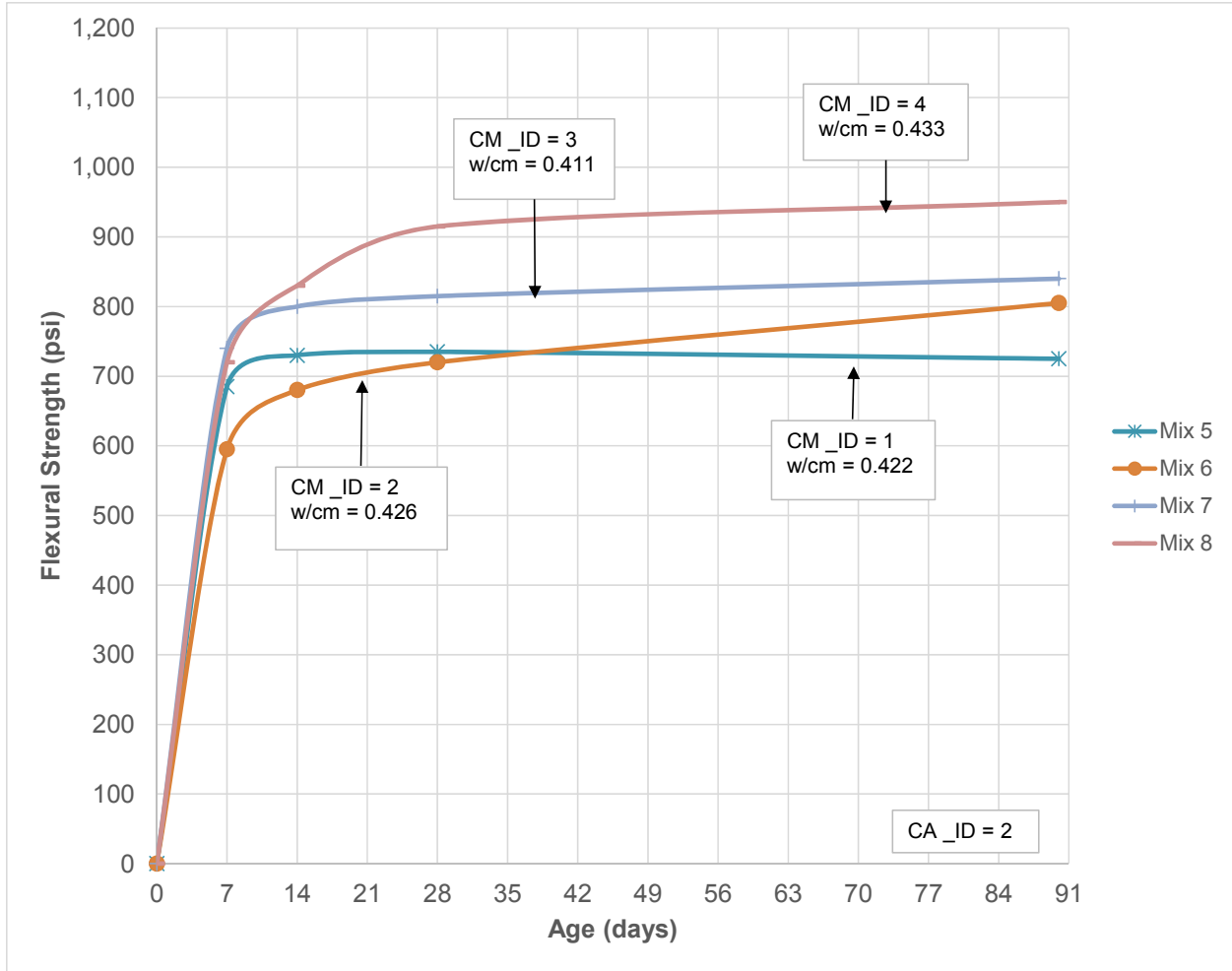


Figure 32. Flexural Strength VS Age - Mixes 5 Through 8 (CA_ID2)

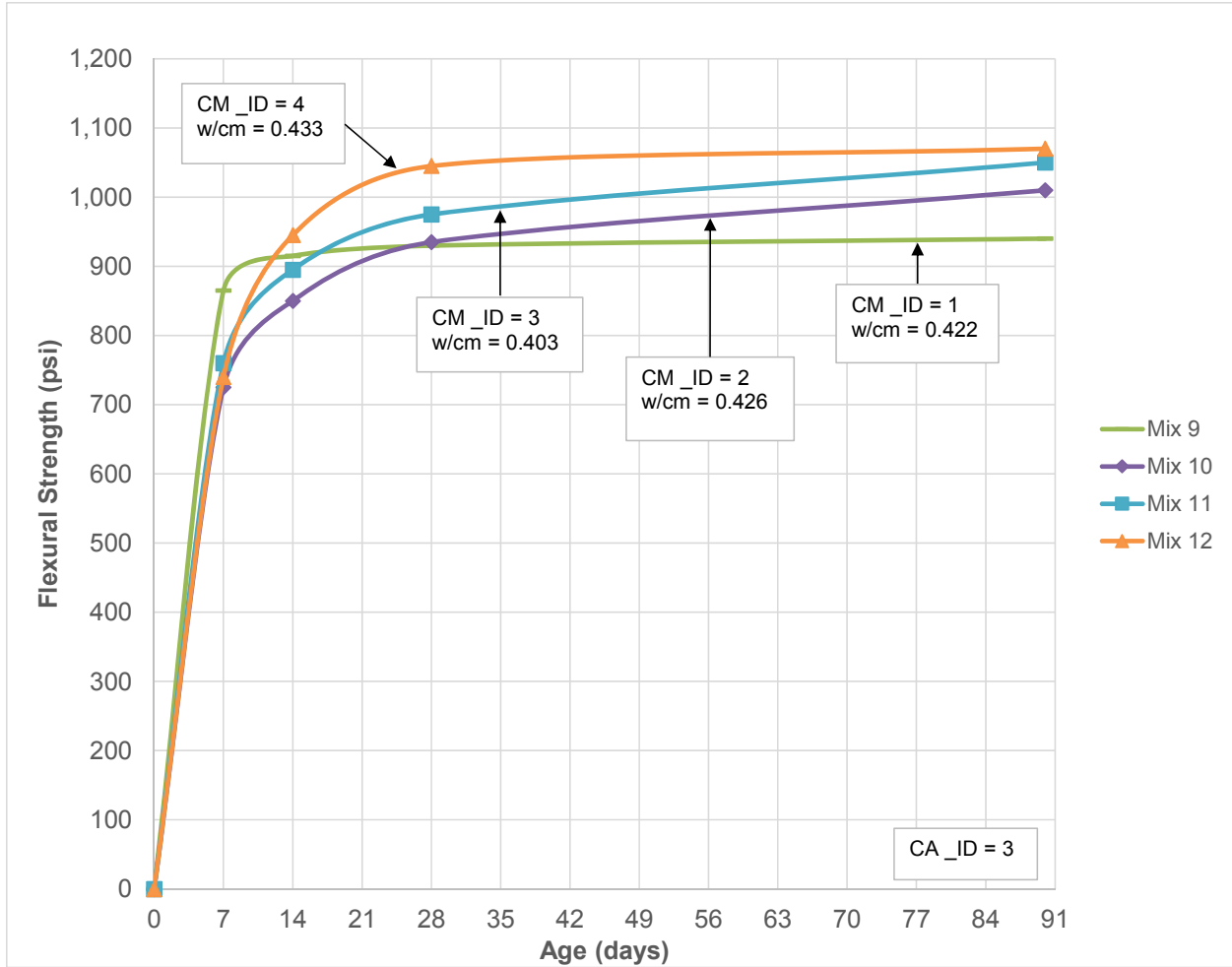


Figure 33. Flexural Strength VS Age - Mixes 9 Through 12 (CA_ID3)

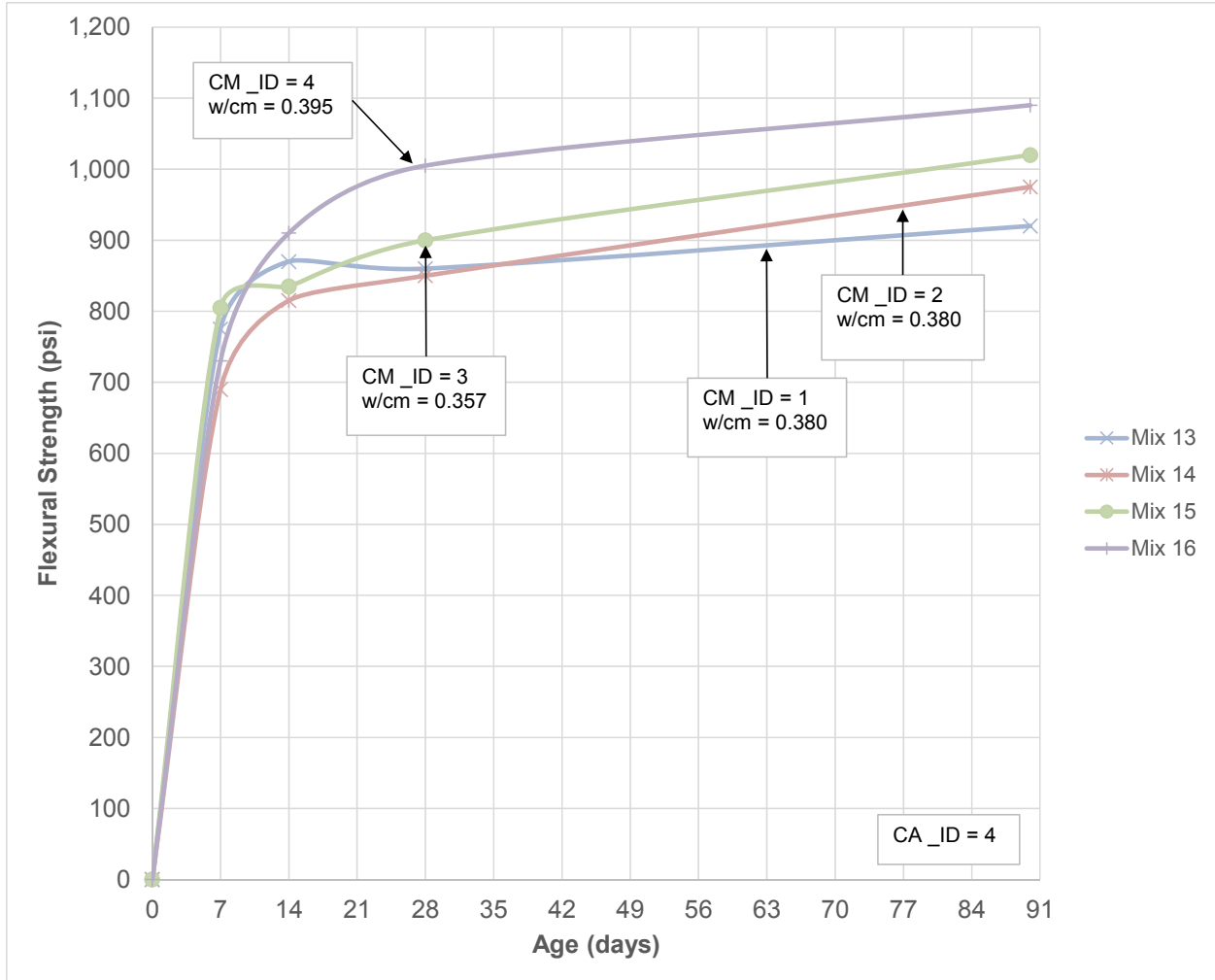


Figure 34. Flexural Strength VS Age - Mixes 13 Through 16 (CA_ID4)

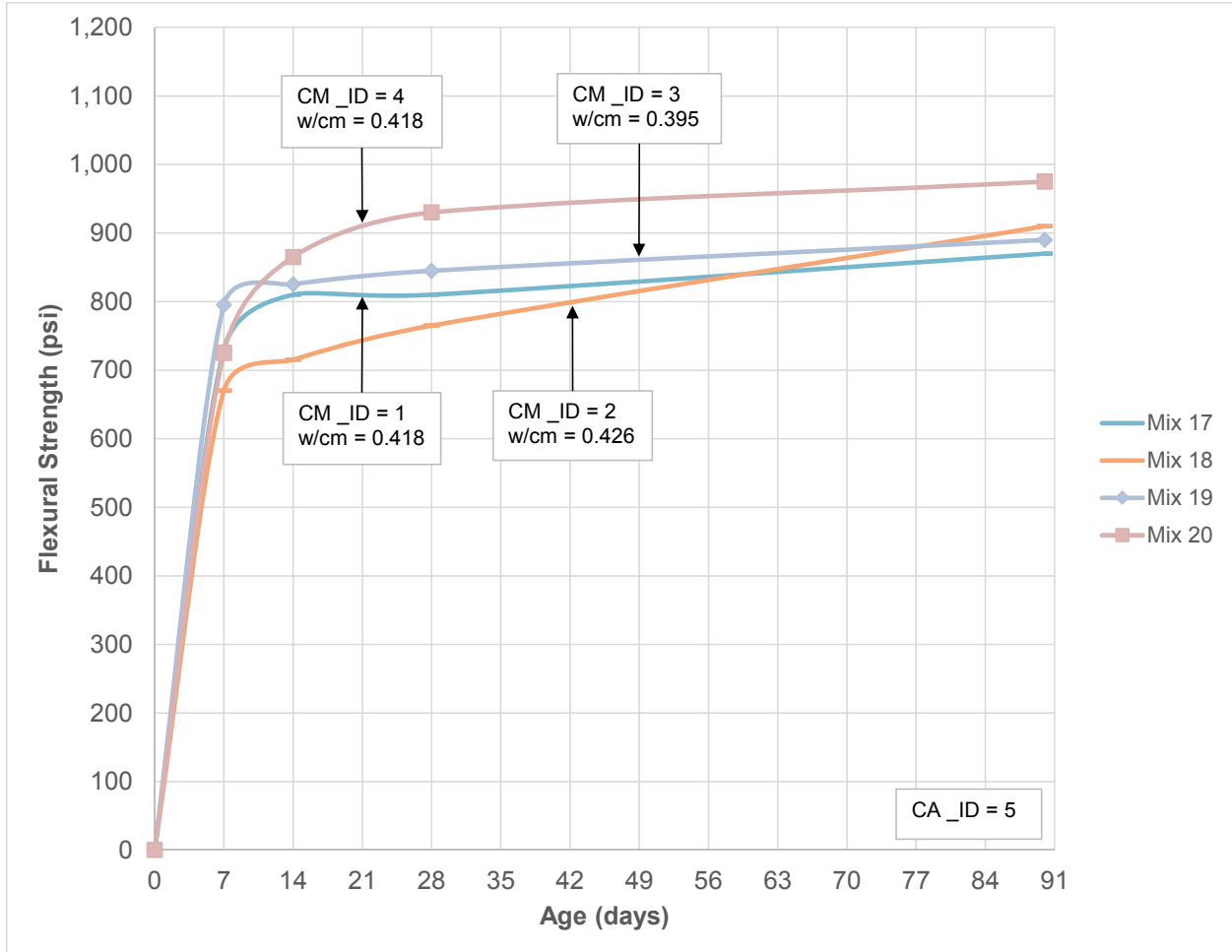


Figure 35. Flexural Strength VS Age - Mixes 17 Through 20 (CA_ID5)

MODULUS OF ELASTICITY AND POISSON’S RATIO

Modulus of elasticity (MOE) and Poisson’s ratio test results are presented in this section. Results of each MOE specimen was calculated to the nearest 1 psi and rounded to the nearest 50,000 psi for reporting. Standard deviation of each set of MOE and Poisson’s ratio was also calculated and reported. The range of MOR and Poisson’s ratio for each test age is as follows:

MOE

7-day – 4.95E+06 psi (Mix 2, 5, and 18) to 6.85E+06 psi (Mix 9)

14-day – 4.95E+06 psi (Mix 2) to 6.85E+06 psi (Mix 11)

28-day – 5.20E+06 psi (Mix 2) to 7.55E+06 psi (Mix 16)

90-day – 5.70E+06 psi (Mix 2) to 7.05E+06 psi (Mix 12)

Poisson's Ratio

7-day – 0.13 (Mix 15) to 0.24 (Mix 12)

14-day – 0.11 (Mix 15) to 0.22 (Mix 11)

28-day – 0.14 (Mix 3) to 0.23 (Mix 7 and 12)

90-day – 0.12 (Mix 19) to 0.23 (Mix 12)

Figure 36 presents graphs of MOE versus age for all mixes. Figures 37 through 41 present graphs of MOE versus age for each coarse aggregate source. The coarse aggregate source and cementitious blend along with w/cm ratio are noted within the figures.

Table 21. Modulus of Elasticity and Poisson's Ratio

Mix No.	Specimen No.	Modulus of Elasticity (psi)				Poisson's Ratio			
		7-Day	14-Day	28-Day	90-Day	7-Day	14-Day	28-Day	90-Day
1	A	5.20E+06	5.45E+06	6.10E+06	5.60E+06	0.16	0.18	0.16	0.15
	B	5.20E+06	5.10E+06	5.60E+06	5.85E+06	0.15	0.10	0.17	0.18
	C	5.40E+06	5.80E+06	5.95E+06	6.65E+06	0.16	0.16	0.18	0.24
	Average	5.25E+06	5.45E+06	5.90E+06	6.05E+06	0.16	0.15	0.17	0.19
	STDEV	1.15E+05	3.50E+05	2.57E+05	5.48E+05	0.00	0.04	0.01	0.04
2	A	5.00E+06	4.95E+06	5.10E+06	5.45E+06	0.14	0.14	0.16	0.14
	B	4.95E+06	4.85E+06	5.50E+06	6.05E+06	0.14	0.16	0.16	0.17
	C	4.90E+06	5.00E+06	5.10E+06	5.60E+06	0.14	0.14	0.16	0.16
	Average	4.95E+06	4.95E+06	5.20E+06	5.70E+06	0.14	0.15	0.16	0.16
	STDEV	5.00E+04	7.64E+04	2.31E+05	3.12E+05	0.00	0.01	0.00	0.02
3	A	5.15E+06	6.20E+06	6.40E+06	5.95E+06	0.15	0.14	0.15	0.13
	B	5.20E+06	5.75E+06	6.65E+06	5.25E+06	0.15	0.18	0.14	0.14
	C	5.00E+06	5.50E+06	5.95E+06	5.85E+06	0.16	0.14	0.14	0.12
	Average	5.15E+06	5.85E+06	6.30E+06	5.70E+06	0.15	0.15	0.14	0.13
	STDEV	1.04E+05	3.55E+05	3.55E+05	3.79E+05	0.01	0.02	0.01	0.01
4	A	5.20E+06	5.45E+06	5.60E+06	6.35E+06	0.14	0.17	0.13	0.17
	B	5.40E+06	5.65E+06	6.15E+06	6.00E+06	0.16	0.16	0.16	0.17
	C	5.05E+06	5.35E+06	6.05E+06	6.40E+06	0.16	0.18	0.17	0.16
	Average	5.20E+06	5.50E+06	5.95E+06	6.25E+06	0.15	0.17	0.15	0.17
	STDEV	1.76E+05	1.53E+05	2.93E+05	2.18E+05	0.01	0.01	0.02	0.01
5	A	4.65E+06	5.25E+06	5.75E+06	5.55E+06	0.19	0.20	0.21	0.20
	B	5.05E+06	5.60E+06	5.30E+06	5.95E+06	0.21	0.22	0.17	0.22
	C	5.15E+06	5.85E+06	5.40E+06	6.00E+06	0.22	0.21	0.19	0.22
	Average	4.95E+06	5.60E+06	5.50E+06	5.85E+06	0.21	0.21	0.19	0.21
	STDEV	2.65E+05	3.01E+05	2.36E+05	2.47E+05	0.02	0.01	0.02	0.01

Final Report

Mix No.	Specimen No.	Modulus of Elasticity (psi)				Poisson's Ratio			
		7-Day	14-Day	28-Day	90-Day	7-Day	14-Day	28-Day	90-Day
6	A	5.75E+06	5.25E+06	5.05E+06	7.00E+06	0.23	0.19	0.19	0.22
	B	5.45E+06	5.50E+06	5.65E+06	6.35E+06	0.24	0.19	0.22	0.21
	C	4.80E+06	4.75E+06	5.50E+06	6.00E+06	0.21	0.19	0.19	0.19
	Average	5.35E+06	5.15E+06	5.40E+06	6.45E+06	0.23	0.19	0.20	0.21
	STDEV	4.86E+05	3.82E+05	3.12E+05	5.07E+05	0.02	0.00	0.02	0.01
7	A	4.75E+06	5.75E+06	5.55E+06	6.10E+06	0.18	0.19	0.20	0.22
	B	5.05E+06	5.45E+06	6.65E+06	5.95E+06	0.18	0.20	0.24	0.21
	C	5.40E+06	5.70E+06	6.90E+06	6.40E+06	0.20	0.20	0.24	0.22
	Average	5.05E+06	5.65E+06	6.35E+06	6.15E+06	0.19	0.20	0.23	0.22
	STDEV	3.25E+05	1.61E+05	7.18E+05	2.29E+05	0.01	0.00	0.03	0.01
8	A	5.35E+06	5.05E+06	5.80E+06	6.00E+06	0.20	0.19	0.21	0.22
	B	5.45E+06	5.75E+06	5.10E+06	5.70E+06	0.21	0.19	0.19	0.23
	C	5.30E+06	6.35E+06	5.35E+06	6.05E+06	0.22	0.23	0.17	0.22
	Average	5.35E+06	5.70E+06	5.40E+06	5.90E+06	0.21	0.21	0.19	0.22
	STDEV	7.64E+04	6.51E+05	3.55E+05	1.89E+05	0.01	0.03	0.02	0.01
9	A	7.10E+06	6.45E+06	6.50E+06	7.30E+06	0.22	0.17	0.21	0.26
	B	6.70E+06	6.85E+06	6.55E+06	6.35E+06	0.21	0.22	0.20	0.21
	C	6.70E+06	6.80E+06	7.00E+06	6.95E+06	0.24	0.21	0.22	0.23
	Average	6.85E+06	6.70E+06	6.65E+06	6.85E+06	0.22	0.20	0.21	0.23
	STDEV	2.31E+05	2.18E+05	2.75E+05	4.80E+05	0.01	0.02	0.01	0.02
10	A	6.60E+06	5.85E+06	6.10E+06	6.80E+06	0.21	0.18	0.20	0.22
	B	6.15E+06	5.85E+06	6.65E+06	6.40E+06	0.20	0.19	0.22	0.19
	C	6.85E+06	6.45E+06	7.00E+06	7.30E+06	0.23	0.20	0.24	0.24
	Average	6.55E+06	6.05E+06	6.60E+06	6.85E+06	0.21	0.19	0.22	0.22
	STDEV	3.55E+05	3.46E+05	4.54E+05	4.51E+05	0.02	0.01	0.02	0.02
11	A	5.75E+06	7.00E+06	6.75E+06	6.55E+06	0.19	0.21	0.20	0.21
	B	6.60E+06	6.90E+06	6.60E+06	6.30E+06	0.22	0.24	0.21	0.21
	C	5.95E+06	6.65E+06	6.60E+06	7.20E+06	0.18	0.22	0.22	0.24
	Average	6.10E+06	6.85E+06	6.65E+06	6.65E+06	0.20	0.22	0.21	0.22
	STDEV	4.44E+05	1.80E+05	8.66E+04	4.65E+05	0.02	0.01	0.01	0.02
12	A	6.15E+06	5.75E+06	6.60E+06	6.50E+06	0.21	0.19	0.24	0.21
	B	6.45E+06	6.30E+06	6.70E+06	7.65E+06	0.25	0.20	0.23	0.26
	C	6.80E+06	6.20E+06	6.35E+06	7.00E+06	0.25	0.22	0.22	0.23
	Average	6.45E+06	6.05E+06	6.55E+06	7.05E+06	0.24	0.20	0.23	0.23
	STDEV	3.25E+05	2.93E+05	1.80E+05	5.77E+05	0.02	0.02	0.01	0.03
13	A	6.60E+06	6.05E+06	6.45E+06	6.90E+06	0.16	0.15	0.14	0.15
	B	7.45E+06	6.55E+06	5.95E+06	6.55E+06	0.15	0.14	0.21	0.13
	C	6.10E+06	6.85E+06	7.35E+06	6.40E+06	0.14	0.15	0.15	0.14
	Average	6.70E+06	6.45E+06	6.60E+06	6.60E+06	0.15	0.14	0.17	0.14
	STDEV	6.83E+05	4.04E+05	7.09E+05	2.57E+05	0.01	0.00	0.03	0.01

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Mix No.	Specimen No.	Modulus of Elasticity (psi)				Poisson's Ratio			
		7-Day	14-Day	28-Day	90-Day	7-Day	14-Day	28-Day	90-Day
14	A	5.55E+06	5.55E+06	6.60E+06	7.25E+06	0.13	0.11	0.13	0.14
	B	6.40E+06	5.65E+06	6.70E+06	6.70E+06	0.14	0.12	0.15	0.14
	C	6.05E+06	5.65E+06	6.40E+06	6.60E+06	0.17	0.14	0.15	0.14
	Average	6.00E+06	5.60E+06	6.55E+06	6.85E+06	0.15	0.13	0.14	0.14
	STDEV	4.27E+05	5.77E+04	1.53E+05	3.50E+05	0.02	0.02	0.01	0.00
15	A	6.10E+06	6.75E+06	6.45E+06	7.10E+06	0.11	0.11	0.16	0.16
	B	6.50E+06	6.20E+06	6.50E+06	7.15E+06	0.13	0.13	0.18	0.14
	C	7.80E+06	6.75E+06	7.05E+06	6.75E+06	0.16	0.11	0.21	0.14
	Average	6.80E+06	6.55E+06	6.65E+06	7.00E+06	0.13	0.11	0.18	0.15
	STDEV	8.89E+05	3.18E+05	3.33E+05	2.18E+05	0.03	0.01	0.02	0.01
16	A	6.85E+06	6.55E+06	7.45E+06	6.25E+06	0.16	0.16	0.14	0.14
	B	6.45E+06	6.65E+06	7.55E+06	6.70E+06	0.15	0.16	0.14	0.13
	C	5.75E+06	6.85E+06	7.60E+06	6.85E+06	0.12	0.18	0.16	0.14
	Average	6.35E+06	6.70E+06	7.55E+06	6.60E+06	0.15	0.17	0.15	0.14
	STDEV	5.57E+05	1.53E+05	7.64E+04	3.12E+05	0.02	0.01	0.01	0.01
17	A	5.45E+06	5.90E+06	5.65E+06	6.60E+06	0.15	0.16	0.13	0.17
	B	5.45E+06	6.20E+06	6.00E+06	5.95E+06	0.15	0.18	0.14	0.14
	C	5.10E+06	5.60E+06	5.85E+06	5.90E+06	0.15	0.14	0.16	0.15
	Average	5.35E+06	5.90E+06	5.85E+06	6.15E+06	0.15	0.16	0.14	0.15
	STDEV	2.02E+05	3.00E+05	1.76E+05	3.91E+05	0.00	0.02	0.01	0.01
18	A	4.95E+06	5.40E+06	5.45E+06	6.00E+06	0.16	0.17	0.14	0.15
	B	5.10E+06	5.35E+06	6.05E+06	5.80E+06	0.14	0.16	0.16	0.14
	C	4.75E+06	5.25E+06	5.60E+06	5.40E+06	0.16	0.15	0.16	0.13
	Average	4.95E+06	5.35E+06	5.70E+06	5.75E+06	0.15	0.16	0.15	0.14
	STDEV	1.76E+05	7.64E+04	3.12E+05	3.06E+05	0.01	0.01	0.01	0.01
19	A	5.75E+06	5.55E+06	6.00E+06	7.10E+06	0.15	0.15	0.14	0.15
	B	5.85E+06	5.70E+06	6.20E+06	6.00E+06	0.15	0.17	0.15	0.11
	C	5.70E+06	6.20E+06	6.55E+06	6.25E+06	0.15	0.20	0.15	0.10
	Average	5.75E+06	5.80E+06	6.25E+06	6.45E+06	0.15	0.17	0.15	0.12
	STDEV	7.64E+04	3.40E+05	2.78E+05	5.77E+05	0.00	0.02	0.01	0.02
20	A	4.85E+06	5.65E+06	5.80E+06	7.15E+06	0.17	0.16	0.15	0.19
	B	5.50E+06	5.70E+06	6.60E+06	6.05E+06	0.16	0.13	0.16	0.16
	C	5.70E+06	5.75E+06	5.05E+06	5.90E+06	0.15	0.17	0.14	0.12
	Average	5.35E+06	5.70E+06	5.80E+06	6.40E+06	0.16	0.15	0.15	0.16
	STDEV	4.44E+05	5.00E+04	7.75E+05	6.83E+05	0.01	0.02	0.01	0.03

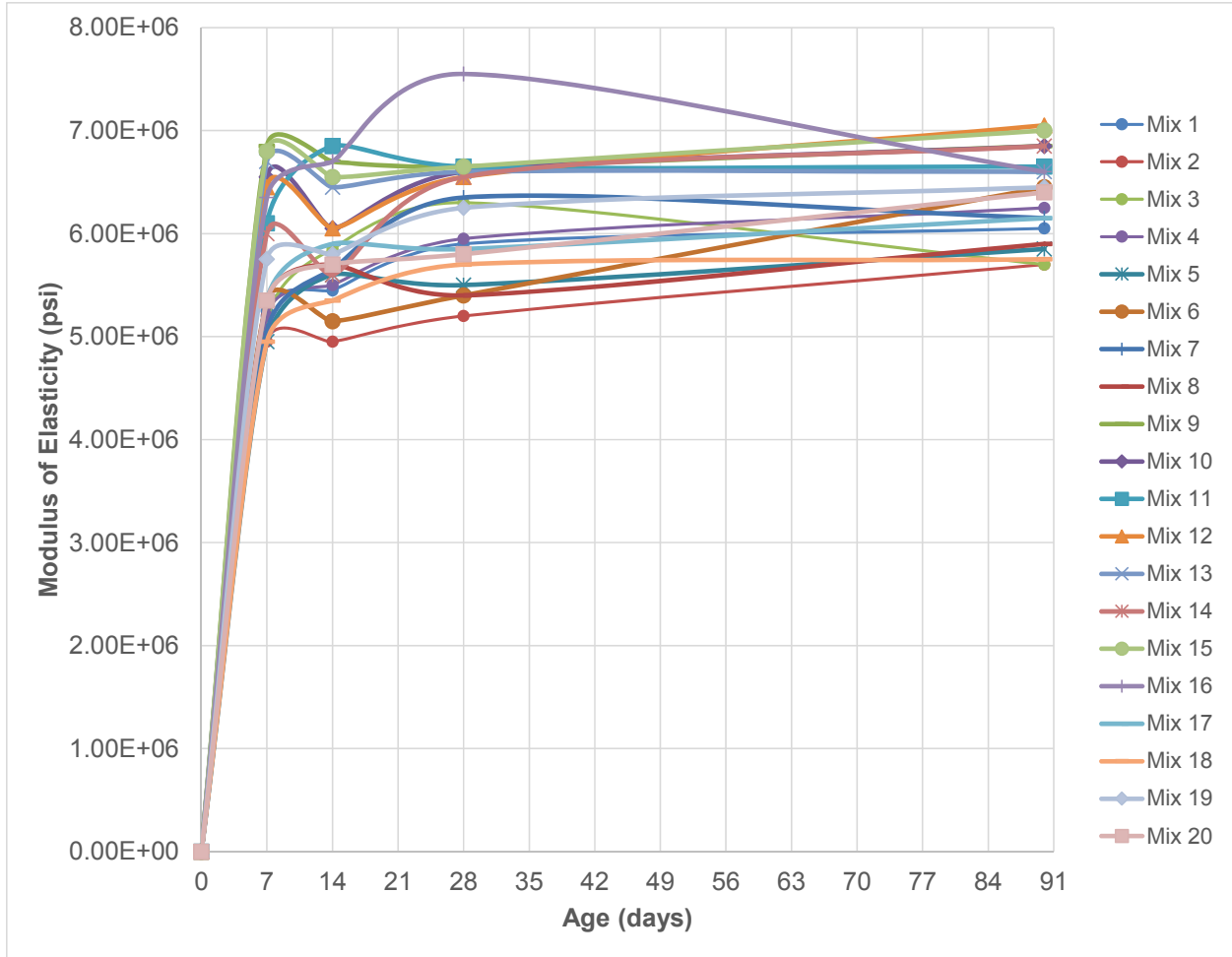


Figure 36. Modulus of Elasticity VS Age - All Mixes

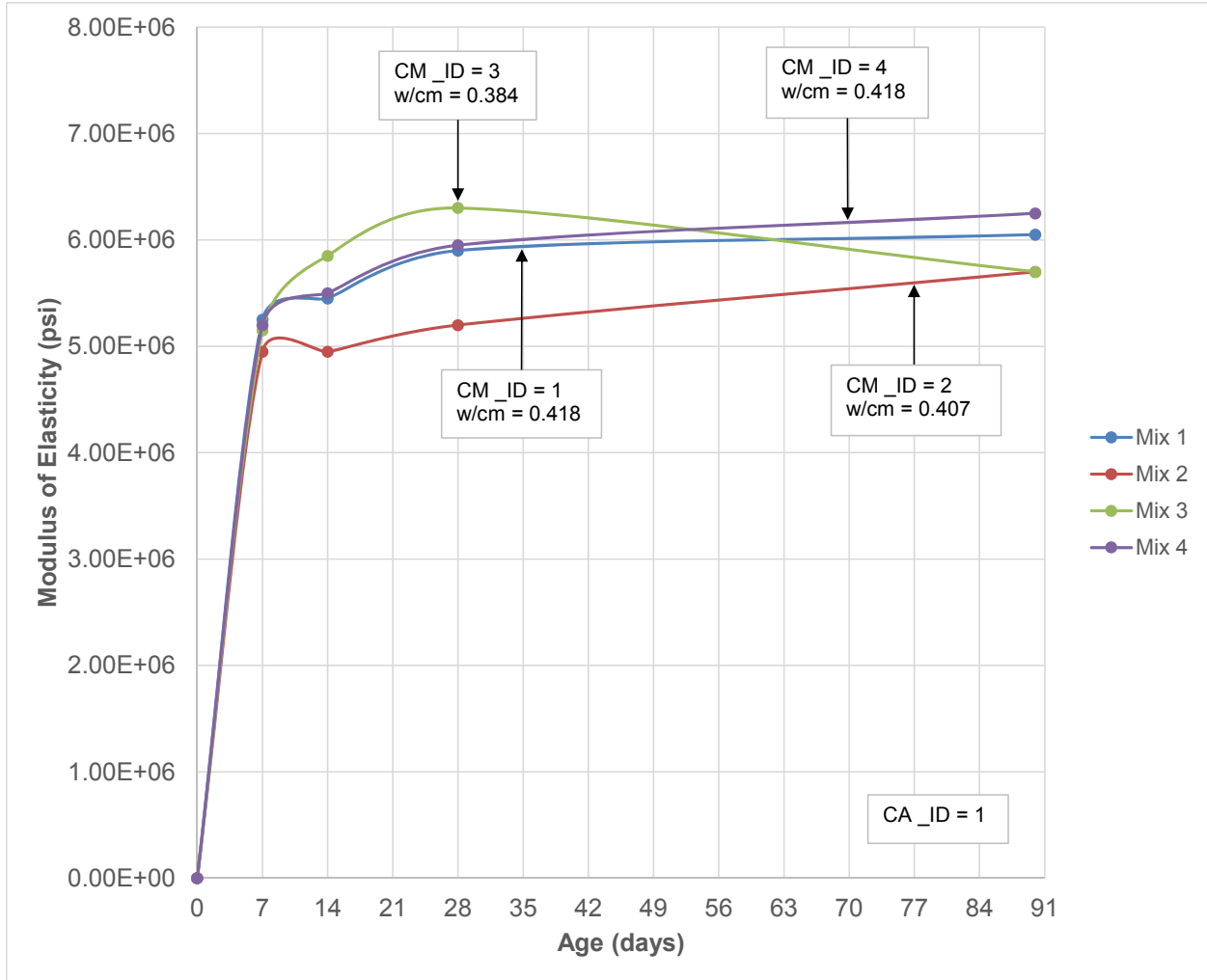


Figure 37. Modulus of Elasticity VS Age - Mixes 1 Through 4 (CA_ID1)

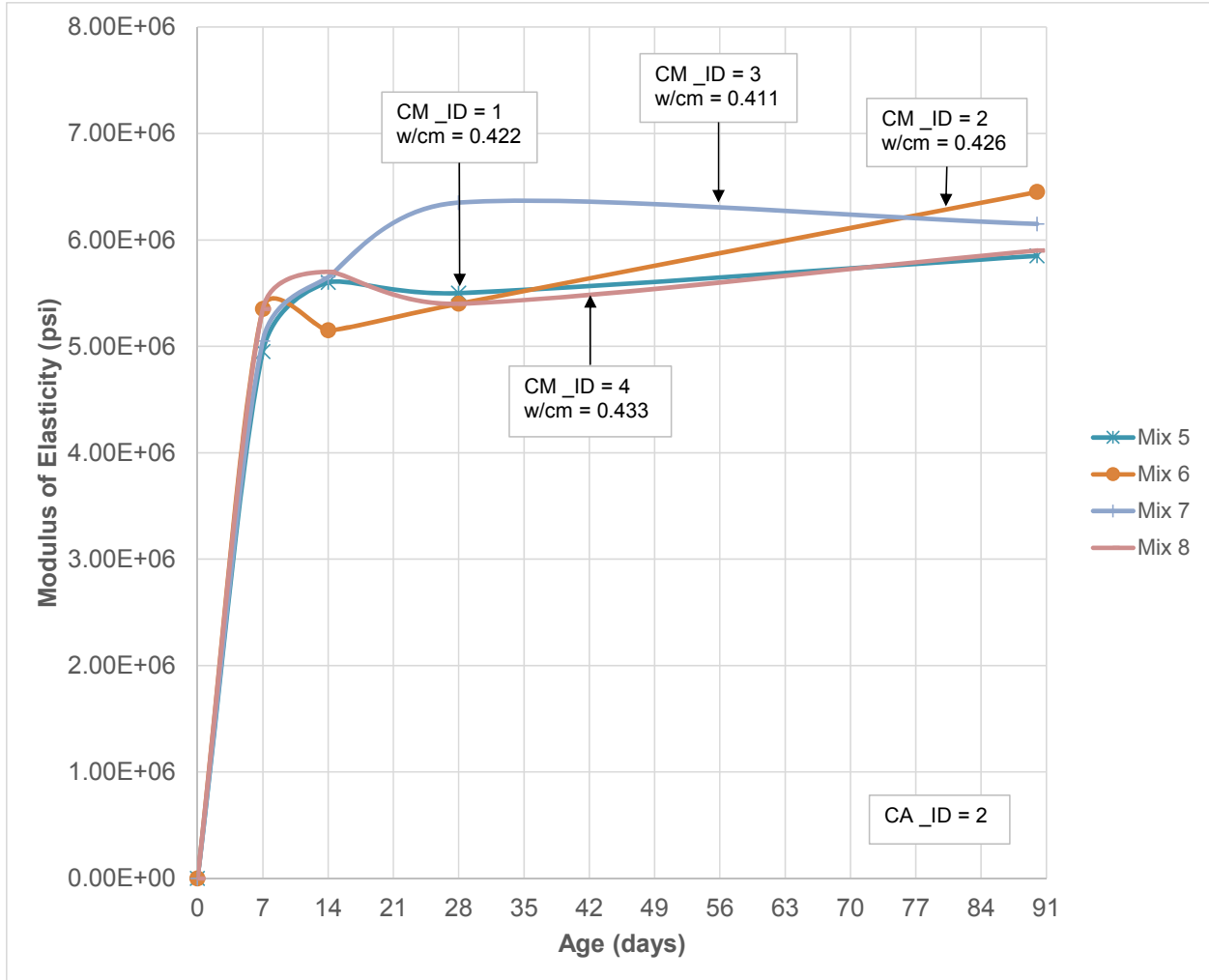


Figure 38 - Modulus of Elasticity VS Age - Mixes 5 Through 8 (CA_ID2)

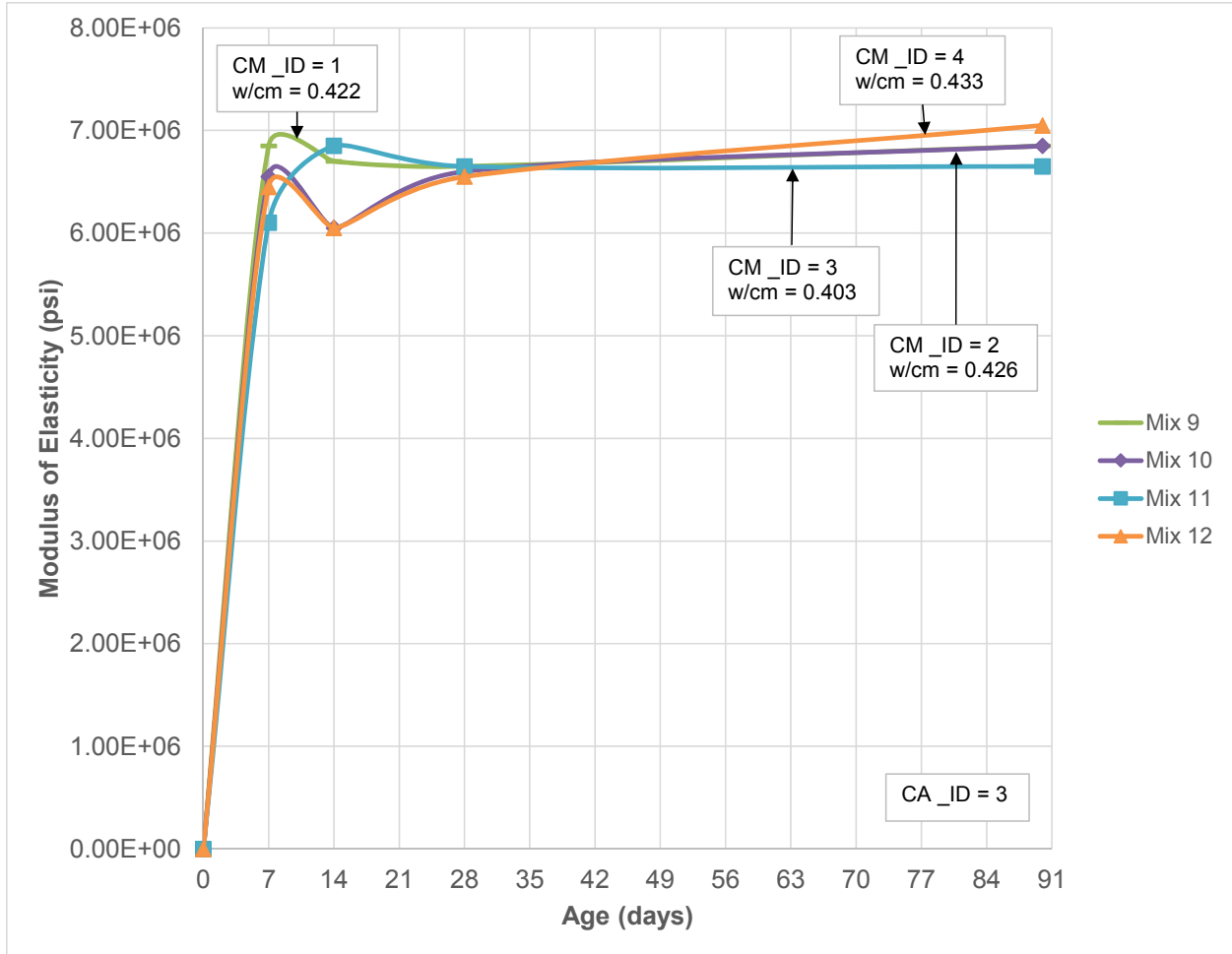


Figure 39 - Modulus of Elasticity VS Age - Mixes 9 Through 12 (CA_ID3)

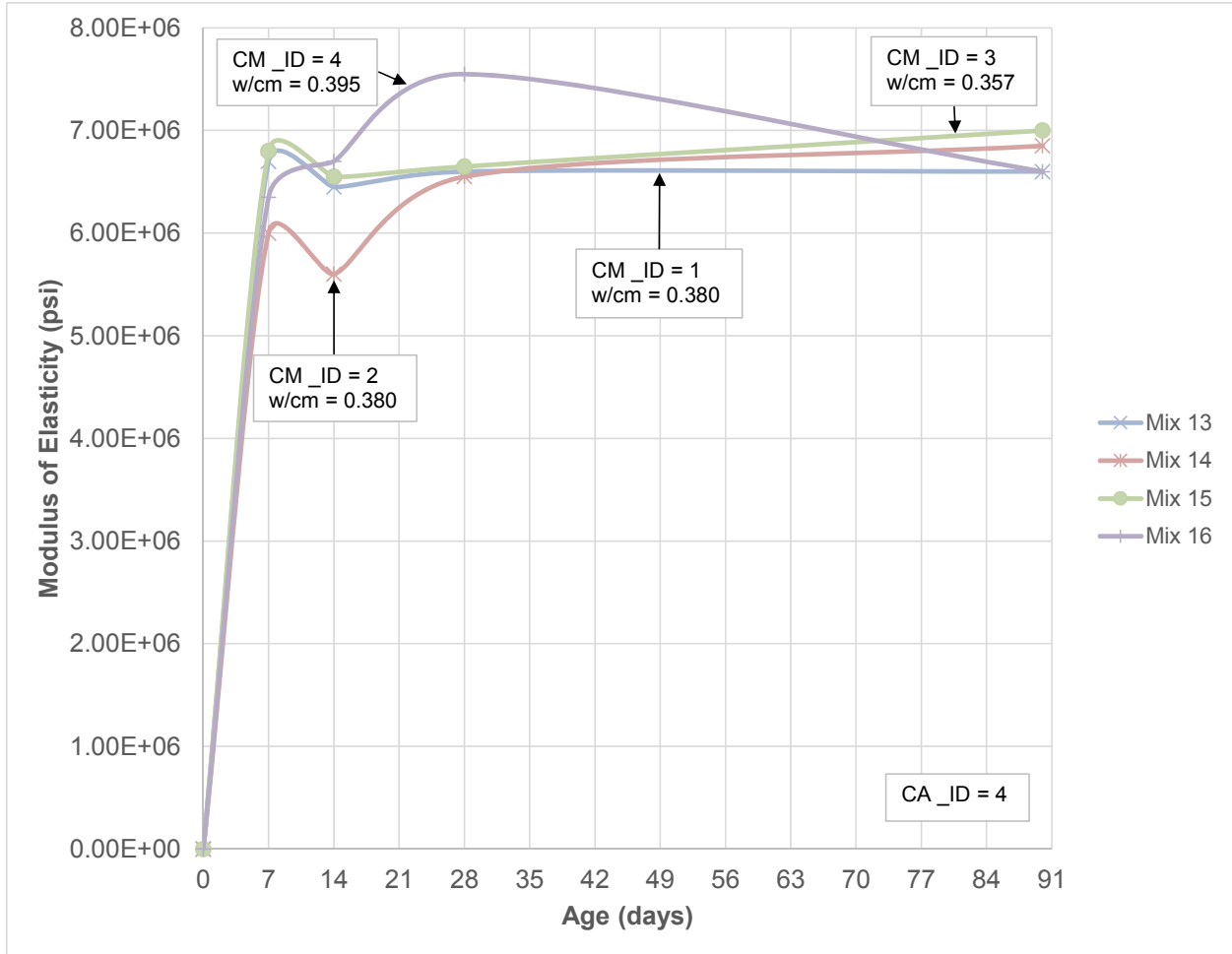


Figure 40 - Modulus of Elasticity VS Age -Mixes 13 Through 16 (CA_ID4)

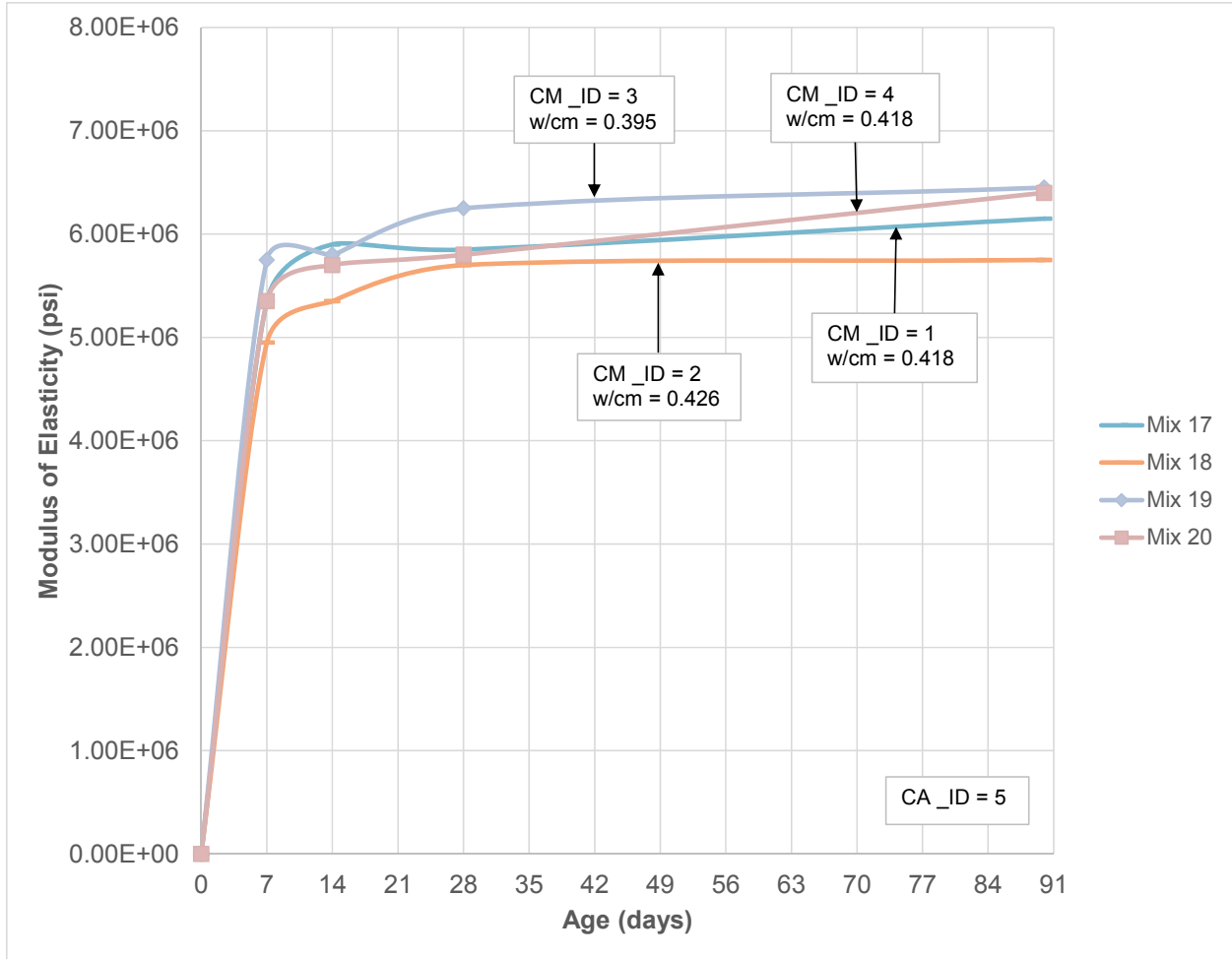


Figure 41 - Modulus of Elasticity VS Age - Mixes 17 Through 20 (CA_ID5)

VOLUME CHANGE PROPERTIES**Coefficient of Thermal Expansion (CTE)**

Results from coefficient of thermal expansion (CTE) testing are presented in this section. This testing was performed by AET, Inc. Results are presented in Table 22. CTE ranged from 4.65×10^{-6} in./in. per °F (Mix 9) to 6.94×10^{-6} in./in. per °F (Mixes 3 and 16).

Table 22. Coefficient of Thermal Expansion, in./in/°F (mm/mm/°C)

Mix No.	Specimen ID	Length, mm	Initial Weight, g	2nd day Weight, g	3rd day Weight, g	CTE, °C	CTE, °F	Avg. CTE, °C	Avg. CTE, °F
1	1-41	177.6	3340.5	3340.8	3340.9	11.83	6.57	11.84	6.58
	1-42	180.3	3385.5	3385.3	3385.7	11.85	6.58		
2	2-41	178.8	3278.3	3278.6	3278.7	11.63	6.46	11.66	6.48
	2-42	179.6	3312.3	3312.6	3312.8	11.69	6.49		
3	3-41	177.9	3357.5	3361.8	3362.6	12.74	7.08	12.49	6.94
	3-42	177.0	3295.8	3299.1	3300.0	12.24	6.80		
4	4-41	177.8	3360.7	3363.6	3364.0	12.26	6.81	12.28	6.82
	4-42	178.8	3380.2	3382.2	3382.9	12.29	6.83		
5	5-41	179.8	3489.4	3489.8	3490.3	9.07	5.04	9.04	5.03
	5-42	177.9	3473.9	3474.5	3475.0	9.01	5.01		
6	6-41	178.8	3464.6	3464.8	3464.9	8.90	4.94	8.98	4.99
	6-42	177.8	3442.1	3442.6	3442.8	9.06	5.04		
7	7-41	179.1	3456.8	3461.0	3461.2	9.57	5.32	9.34	5.19
	7-42	179.2	3477.5	3481.9	3482.5	9.11	5.06		
8	8-41	177.7	3434.5	3434.8	3435.0	9.33	5.18	9.46	5.25
	8-42	177.4	3429.3	3429.8	3429.7	9.58	5.32		
9	9-41	177.1	3560.8	3561.5	---	8.38	4.65	8.38	4.65
	9-42	178.0	3560.0	3561.0	---	8.38	4.65		
10	10-41	176.1	3501.4	3501.5	350.6	8.86	4.92	8.75	4.86
	10-42	176.0	3499.3	3499.7	3500.0	8.64	4.80		
11	11-41	178.1	3561.5	3565.0	3565.7	9.47	5.26	9.25	5.14
	11-42	178.3	3543.3	3546.9	3547.5	9.03	5.02		
12	12-41	178.2	3524.3	3524.1	3524.7	9.45	5.25	9.53	5.29
	12-42	178.2	3525.0	3525.1	3525.6	9.60	5.33		
13	13-41	179.0	3454.7	3455.5	3456.2	12.28	6.82	12.28	6.82
	13-42	180.1	3491.1	3491.9	3492.5	12.28	6.82		
14	14-41	177.4	3432.8	3434.3	3434.7	12.17	6.76	12.15	6.75
	14-42	177.6	3452.2	3453.4	3453.9	12.12	6.73		
15	15-41	177.3	3452.8	3453.1	---	12.22	6.79	12.23	6.80
	15-42	177.7	3456.0	3456.3	---	12.24	6.80		
16	16-41	177.6	3440.1	3440.1	---	12.75	7.08	12.49	6.94
	16-42	177.5	2450.9	3451.1	---	12.22	6.79		
17	17-41	177.2	3378.3	3381.1	3381.0	12.06	6.70	11.99	6.66
	17-42	176.8	3355.8	3358.2	3358.4	11.91	6.62		
18	18-41	177.0	3385.8	3386.3	3386.4	11.85	6.58	11.82	6.57
	18-42	177.5	3370.7	3371.3	3371.6	11.79	6.55		
19	19-41	177.7	3389.9	3391.2	3392.1	12.10	6.72	12.12	6.73
	19-42	177.8	3404.3	3405.7	3406.4	12.14	6.74		
20	20-41	177.4	3417.2	3418.6	3418.9	12.35	6.86	12.32	6.84
	20-42	178.1	3427.7	3429.1	3429.1	12.28	6.82		

Length Change (50% Relative Humidity)

Testing was performed to determine unrestrained length change. The ages given in the tables and figures are from the end of the initial 7-day moist curing period. Table 23 presents a summary of the length change data. Standard deviation was calculated for replicate specimens and presented in this table. Length change was calculated from a baseline established at the initial comparator reading. This initial comparator reading occurred at a specimen age of $24 \pm \frac{1}{2}$ hours after the addition of water to the cement during the mixing operation. An explanation of length change calculations is provided in Chapter 4. Length change at 812 days of drying ranged from (-) 0.0320 percent (Mix 16) to a high of (-) 0.0443 percent (Mix 7).

Figure 42 presents graphs of length change versus age for all mixtures. Figures 43 through 47 present graphs of length change versus age for each coarse aggregate source. The coarse aggregate source and cementitious blend along with w/cm ratio are noted in the figures.

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Table 23. Length Change Based on Initial Comparator Reading at Specimen Age of 24 Hours (50% Relative Humidity)

Mix No.	Specimen	Time after initial wet curing (days)																		
		Drying											Wetting							
		0	5	7	14	28	35 ¹	56	112	224	448	812	813	815	819	826	840	847	868	940
1	1	0.0030	-0.0050	-0.0060	-0.0100	-0.0150	-0.0182	-0.0230	-0.0300	-0.0360	-0.0380	-0.0400	-0.0210	-0.0190	-0.0170	-0.0140	-0.0140	-0.0140	-0.0130	-0.0110
	2	0.0030	-0.0040	-0.0060	-0.0090	-0.0140	-0.0177	-0.0220	-0.0310	-0.0360	-0.0390	-0.0410	-0.0230	-0.0190	-0.0190	-0.0140	-0.0130	-0.0150	-0.0130	-0.0110
	3	0.0020	-0.0060	-0.0080	-0.0120	-0.0170	-0.0207	-0.0250	-0.0340	-0.0390	-0.0410	-0.0440	-0.0250	-0.0220	-0.0200	-0.0170	-0.0170	-0.0170	-0.0170	-0.0140
	4	0.0030	-0.0040	-0.0060	-0.0100	-0.0150	-0.0177	-0.0210	-0.0290	-0.0340	-0.0360	-0.0380	-0.0190	-0.0170	-0.0160	-0.0120	-0.0120	-0.0130	-0.0120	-0.0090
	Avg	0.0028	-0.0048	-0.0065	-0.0102	-0.0153	-0.0186	-0.0228	-0.0310	-0.0363	-0.0385	-0.0408	-0.0220	-0.0193	-0.0180	-0.0143	-0.0140	-0.0148	-0.0138	-0.0113
	SD	0.0005	0.0010	0.0010	0.0013	0.0013	0.0015	0.0017	0.0022	0.0021	0.0021	0.0025	0.0026	0.0021	0.0018	0.0021	0.0022	0.0017	0.0022	0.0021
2	5	0.0030	-0.0050	-0.0080	-0.0120	-0.0190	-0.0212	-0.0270	-0.0310	-0.0360	-0.0370	-0.0400	-0.0240	-0.0210	-0.0180	-0.0180	-0.0170	-0.0170	-0.0170	-0.0140
	6	0.0040	-0.0050	-0.0060	-0.0100	-0.0180	-0.0198	-0.0250	-0.0320	-0.0360	-0.0370	-0.0390	-0.0230	-0.0210	-0.0170	-0.0170	-0.0160	-0.0160	-0.0160	-0.0110
	7	0.0040	-0.0050	-0.0070	-0.0130	-0.0190	-0.0222	-0.0280	-0.0330	-0.0390	-0.0400	-0.0430	-0.0270	-0.0250	-0.0230	-0.0220	-0.0200	-0.0200	-0.0190	-0.0180
	8	0.0050	-0.0040	-0.0070	-0.0100	-0.0180	-0.0199	-0.0260	-0.0310	-0.0360	-0.0370	-0.0400	-0.0220	-0.0210	-0.0190	-0.0170	-0.0170	-0.0170	-0.0180	-0.0150
	Avg	0.0040	-0.0047	-0.0070	-0.0113	-0.0185	-0.0208	-0.0265	-0.0318	-0.0368	-0.0378	-0.0405	-0.0240	-0.0220	-0.0193	-0.0185	-0.0175	-0.0175	-0.0175	-0.0145
	SD	0.0008	0.0005	0.0008	0.0015	0.0006	0.0011	0.0013	0.0010	0.0015	0.0015	0.0017	0.0022	0.0020	0.0026	0.0024	0.0017	0.0017	0.0013	0.0029
3	9	0.0020	-0.0060	-0.0110	-0.0110	-0.0180	-0.0197	-0.0240	-0.0300	-0.0340	-0.0360	-0.0370	-0.0180	-0.0170	-0.0160	-0.0150	-0.0150	-0.0150	-0.0160	-0.0110
	10	0.0050	-0.0040	-0.0100	-0.0100	-0.0180	-0.0192	-0.0230	-0.0300	-0.0340	-0.0350	-0.0380	-0.0170	-0.0160	-0.0150	-0.0150	-0.0140	-0.0130	-0.0140	-0.0080
	11	0.0050	-0.0050	-0.0090	-0.0110	-0.0170	-0.0191	-0.0230	-0.0290	-0.0340	-0.0360	-0.0380	-0.0180	-0.0160	-0.0160	-0.0150	-0.0150	-0.0140	-0.0150	-0.0100
	12	0.0040	-0.0070	-0.0110	-0.0120	-0.0190	-0.0202	-0.0240	-0.0310	-0.0360	-0.0370	-0.0390	-0.0190	-0.0190	-0.0180	-0.0170	-0.0180	-0.0160	-0.0150	-0.0110
	Avg	0.0040	-0.0055	-0.0103	-0.0110	-0.0180	-0.0196	-0.0235	-0.0300	-0.0345	-0.0360	-0.0380	-0.0180	-0.0170	-0.0163	-0.0155	-0.0155	-0.0145	-0.0150	-0.0100
	SD	0.0014	0.0013	0.0010	0.0008	0.0008	0.0005	0.0006	0.0008	0.0010	0.0008	0.0008	0.0008	0.0014	0.0013	0.0010	0.0017	0.0013	0.0008	0.0014
4	13	0.0060	0.0000	-0.0030	-0.0040	-0.0070	-0.0090	-0.0100	-0.0180	-0.0270	-0.0310	-0.0360	-0.0170	-0.0150	-0.0130	-0.0100	-0.0080	-0.0080	-0.0090	-0.0030
	14	0.0050	-0.0010	-0.0030	-0.0040	-0.0070	-0.0089	-0.0100	-0.0170	-0.0240	-0.0290	-0.0330	-0.0160	-0.0150	-0.0120	-0.0100	-0.0090	-0.0090	-0.0090	-0.0020
	15	0.0060	-0.0010	-0.0020	-0.0020	-0.0050	-0.0064	-0.0070	-0.0140	-0.0210	-0.0260	-0.0320	-0.0130	-0.0110	-0.0090	-0.0070	-0.0070	-0.0060	-0.0060	0.0010
	16	0.0090	0.0010	0.0010	0.0000	-0.0050	-0.0060	-0.0080	-0.0140	-0.0210	-0.0260	-0.0290	-0.0120	-0.0110	-0.0090	-0.0070	-0.0060	-0.0040	0.0020	0.0030
	Avg	0.0065	-0.0003	-0.0018	-0.0025	-0.0060	-0.0076	-0.0088	-0.0158	-0.0233	-0.0280	-0.0325	-0.0145	-0.0130	-0.0108	-0.0085	-0.0075	-0.0068	-0.0055	-0.0003
	SD	0.0017	0.0010	0.0019	0.0019	0.0012	0.0016	0.0015	0.0021	0.0029	0.0024	0.0029	0.0024	0.0023	0.0021	0.0017	0.0013	0.0022	0.0052	0.0028

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Mix No.	Speci-men	Time after initial wet curing (days)																		
		Drying											Wetting							
		0	5	7	14	28	35 ¹	56	112	224	448	812	813	815	819	826	840	847	868	940
5	17	0.0030	-0.0070	-0.0090	-0.0130	-0.0200	-0.0211	-0.0250	-0.0310	-0.0350	-0.0370	-0.0370	-0.0200	-0.0190	-0.0170	-0.0170	-0.0150	-0.0150	-0.0150	-0.0100
	18	0.0020	-0.0080	-0.0110	-0.0140	-0.0220	-0.0233	-0.0280	-0.0340	-0.0390	-0.0410	-0.0440	-0.0240	-0.0210	-0.0190	-0.0190	-0.0180	-0.0180	-0.0180	-0.0120
	19	0.0040	-0.0070	-0.0090	-0.0130	-0.0210	-0.0217	-0.0250	-0.0330	-0.0370	-0.0390	-0.0420	-0.0220	-0.0200	-0.0190	-0.0180	-0.0170	-0.0170	-0.0170	-0.0110
	20	0.0020	-0.0080	-0.0110	-0.0150	-0.0220	-0.0231	-0.0260	-0.0330	-0.0370	-0.0390	-0.0420	-0.0230	-0.0200	-0.0190	-0.0170	-0.0180	-0.0170	-0.0160	-0.0110
	Avg	0.0028	-0.0075	-0.0100	-0.0137	-0.0212	-0.0223	-0.0260	-0.0328	-0.0370	-0.0390	-0.0413	-0.0223	-0.0200	-0.0185	-0.0178	-0.0170	-0.0168	-0.0165	-0.0110
	SD	0.0010	0.0006	0.0012	0.0010	0.0010	0.0010	0.0014	0.0013	0.0016	0.0016	0.0030	0.0017	0.0008	0.0010	0.0010	0.0014	0.0013	0.0013	0.0008
6	21	0.0010	-0.0080	-0.0100	-0.0160	-0.0230	-0.0241	-0.0270	-0.0340	-0.0380	-0.0390	-0.0390	-0.0270	-0.0220	-0.0220	-0.0230	-0.0220	-0.0230	-0.0200	-0.0180
	22	0.0050	-0.0040	-0.0060	-0.0130	-0.0200	-0.0211	-0.0240	-0.0310	-0.0350	-0.0360	-0.0370	-0.0240	-0.0190	-0.0180	-0.0190	-0.0180	-0.0180	-0.0150	-0.0110
	23	0.0010	-0.0070	-0.0100	-0.0170	-0.0240	-0.0251	-0.0290	-0.0350	-0.0400	-0.0410	-0.0430	-0.0290	-0.0250	-0.0230	-0.0230	-0.0230	-0.0220	-0.0200	-0.0170
	24	0.0010	-0.0070	-0.0100	-0.0170	-0.0240	-0.0251	-0.0280	-0.0350	-0.0400	-0.0400	-0.0410	-0.0270	-0.0230	-0.0210	-0.0220	-0.0210	-0.0210	-0.0180	-0.0160
	Avg	0.0020	-0.0065	-0.0090	-0.0157	-0.0227	-0.0238	-0.0270	-0.0338	-0.0383	-0.0390	-0.0400	-0.0268	-0.0223	-0.0210	-0.0218	-0.0210	-0.0210	-0.0183	-0.0155
	SD	0.0020	0.0017	0.0020	0.0019	0.0019	0.0019	0.0022	0.0019	0.0024	0.0022	0.0026	0.0021	0.0025	0.0022	0.0019	0.0022	0.0022	0.0024	0.0031
7	25	0.0090	0.0000	-0.0080	-0.0160	-0.0240	-0.0246	-0.0290	-0.0340	-0.0390	-0.0390	-0.0410	-0.0270	-0.0240	-0.0200	-0.0200	-0.0190	-0.0190	-0.0170	-0.0130
	26	0.0030	-0.0070	-0.0140	-0.0210	-0.0300	-0.0301	-0.0340	-0.0390	-0.0420	-0.0420	-0.0440	-0.0290	-0.0250	-0.0230	-0.0240	-0.0220	-0.0210	-0.0200	-0.0150
	27	0.0030	-0.0070	-0.0150	-0.0220	-0.0310	-0.0312	-0.0360	-0.0410	-0.0450	-0.0460	-0.0480	-0.0320	-0.0270	-0.0250	-0.0260	-0.0250	-0.0240	-0.0220	-0.0170
	28	0.0020	-0.0070	-0.0140	-0.0210	-0.0290	-0.0296	-0.0340	-0.0390	-0.0420	-0.0430	-0.0440	-0.0290	-0.0250	-0.0230	-0.0230	-0.0220	-0.0220	-0.0190	-0.0160
	Avg	0.0043	-0.0052	-0.0127	-0.0200	-0.0285	-0.0289	-0.0333	-0.0383	-0.0420	-0.0425	-0.0443	-0.0292	-0.0253	-0.0228	-0.0233	-0.0220	-0.0215	-0.0195	-0.0152
	SD	0.0032	0.0035	0.0032	0.0027	0.0031	0.0029	0.0030	0.0030	0.0024	0.0029	0.0029	0.0021	0.0013	0.0021	0.0025	0.0024	0.0021	0.0021	0.0017
8	29	0.0050	-0.0040	-0.0060	-0.0100	-0.0140	-0.0160	-0.0190	-0.0240	-0.0310	-0.0350	-0.0370	-0.0210	-0.0160	-0.0140	-0.0130	-0.0100	-0.0100	-0.0110	-0.0020
	30	0.0040	-0.0040	-0.0070	-0.0100	-0.0140	-0.0161	-0.0190	-0.0250	-0.0320	-0.0360	-0.0390	-0.0230	-0.0170	-0.0160	-0.0150	-0.0130	-0.0130	-0.0130	-0.0070
	31	0.0060	-0.0020	-0.0040	-0.0090	-0.0120	-0.0139	-0.0160	-0.0210	-0.0280	-0.0320	-0.0340	-0.0190	-0.0120	-0.0120	-0.0100	-0.0070	-0.0070	-0.0090	0.0000
	32	0.0060	-0.0030	-0.0060	-0.0090	-0.0130	-0.0151	-0.0180	-0.0240	-0.0310	-0.0350	-0.0380	-0.0230	-0.0160	-0.0160	-0.0150	-0.0130	-0.0130	-0.0140	-0.0050
	Avg	0.0053	-0.0032	-0.0057	-0.0095	-0.0132	-0.0153	-0.0180	-0.0235	-0.0305	-0.0345	-0.0370	-0.0215	-0.0153	-0.0145	-0.0133	-0.0108	-0.0108	-0.0118	-0.0035
	SD	0.0010	0.0010	0.0013	0.0006	0.0010	0.0010	0.0014	0.0017	0.0017	0.0017	0.0022	0.0019	0.0022	0.0019	0.0024	0.0029	0.0029	0.0022	0.0031

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Mix No.	Speci-men	Time after initial wet curing (days)																		
		Drying											Wetting							
		0	5	7	14	28	35 ¹	56	112	224	448	812	813	815	819	826	840	847	868	940
9	33	0.0010	-0.0090	-0.0110	-0.0150	-0.0190	-0.0205	-0.0240	-0.0280	-0.0340	-0.0350	-0.0380	-0.0230	-0.0210	-0.0200	-0.0190	-0.0170	-0.0170	-0.0160	-0.0110
	34	0.0030	-0.0050	-0.0070	-0.0120	-0.0140	-0.0159	-0.0180	-0.0230	-0.0280	-0.0290	-0.0320	-0.0180	-0.0160	-0.0140	-0.0140	-0.0120	-0.0110	-0.0110	-0.0060
	35	0.0010	-0.0080	-0.0100	-0.0140	-0.0170	-0.0190	-0.0220	-0.0260	-0.0310	-0.0320	-0.0340	-0.0220	-0.0190	-0.0170	-0.0160	-0.0150	-0.0150	-0.0130	-0.0090
	36	0.0010	-0.0090	-0.0100	-0.0140	-0.0180	-0.0200	-0.0230	-0.0280	-0.0330	-0.0340	-0.0370	-0.0230	-0.0200	-0.0190	-0.0180	-0.0170	-0.0170	-0.0150	-0.0110
	Avg	0.0015	-0.0077	-0.0095	-0.0138	-0.0170	-0.0188	-0.0218	-0.0263	-0.0315	-0.0325	-0.0353	-0.0215	-0.0190	-0.0175	-0.0168	-0.0153	-0.0150	-0.0138	-0.0092
	SD	0.0010	0.0019	0.0017	0.0013	0.0022	0.0020	0.0026	0.0024	0.0026	0.0026	0.0028	0.0024	0.0022	0.0026	0.0022	0.0024	0.0028	0.0022	0.0024
10	37	0.0040	-0.0040	-0.0090	-0.0130	-0.0180	-0.0195	-0.0230	-0.0270	-0.0310	-0.0330	-0.0360	-0.0240	-0.0230	-0.0210	-0.0200	-0.0170	-0.0160	-0.0160	-0.0140
	38	0.0010	-0.0060	-0.0110	-0.0140	-0.0190	-0.0200	-0.0240	-0.0270	-0.0310	-0.0320	-0.0360	-0.0250	-0.0230	-0.0200	-0.0220	-0.0220	-0.0220	-0.0210	-0.0170
	39	0.0040	-0.0040	-0.0080	-0.0120	-0.0160	-0.0175	-0.0210	-0.0240	-0.0290	-0.0290	-0.0330	-0.0220	-0.0210	-0.0200	-0.0190	-0.0180	-0.0170	-0.0190	-0.0140
	40	0.0030	-0.0040	-0.0090	-0.0130	-0.0170	-0.0190	-0.0230	-0.0270	-0.0320	-0.0320	-0.0370	-0.0240	-0.0220	-0.0210	-0.0170	-0.0160	-0.0160	-0.0140	-0.0120
	Avg	0.0030	-0.0045	-0.0093	-0.0130	-0.0175	-0.0190	-0.0228	-0.0263	-0.0308	-0.0315	-0.0355	-0.0238	-0.0223	-0.0205	-0.0195	-0.0183	-0.0178	-0.0175	-0.0143
	SD	0.0014	0.0010	0.0013	0.0008	0.0013	0.0011	0.0013	0.0015	0.0013	0.0017	0.0017	0.0013	0.0010	0.0006	0.0021	0.0026	0.0029	0.0031	0.0021
11	41	0.0030	-0.0060	-0.0120	-0.0190	-0.0240	-0.0250	-0.0290	-0.0320	-0.0360	-0.0360	-0.0410	-0.0290	-0.0270	-0.0240	-0.0220	-0.0200	-0.0200	-0.0200	-0.0150
	42	0.0030	-0.0040	-0.0120	-0.0180	-0.0250	-0.0260	-0.0310	-0.0340	-0.0390	-0.0400	-0.0420	-0.0310	-0.0280	-0.0270	-0.0250	-0.0240	-0.0240	-0.0240	-0.0190
	43	0.0010	-0.0070	-0.0140	-0.0210	-0.0270	-0.0281	-0.0320	-0.0360	-0.0390	-0.0400	-0.0440	-0.0320	-0.0280	-0.0260	-0.0250	-0.0240	-0.0240	-0.0240	-0.0190
	44	0.0030	-0.0060	-0.0120	-0.0190	-0.0250	-0.0265	-0.0310	-0.0340	-0.0380	-0.0380	-0.0430	-0.0300	-0.0290	-0.0260	-0.0250	-0.0230	-0.0230	-0.0220	-0.0180
	Avg	0.0025	-0.0057	-0.0125	-0.0192	-0.0252	-0.0264	-0.0308	-0.0340	-0.0380	-0.0385	-0.0425	-0.0305	-0.0280	-0.0258	-0.0243	-0.0228	-0.0228	-0.0225	-0.0177
	SD	0.0010	0.0013	0.0010	0.0013	0.0013	0.0013	0.0013	0.0016	0.0014	0.0019	0.0013	0.0013	0.0008	0.0013	0.0015	0.0019	0.0019	0.0019	0.0019
12	45	0.0030	-0.0060	-0.0070	-0.0090	-0.0130	-0.0144	-0.0170	-0.0220	-0.0270	-0.0310	-0.0370	-0.0240	-0.0200	-0.0170	-0.0170	-0.0150	-0.0120	-0.0110	-0.0080
	46	0.0070	-0.0020	-0.0040	-0.0050	-0.0100	-0.0111	-0.0140	-0.0190	-0.0250	-0.0290	-0.0360	-0.0230	-0.0200	-0.0150	-0.0150	-0.0130	-0.0100	-0.0090	-0.0070
	47	0.0050	-0.0040	-0.0050	-0.0080	-0.0110	-0.0135	-0.0160	-0.0220	-0.0270	-0.0310	-0.0370	-0.0230	-0.0190	-0.0160	-0.0160	-0.0140	-0.0120	-0.0100	-0.0080
	48	0.0040	-0.0030	-0.0050	-0.0070	-0.0110	-0.0124	-0.0150	-0.0190	-0.0240	-0.0270	-0.0320	-0.0190	-0.0150	-0.0120	-0.0120	-0.0110	-0.0070	-0.0070	-0.0040
	Avg	0.0047	-0.0038	-0.0052	-0.0073	-0.0113	-0.0129	-0.0155	-0.0205	-0.0258	-0.0295	-0.0355	-0.0223	-0.0185	-0.0150	-0.0150	-0.0133	-0.0103	-0.0092	-0.0067
	SD	0.0017	0.0017	0.0013	0.0017	0.0013	0.0014	0.0013	0.0017	0.0015	0.0019	0.0024	0.0022	0.0024	0.0022	0.0022	0.0017	0.0024	0.0017	0.0019

Final Report

Mix No.	Speci-men	Time after initial wet curing (days)																		
		Drying											Wetting							
		0	5	7	14	28	35 ¹	56	112	224	448	812	813	815	819	826	840	847	868	940
13	49	-0.0010	-0.0080	-0.0100	-0.0120	-0.0180	-0.0212	-0.0270	-0.0320	-0.0390	-0.0390	-0.0430	-0.0290	-0.0230	-0.0210	-0.0200	-0.0180	-0.0200	-0.0160	-0.0130
	50	0.0000	-0.0070	-0.0090	-0.0110	-0.0160	-0.0186	-0.0230	-0.0280	-0.0340	-0.0330	-0.0360	-0.0210	-0.0160	-0.0140	-0.0130	-0.0110	-0.0110	-0.0050	-0.0080
	51	0.0000	-0.0080	-0.0100	-0.0130	-0.0180	-0.0207	-0.0260	-0.0310	-0.0360	-0.0370	-0.0400	-0.0290	-0.0230	-0.0220	-0.0220	-0.0170	-0.0210	-0.0160	-0.0130
	52	0.0000	-0.0080	-0.0090	-0.0120	-0.0170	-0.0197	-0.0250	-0.0300	-0.0360	-0.0370	-0.0400	-0.0280	-0.0220	-0.0210	-0.0210	-0.0150	-0.0190	-0.0140	-0.0120
	Avg	-0.0002	-0.0077	-0.0095	-0.0120	-0.0173	-0.0201	-0.0253	-0.0303	-0.0363	-0.0365	-0.0398	-0.0268	-0.0210	-0.0195	-0.0190	-0.0153	-0.0178	-0.0127	-0.0115
	SD	0.0005	0.0005	0.0006	0.0008	0.0010	0.0012	0.0017	0.0017	0.0021	0.0025	0.0029	0.0039	0.0034	0.0037	0.0041	0.0031	0.0046	0.0053	0.0024
14	53	0.0010	-0.0040	-0.0080	-0.0110	-0.0160	-0.0181	-0.0230	-0.0260	-0.0310	-0.0310	-0.0350	-0.0260	-0.0200	-0.0190	-0.0160	-0.0210	-0.0180	-0.0150	-0.0120
	54	0.0020	-0.0020	-0.0070	-0.0100	-0.0150	-0.0165	-0.0200	-0.0240	-0.0280	-0.0290	-0.0320	-0.0240	-0.0200	-0.0170	-0.0160	-0.0170	-0.0140	-0.0120	-0.0100
	55	0.0010	-0.0040	-0.0070	-0.0100	-0.0140	-0.0165	-0.0200	-0.0250	-0.0280	-0.0290	-0.0330	-0.0240	-0.0180	-0.0180	-0.0160	-0.0190	-0.0150	-0.0130	-0.0100
	56	0.0010	-0.0040	-0.0080	-0.0110	-0.0170	-0.0191	-0.0240	-0.0280	-0.0310	-0.0320	-0.0350	-0.0260	-0.0200	-0.0200	-0.0180	-0.0200	-0.0180	-0.0160	-0.0120
	Avg	0.0013	-0.0035	-0.0075	-0.0105	-0.0155	-0.0175	-0.0218	-0.0258	-0.0295	-0.0303	-0.0338	-0.0250	-0.0195	-0.0185	-0.0165	-0.0193	-0.0163	-0.0140	-0.0110
	SD	0.0005	0.0010	0.0006	0.0006	0.0013	0.0013	0.0021	0.0017	0.0017	0.0015	0.0015	0.0012	0.0010	0.0013	0.0010	0.0017	0.0021	0.0018	0.0012
15	57	0.0010	-0.0090	-0.0120	-0.0160	-0.0210	-0.0220	-0.0260	-0.0290	-0.0340	-0.0340	-0.0360	-0.0240	-0.0210	-0.0200	-0.0200	-0.0170	-0.0170	-0.0180	-0.0130
	58	0.0010	-0.0080	-0.0110	-0.0150	-0.0210	-0.0225	-0.0270	-0.0300	-0.0340	-0.0340	-0.0390	-0.0260	-0.0230	-0.0220	-0.0200	-0.0190	-0.0200	-0.0150	-0.0140
	59	0.0010	-0.0080	-0.0100	-0.0150	-0.0200	-0.0220	-0.0260	-0.0300	-0.0330	-0.0330	-0.0300	-0.0230	-0.0200	-0.0190	-0.0170	-0.0150	-0.0150	-0.0100	-0.0090
	60	0.0000	-0.0090	-0.0110	-0.0150	-0.0200	-0.0211	-0.0240	-0.0290	-0.0330	-0.0330	-0.0370	-0.0250	-0.0220	-0.0210	-0.0200	-0.0170	-0.0170	-0.0130	-0.0120
	Avg	0.0008	-0.0085	-0.0110	-0.0153	-0.0205	-0.0219	-0.0258	-0.0295	-0.0335	-0.0335	-0.0355	-0.0245	-0.0215	-0.0205	-0.0193	-0.0170	-0.0173	-0.0140	-0.0120
	SD	0.0005	0.0006	0.0008	0.0005	0.0006	0.0006	0.0013	0.0006	0.0006	0.0006	0.0039	0.0013	0.0013	0.0013	0.0015	0.0016	0.0021	0.0034	0.0022
16	61	0.0060	0.0000	-0.0020	-0.0040	-0.0070	-0.0084	-0.0100	-0.0150	-0.0200	-0.0240	-0.0280	-0.0160	-0.0120	-0.0120	-0.0100	-0.0090	-0.0080	-0.0020	0.0000
	62	0.0040	-0.0020	-0.0050	-0.0060	-0.0090	-0.0109	-0.0130	-0.0190	-0.0240	-0.0290	-0.0350	-0.0220	-0.0170	-0.0160	-0.0150	-0.0130	-0.0130	-0.0080	-0.0050
	63	0.0050	-0.0010	-0.0040	-0.0040	-0.0070	-0.0089	-0.0110	-0.0170	-0.0230	-0.0270	-0.0330	-0.0200	-0.0160	-0.0150	-0.0140	-0.0110	-0.0110	-0.0060	-0.0030
	64	0.0050	-0.0010	-0.0020	-0.0040	-0.0080	-0.0090	-0.0110	-0.0160	-0.0220	-0.0270	-0.0320	-0.0190	-0.0140	-0.0130	-0.0110	-0.0100	-0.0100	-0.0050	-0.0010
	Avg	0.0050	-0.0010	-0.0033	-0.0045	-0.0078	-0.0093	-0.0113	-0.0168	-0.0223	-0.0268	-0.0320	-0.0193	-0.0148	-0.0140	-0.0125	-0.0108	-0.0105	-0.0052	-0.0022
	SD	0.0008	0.0008	0.0015	0.0010	0.0010	0.0011	0.0013	0.0017	0.0017	0.0021	0.0029	0.0025	0.0022	0.0018	0.0024	0.0017	0.0021	0.0025	0.0022

Final Report

Mix No.	Speci-men	Time after initial wet curing (days)																		
		Drying											Wetting							
		0	5	7	14	28	35 ¹	56	112	224	448	812	813	815	819	826	840	847	868	940
17	65	0.0020	-0.0030	-0.0060	-0.0100	-0.0170	-0.0188	-0.0230	-0.0300	-0.0380	-0.0400	-0.0440	-0.0300	-0.0250	-0.0220	-0.0180	-0.0190	-0.0180	-0.0140	-0.0130
	66	0.0020	-0.0020	-0.0050	-0.0100	-0.0140	-0.0172	-0.0210	-0.0290	-0.0360	-0.0380	-0.0410	-0.0300	-0.0230	-0.0210	-0.0160	-0.0170	-0.0180	-0.0140	-0.0120
	67	0.0020	-0.0030	-0.0060	-0.0100	-0.0160	-0.0187	-0.0230	-0.0310	-0.0370	-0.0400	-0.0450	-0.0320	-0.0260	-0.0240	-0.0200	-0.0220	-0.0200	-0.0160	-0.0140
	68	0.0020	-0.0020	-0.0040	-0.0090	-0.0150	-0.0172	-0.0210	-0.0280	-0.0330	-0.0360	-0.0400	-0.0270	-0.0210	-0.0190	-0.0160	-0.0160	-0.0150	-0.0120	-0.0090
	Avg	0.0020	-0.0025	-0.0053	-0.0098	-0.0155	-0.0180	-0.0220	-0.0295	-0.0360	-0.0385	-0.0425	-0.0298	-0.0238	-0.0215	-0.0175	-0.0185	-0.0178	-0.0140	-0.0120
	SD	0.0000	0.0006	0.0010	0.0005	0.0013	0.0009	0.0012	0.0013	0.0022	0.0019	0.0024	0.0021	0.0022	0.0021	0.0019	0.0026	0.0021	0.0016	0.0022
18	69	0.0010	-0.0070	-0.0080	-0.0120	-0.0190	-0.0207	-0.0250	-0.0310	-0.0370	-0.0390	-0.0430	-0.0300	-0.0220	-0.0240	-0.0230	-0.0190	-0.0200	-0.0200	-0.0170
	70	0.0010	-0.0070	-0.0080	-0.0120	-0.0180	-0.0196	-0.0230	-0.0300	-0.0360	-0.0380	-0.0420	-0.0290	-0.0260	-0.0220	-0.0250	-0.0210	-0.0210	-0.0190	-0.0160
	71	0.0010	-0.0070	-0.0090	-0.0140	-0.0190	-0.0216	-0.0260	-0.0310	-0.0370	-0.0400	-0.0440	-0.0320	-0.0270	-0.0260	-0.0270	-0.0230	-0.0220	-0.0210	-0.0180
	72	0.0010	-0.0060	-0.0080	-0.0120	-0.0170	-0.0196	-0.0230	-0.0300	-0.0350	-0.0350	-0.0390	-0.0280	-0.0250	-0.0210	-0.0240	-0.0200	-0.0190	-0.0170	-0.0150
	Avg	0.0010	-0.0068	-0.0083	-0.0125	-0.0183	-0.0204	-0.0243	-0.0305	-0.0363	-0.0380	-0.0420	-0.0298	-0.0250	-0.0233	-0.0248	-0.0208	-0.0205	-0.0193	-0.0165
	SD	0.0000	0.0005	0.0005	0.0010	0.0010	0.0009	0.0015	0.0006	0.0010	0.0022	0.0022	0.0017	0.0022	0.0022	0.0017	0.0017	0.0013	0.0017	0.0013
19	73	0.0030	-0.0040	-0.0070	-0.0110	-0.0170	-0.0197	-0.0250	-0.0310	-0.0350	-0.0380	-0.0410	-0.0260	-0.0220	-0.0200	-0.0210	-0.0150	-0.0160	-0.0130	-0.0130
	74	0.0030	-0.0040	-0.0080	-0.0120	-0.0170	-0.0202	-0.0250	-0.0320	-0.0350	-0.0390	-0.0420	-0.0280	-0.0250	-0.0200	-0.0200	-0.0170	-0.0190	-0.0170	-0.0150
	75	0.0020	-0.0060	-0.0090	-0.0140	-0.0200	-0.0222	-0.0270	-0.0330	-0.0380	-0.0410	-0.0450	-0.0300	-0.0260	-0.0220	-0.0230	-0.0190	-0.0180	-0.0170	-0.0160
	76	0.0030	-0.0040	-0.0080	-0.0120	-0.0180	-0.0209	-0.0260	-0.0330	-0.0380	-0.0400	-0.0450	-0.0300	-0.0270	-0.0220	-0.0230	-0.0190	-0.0200	-0.0180	-0.0150
	Avg	0.0027	-0.0045	-0.0080	-0.0123	-0.0180	-0.0208	-0.0258	-0.0323	-0.0365	-0.0395	-0.0433	-0.0285	-0.0250	-0.0210	-0.0218	-0.0175	-0.0183	-0.0163	-0.0148
	SD	0.0005	0.0010	0.0008	0.0013	0.0014	0.0011	0.0010	0.0010	0.0017	0.0013	0.0021	0.0019	0.0022	0.0012	0.0015	0.0019	0.0017	0.0022	0.0013
20	77	0.0020	-0.0030	-0.0030	-0.0050	-0.0070	-0.0089	-0.0110	-0.0160	-0.0230	-0.0300	-0.0380	-0.0290	-0.0180	-0.0170	-0.0180	-0.0130	-0.0120	-0.0100	-0.0080
	78	0.0040	-0.0020	-0.0020	-0.0040	-0.0060	-0.0079	-0.0100	-0.0150	-0.0220	-0.0290	-0.0360	-0.0250	-0.0180	-0.0170	-0.0180	-0.0110	-0.0110	-0.0070	-0.0050
	79	0.0020	-0.0030	-0.0040	-0.0060	-0.0080	-0.0099	-0.0110	-0.0170	-0.0230	-0.0300	-0.0330	-0.0250	-0.0180	-0.0140	-0.0130	-0.0090	-0.0110	-0.0070	-0.0060
	80	0.0030	-0.0030	-0.0030	-0.0050	-0.0060	-0.0089	-0.0110	-0.0160	-0.0230	-0.0290	-0.0370	-0.0270	-0.0180	-0.0150	-0.0180	-0.0120	-0.0110	-0.0080	-0.0070
	Avg	0.0027	-0.0028	-0.0030	-0.0050	-0.0068	-0.0089	-0.0108	-0.0160	-0.0228	-0.0295	-0.0360	-0.0265	-0.0180	-0.0158	-0.0168	-0.0113	-0.0113	-0.0080	-0.0065
	SD	0.0010	0.0005	0.0008	0.0008	0.0010	0.0008	0.0005	0.0008	0.0005	0.0006	0.0022	0.0019	0.0000	0.0015	0.0025	0.0017	0.0005	0.0014	0.0013

Note 1: Comparator readings were not taken at 35 days. Values shown were based on equations derived from best fitting curves. See Chapter 4 for details.

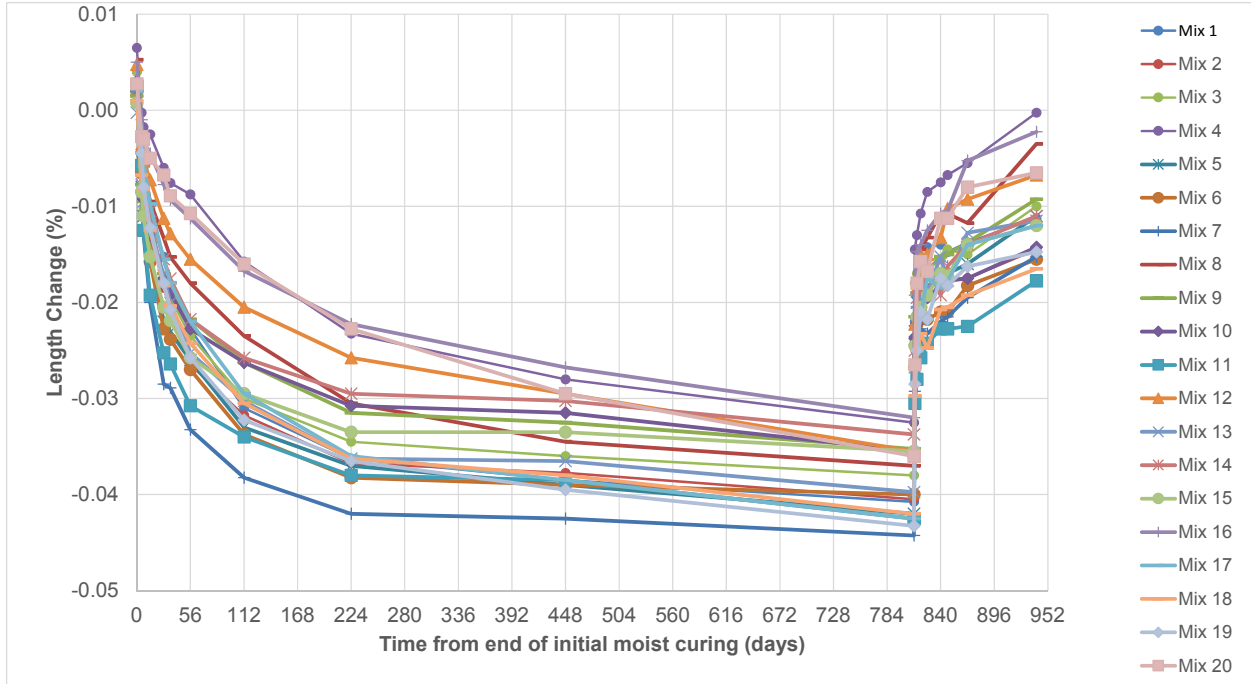


Figure 42. Length Change VS Drying Time (All Mixes)

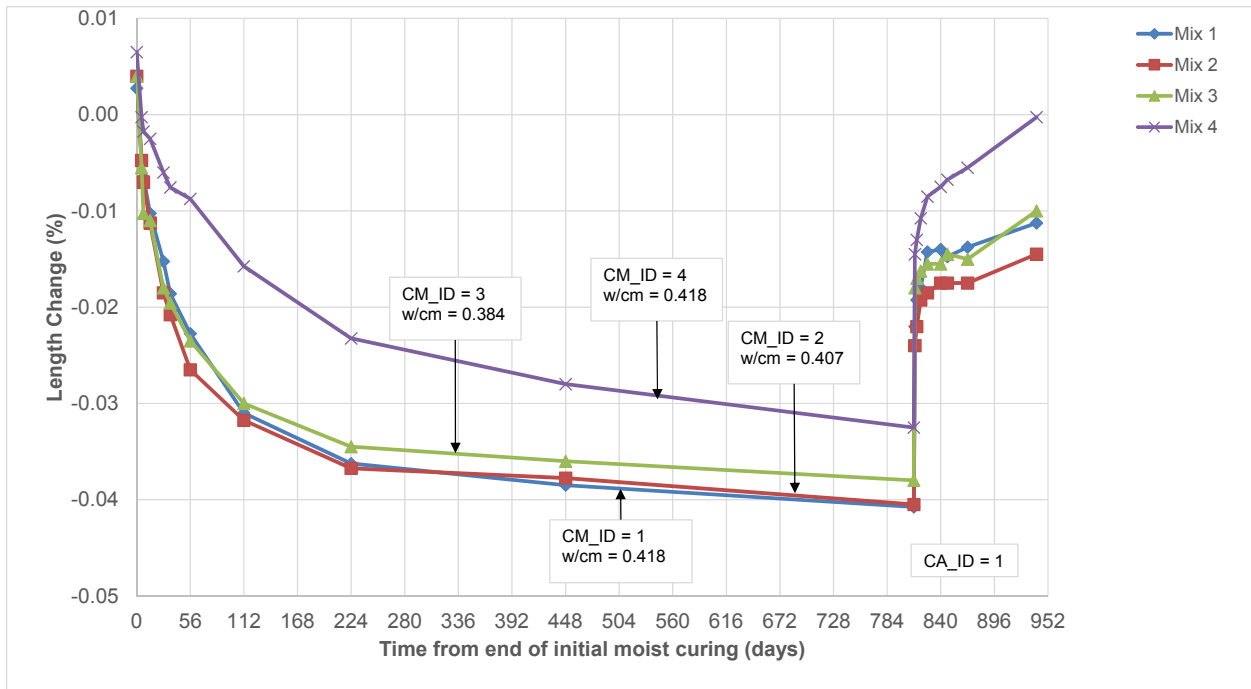


Figure 43. Length Change VS Drying Time - Mixes 1 through 4 (CA_ID1)

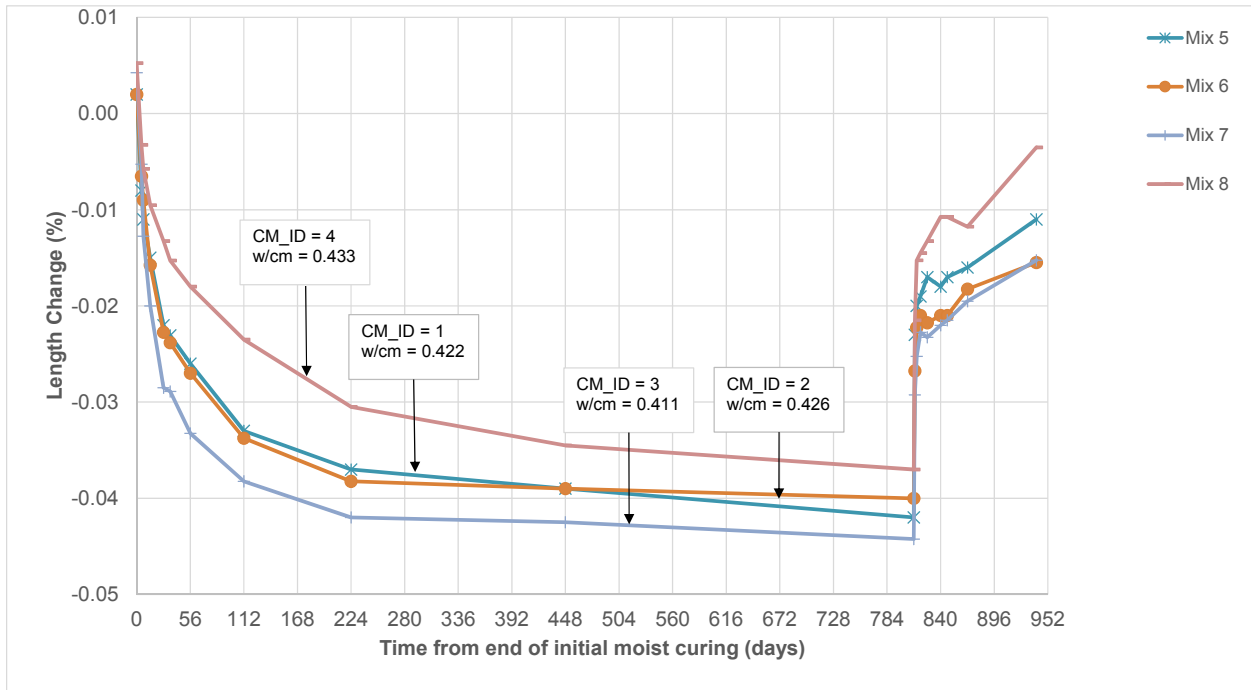


Figure 44. Length Change VS Drying Time - Mixes 5 through 8 (CA_ID2)

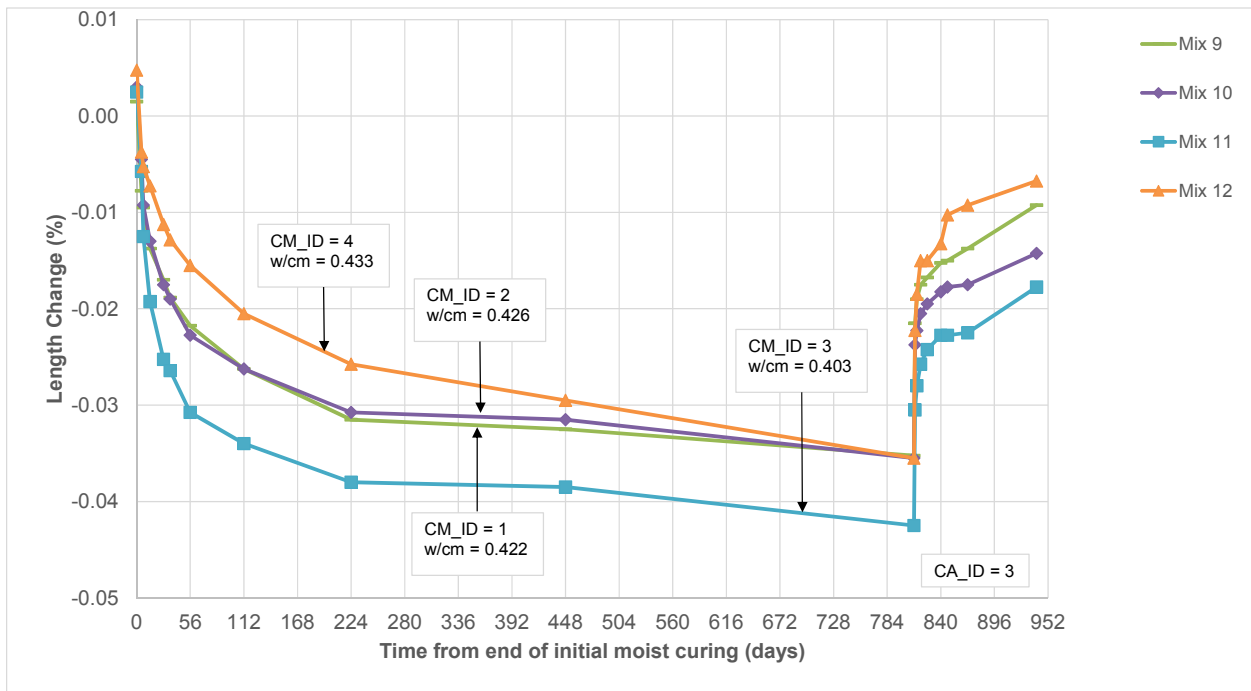


Figure 45. Length Change VS Drying Time - Mixes 9 through 12 (CA_ID3)

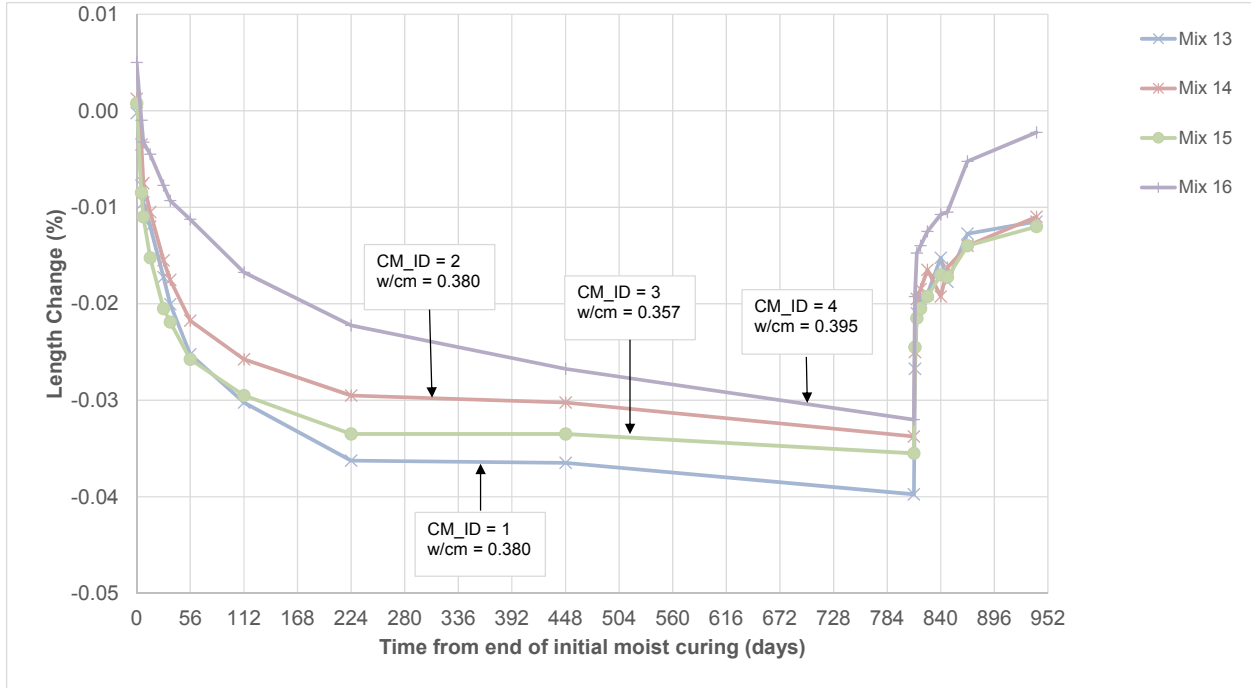


Figure 46. Length Change VS Drying Time – Mixes 13 through 16 (CA_ID4)

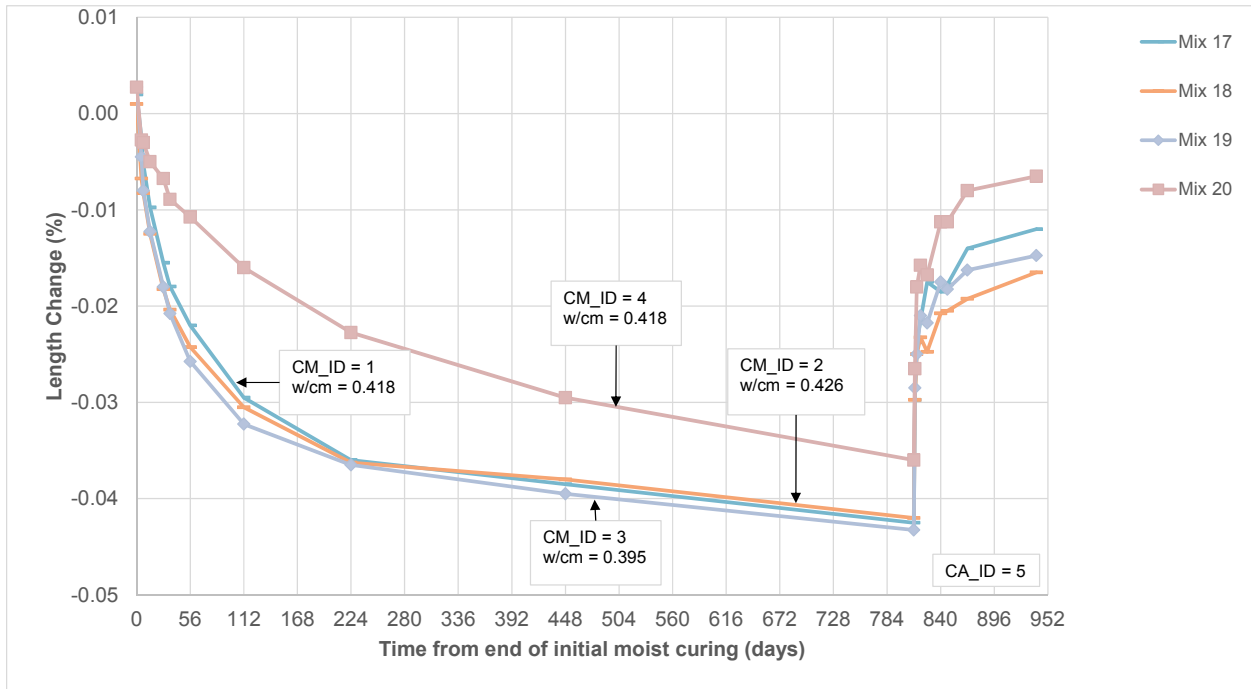


Figure 47. Length Change VS Drying Time - Mixes 17 through 20 (CA_ID5)

Shrinkage Strain (50% RH)

Shrinkage strain is presented in Table 24. Standard deviation was calculated and presented in this table as well. These shrinkage strain calculations are based on comparator readings at the end of initial 7-day moist curing period. The specimens were then stored in a control room with temperatures of $73^{\circ} \pm 3^{\circ}$ F and relative humidity of 50 ± 4 percent. An explanation of shrinkage strain calculations is provided in Chapter 4. Shrinkage strain determined at 812 after the end of initial moist curing ranged from 350×10^{-6} (Mix 14) to a high of 485×10^{-6} (Mix 7).

Figure 48 presents graphs of shrinkage strain versus time from the end of the initial moist curing period for all mixtures. Figures 49 through 53 present graphs of shrinkage strain versus time from the end of the initial moist curing period for each coarse aggregate source. The coarse aggregate source, cementitious blend, and w/cm ratio are noted within the figures.

Table 24. Negative Shrinkage Strain x 10⁻⁶ Measured From End of Initial Curing (50% RH)

Mix No.	Speci -men	Time after initial wet curing (days)																		
		Drying											Wetting							
		0	5	7	14	28	35 ¹	56	112	224	448	812	813	815	819	826	840	847	868	940
1	1	0	80	90	130	180	213	260	330	390	410	430	240	220	200	170	170	170	160	140
	2	0	70	90	120	170	207	250	340	390	420	440	260	220	220	170	160	180	160	140
	3	0	80	100	140	190	227	270	360	410	430	460	270	240	220	190	190	190	190	160
	4	0	70	90	130	180	206	240	320	370	390	410	220	200	190	150	150	160	150	120
	Avg	0	75	92	130	180	213	255	338	390	413	435	248	220	208	170	168	175	165	140
	SD	0	6	5	8	8	10	13	17	16	17	21	22	16	15	16	17	13	17	16
2	5	0	80	110	150	220	241	300	340	390	400	430	270	240	210	210	200	200	200	170
	6	0	90	100	140	220	240	290	360	400	410	430	270	250	210	210	200	200	200	150
	7	0	90	110	170	230	260	320	370	430	440	470	310	290	270	260	240	240	230	220
	8	0	90	120	150	230	250	310	360	410	420	450	270	260	240	220	220	220	230	200
	Avg	0	87	110	153	225	248	305	358	408	418	445	280	260	233	225	215	215	215	185
	SD	0	5	8	13	6	10	13	13	17	17	19	20	22	29	24	19	19	17	31
3	9	0	80	130	130	200	216	260	320	360	380	390	200	190	180	170	170	170	180	130
	10	0	90	150	150	230	241	280	350	390	400	430	220	210	200	200	190	180	190	130
	11	0	100	140	160	220	239	280	340	390	410	430	230	210	210	200	200	190	200	150
	12	0	110	150	160	230	244	280	350	400	410	430	230	230	220	210	220	200	190	150
	Avg	0	95	143	150	220	235	275	340	385	400	420	220	210	203	195	195	185	190	140
	SD	0	13	10	14	14	13	10	14	17	14	20	14	16	17	17	21	13	8	12
4	13	0	60	90	100	130	149	160	240	330	370	420	230	210	190	160	140	140	150	90
	14	0	60	80	90	120	138	150	220	290	340	380	210	200	170	150	140	140	140	70
	15	0	70	80	80	110	123	130	200	270	320	380	190	170	150	130	130	120	120	50
	16	0	80	80	90	140	149	170	230	300	350	380	210	200	180	160	150	130	70	60
	Avg	0	68	83	90	125	140	153	223	298	345	390	210	195	173	150	140	133	120	67
	SD	0	10	5	8	13	12	17	17	25	21	20	16	17	17	14	8	10	36	17

Final Report

Mix No.	Speci -men	Time after initial wet curing (days)																		
		Drying											Wetting							
		0	5	7	14	28	35 ¹	56	112	224	448	812	813	815	819	826	840	847	868	940
5	17	0	100	120	160	230	242	280	340	380	400	400	230	220	200	200	180	180	180	130
	18	0	100	130	160	240	253	300	360	410	430	460	260	230	210	210	200	200	200	140
	19	0	110	130	170	250	259	290	370	410	430	460	260	240	230	220	210	210	210	150
	20	0	100	130	170	240	250	280	350	390	410	440	250	220	210	190	200	190	180	130
	Avg	0	103	127	165	240	251	288	355	398	418	440	250	228	213	205	198	195	193	137
	SD	0	5	5	6	8	7	10	13	15	15	28	14	10	13	13	13	13	15	10
6	21	0	90	110	170	240	250	280	350	390	400	400	280	230	230	240	230	240	210	190
	22	0	90	110	180	250	260	290	360	400	410	420	290	240	230	240	230	230	200	160
	23	0	80	110	180	250	262	300	360	410	420	440	300	260	240	240	240	230	210	180
	24	0	80	110	180	250	260	290	360	410	410	420	280	240	220	230	220	220	190	170
	Avg	0	85	110	178	247	258	290	358	403	410	420	288	243	230	238	230	230	203	175
	SD	0	6	0	5	5	5	8	5	10	8	16	10	13	8	5	8	8	10	13
7	25	0	90	170	250	330	337	380	430	480	480	500	360	330	290	290	280	280	260	220
	26	0	100	170	240	330	330	370	420	450	450	470	320	280	260	270	250	240	230	180
	27	0	100	180	250	340	344	390	440	480	490	510	350	300	280	290	280	270	250	200
	28	0	90	160	230	310	317	360	410	440	450	460	310	270	250	250	240	240	210	180
	Avg	0	95	170	242	327	332	375	425	462	468	485	335	295	270	275	263	258	237	195
	SD	0	6	8	10	13	12	13	13	21	21	24	24	26	18	19	21	21	22	19
8	29	0	90	110	150	190	209	240	290	360	400	420	260	210	190	180	150	150	160	70
	30	0	80	110	140	180	201	230	290	360	400	430	270	210	200	190	170	170	170	110
	31	0	80	100	150	180	198	220	270	340	380	400	250	180	180	160	130	130	150	60
	32	0	90	120	150	190	211	240	300	370	410	440	290	220	220	210	190	190	200	110
	Avg	0	85	110	147	185	205	233	288	358	398	423	268	205	198	185	160	160	170	87
	SD	0	6	8	5	6	6	10	13	13	13	17	17	17	17	21	26	26	22	26

Final Report

Mix No.	Speci -men	Time after initial wet curing (days)																		
		Drying											Wetting							
		0	5	7	14	28	35 ¹	56	112	224	448	812	813	815	819	826	840	847	868	940
9	33	0	100	120	160	200	209	250	290	350	360	390	240	220	210	200	180	180	170	120
	34	0	80	100	150	170	191	210	260	310	320	350	210	190	170	170	150	140	140	90
	35	0	90	110	150	180	200	230	270	320	330	350	230	200	180	170	160	160	140	100
	36	0	100	110	150	190	209	240	290	340	350	380	240	210	200	190	180	180	160	120
	Avg	0	93	110	153	185	202	233	278	330	340	368	230	205	190	183	168	165	153	108
	SD	0	10	8	5	13	9	17	15	18	18	21	14	13	18	15	15	19	15	15
10	37	0	80	130	170	220	234	270	310	350	370	400	280	270	250	240	210	200	200	180
	38	0	70	120	150	200	212	250	280	320	330	370	260	240	210	230	230	230	220	180
	39	0	80	120	160	200	215	250	280	330	330	370	260	250	240	230	220	210	230	180
	40	0	70	120	160	200	221	260	300	350	350	400	270	250	240	200	190	190	170	150
	Avg	0	75	123	160	205	221	258	293	338	345	385	268	253	235	225	213	208	205	173
	SD	0	6	5	8	10	10	10	15	15	19	17	10	13	17	17	17	17	26	15
11	41	0	90	150	220	270	282	320	350	390	390	440	320	300	270	250	230	230	230	180
	42	0	70	150	210	280	290	340	370	420	430	450	340	310	300	280	270	270	270	220
	43	0	80	150	220	280	291	330	370	400	410	450	330	290	270	260	250	250	250	200
	44	0	90	150	220	280	293	340	370	410	410	460	330	320	290	280	260	260	250	210
	Avg	0	83	150	218	277	289	333	365	405	410	450	330	305	283	268	253	253	250	203
	SD	0	10	0	5	5	5	10	10	13	16	8	8	13	15	15	17	17	16	17
12	45	0	90	100	120	160	175	200	250	300	340	400	270	230	200	200	180	150	140	110
	46	0	90	110	120	170	182	210	260	320	360	430	300	270	220	220	200	170	160	140
	47	0	90	100	130	160	184	210	270	320	360	420	280	240	210	210	190	170	150	130
	48	0	70	90	110	150	163	190	230	280	310	360	230	190	160	160	150	110	110	80
	Avg	0	85	100	120	160	176	203	253	305	343	403	270	233	198	198	180	150	140	115
	SD	0	10	8	8	8	10	10	17	19	24	31	29	33	26	26	22	28	22	26

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Mix No.	Speci -men	Time after initial wet curing (days)																		
		Drying											Wetting							
		0	5	7	14	28	35 ¹	56	112	224	448	812	813	815	819	826	840	847	868	940
13	49	0	70	90	110	170	200	260	310	380	380	420	280	220	200	190	170	190	150	120
	50	0	70	90	110	160	185	230	280	340	330	360	210	160	140	130	110	110	50	80
	51	0	80	100	130	180	209	260	310	360	370	400	290	230	220	220	170	210	160	130
	52	0	80	90	120	170	199	250	300	360	370	400	280	220	210	210	150	190	140	120
	Avg	0	75	92	118	170	198	250	300	360	363	395	265	208	193	188	150	175	125	113
	SD	0	6	5	10	8	10	14	14	16	22	25	37	32	36	40	28	44	51	22
14	53	0	50	90	120	170	191	240	270	320	320	360	270	210	200	170	220	190	160	130
	54	0	40	90	120	170	184	220	260	300	310	340	260	220	190	180	190	160	140	120
	55	0	50	80	110	150	173	210	260	290	300	340	250	190	190	170	200	160	140	110
	56	0	50	90	120	180	200	250	290	320	330	360	270	210	210	190	210	190	170	130
	Avg	0	48	87	118	168	187	230	270	308	315	350	263	208	198	178	205	175	153	123
	SD	0	5	5	5	13	11	18	14	15	13	12	10	13	10	10	13	17	15	10
15	57	0	100	130	170	220	232	270	300	350	350	370	250	220	210	210	180	180	190	140
	58	0	90	120	160	220	233	280	310	350	350	400	270	240	230	210	200	210	160	150
	59	0	90	110	160	210	228	270	310	340	340	310	240	210	200	180	160	160	110	100
	60	0	90	110	150	200	212	240	290	330	330	370	250	220	210	200	170	170	130	120
	Avg	0	93	118	160	213	226	265	303	343	343	363	253	223	213	200	178	180	148	128
	SD	0	5	10	8	10	10	17	10	10	10	38	13	13	13	14	17	22	35	22
16	61	0	60	80	100	130	144	160	210	260	300	340	220	180	180	160	150	140	80	60
	62	0	60	90	100	130	150	170	230	280	330	390	260	210	200	190	170	170	120	90
	63	0	60	90	90	120	140	160	220	280	320	380	250	210	200	190	160	160	110	80
	64	0	60	70	90	130	141	160	210	270	320	370	240	190	180	160	150	150	100	60
	Avg	0	60	83	95	128	143	163	218	273	318	370	243	198	190	175	158	155	103	73
	SD	0	0	10	6	5	5	5	10	10	13	22	17	15	12	17	10	13	17	15

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Mix No.	Speci-men	Time after initial wet curing (days)																		
		Drying											Wetting							
		0	5	7	14	28	35 ¹	56	112	224	448	812	813	815	819	826	840	847	868	940
17	65	0	50	80	120	190	208	250	320	400	420	460	320	270	240	200	210	200	160	150
	66	0	40	70	120	160	194	230	310	380	400	430	320	250	230	180	190	200	160	140
	67	0	50	80	120	180	208	250	330	390	420	470	340	280	260	220	240	220	180	160
	68	0	40	60	110	170	191	230	300	350	380	420	290	230	210	180	180	170	140	110
	Avg	0	45	73	118	175	200	240	315	380	405	445	318	258	235	195	205	198	160	140
	SD	0	6	10	5	13	9	12	13	22	19	24	21	22	21	19	26	21	16	22
18	69	0	80	90	130	200	216	260	320	380	400	440	310	230	250	240	200	210	210	180
	70	0	80	90	130	190	207	240	310	370	390	430	300	270	230	260	220	220	200	170
	71	0	80	100	150	200	225	270	320	380	410	450	330	280	270	280	240	230	220	190
	72	0	70	90	130	180	204	240	310	360	360	400	290	260	220	250	210	200	180	160
	Avg	0	77	92	135	193	213	252	315	373	390	430	308	260	243	258	218	215	202	175
	SD	0	5	5	10	10	9	15	6	10	22	22	17	22	22	17	17	13	17	13
19	73	0	70	100	140	200	228	280	340	380	410	440	290	250	230	240	180	190	160	160
	74	0	70	110	150	200	233	280	350	380	420	450	310	280	230	230	200	220	200	180
	75	0	80	110	160	220	244	290	350	400	430	470	320	280	240	250	210	200	190	180
	76	0	70	110	150	210	240	290	360	410	430	480	330	300	250	260	220	230	210	180
	Avg	0	72	108	150	208	236	285	350	392	422	460	313	278	238	245	202	210	190	175
	SD	0	5	5	8	10	7	6	8	15	10	18	17	21	10	13	17	18	22	10
20	77	0	50	50	70	90	111	130	180	250	320	400	310	200	190	200	150	140	120	100
	78	0	60	60	80	100	121	140	190	260	330	400	290	220	210	220	150	150	110	90
	79	0	50	60	80	100	119	130	190	250	320	350	270	200	160	150	110	130	90	80
	80	0	60	60	80	90	118	140	190	260	320	400	300	210	180	210	150	140	110	100
	Avg	0	55	57	77	95	117	135	187	255	322	387	293	208	185	195	140	140	107	92
	SD	0	6	5	5	6	4	6	5	6	5	25	17	10	21	31	20	8	13	10

Note 1: Comparator readings were not taken at 35 days. Values shown were based on equations derived from best fitting curves. See Chapter 4 for details.

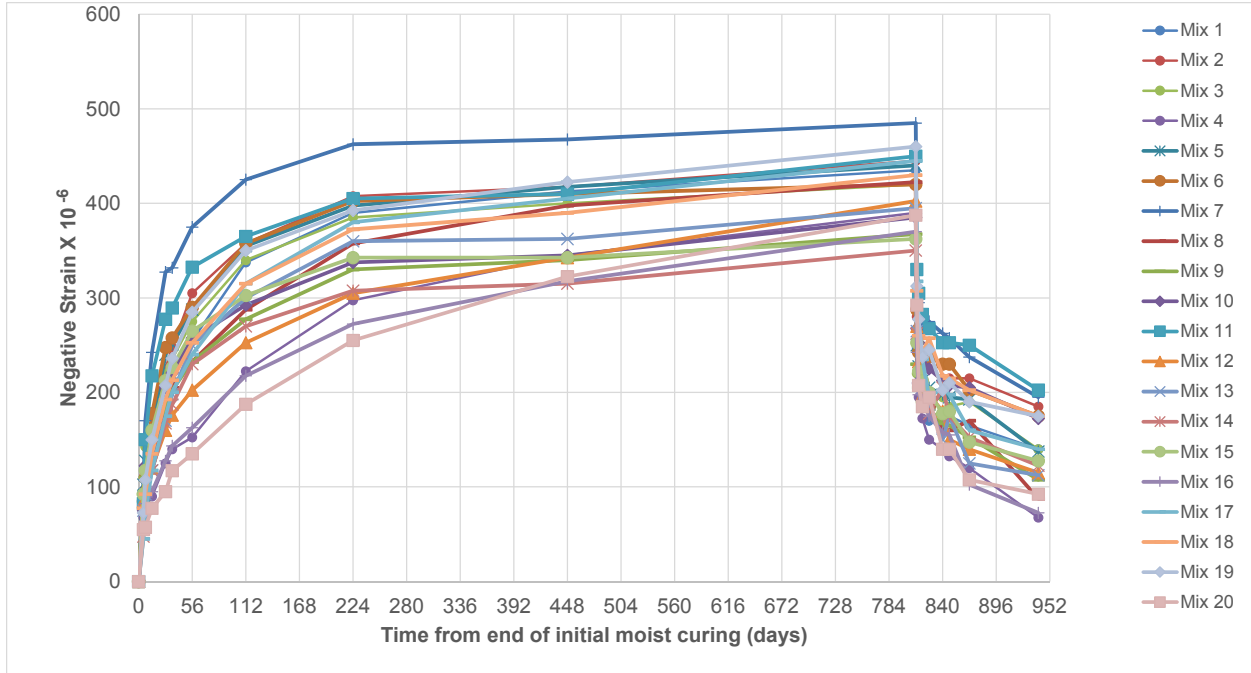


Figure 48. Negative Strain VS Drying Time - All Mixes (50% RH)

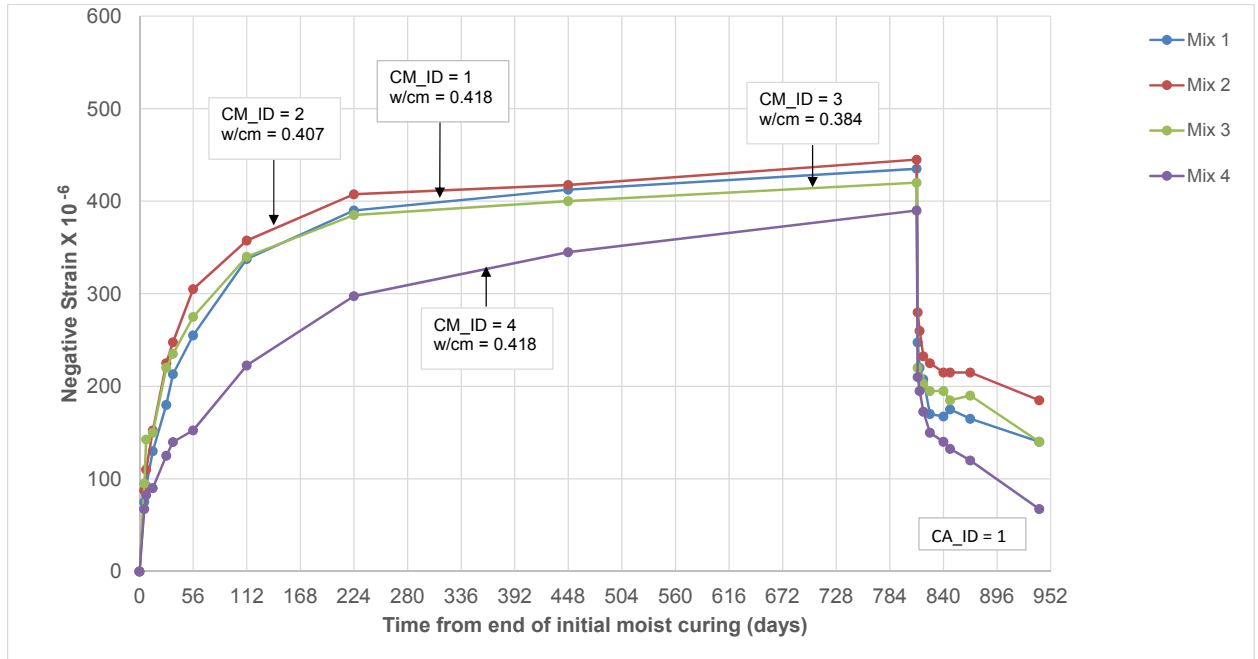


Figure 49. Negative Strain VS Drying Time - Mixes 1 through 4 (50% RH) (CA_ID1)

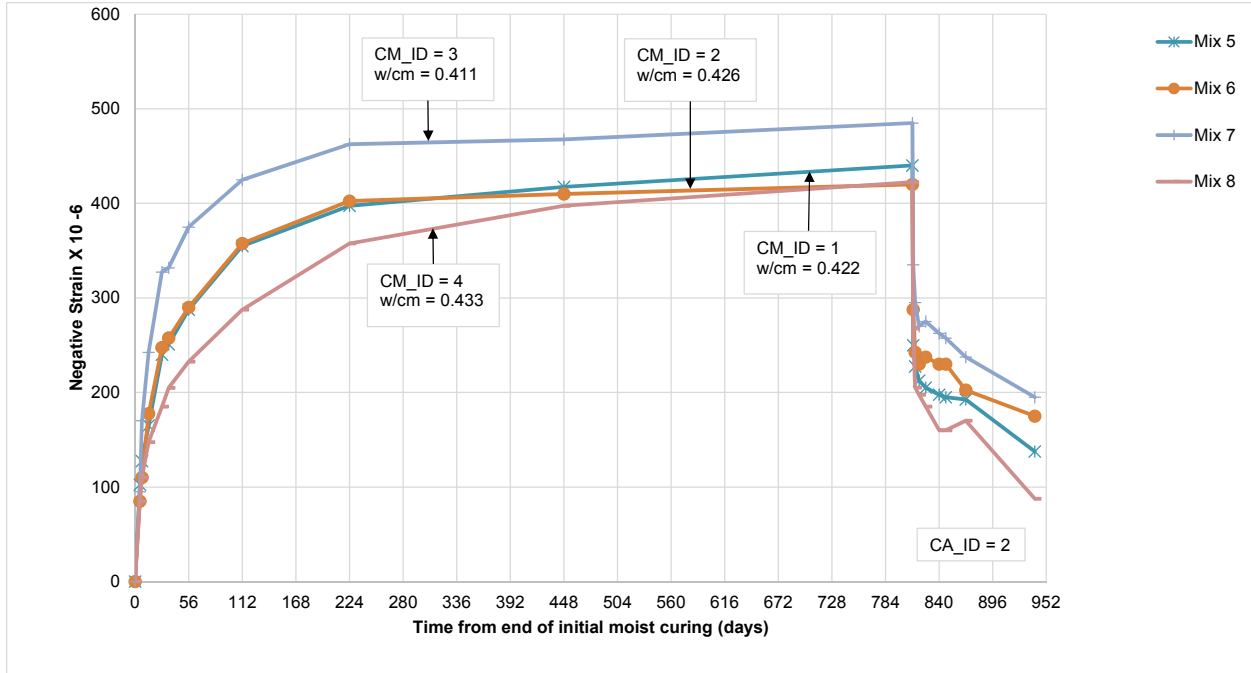


Figure 50. Negative Strain VS Drying Time - Mixes 5 through 8 (50% RH) (CA_ID2)

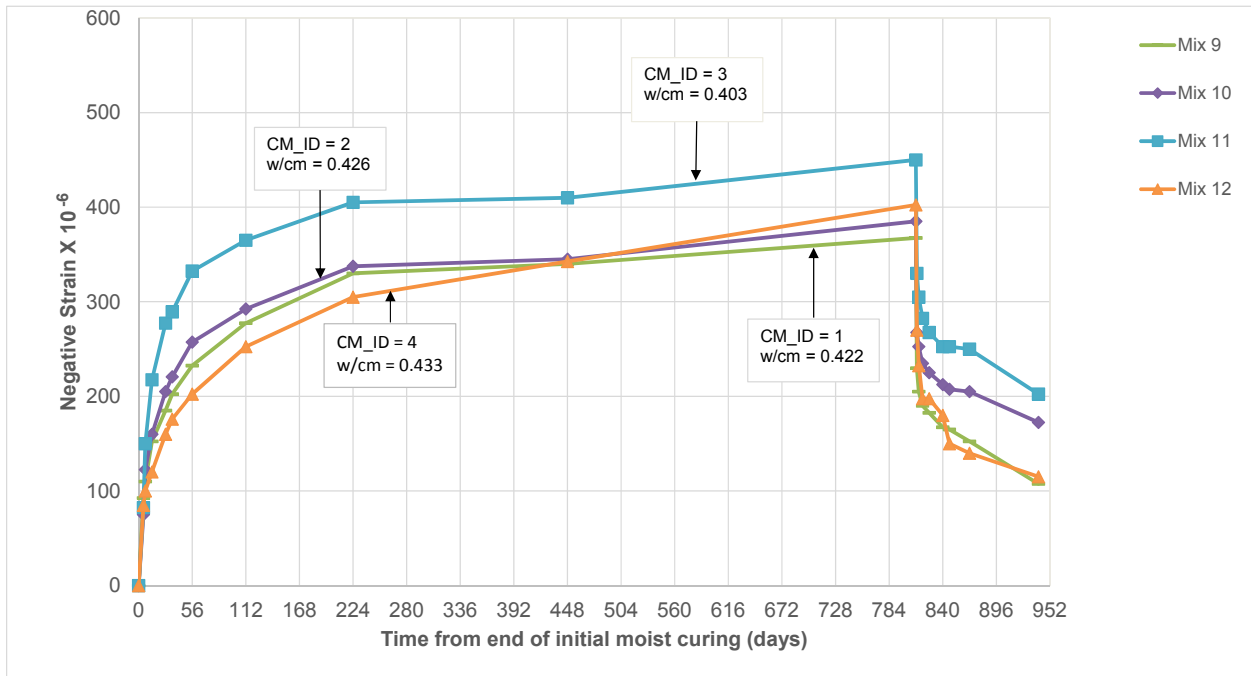


Figure 51. Negative Strain VS Drying Time - Mixes 9 through 12 (50% RH) (CA_ID3)

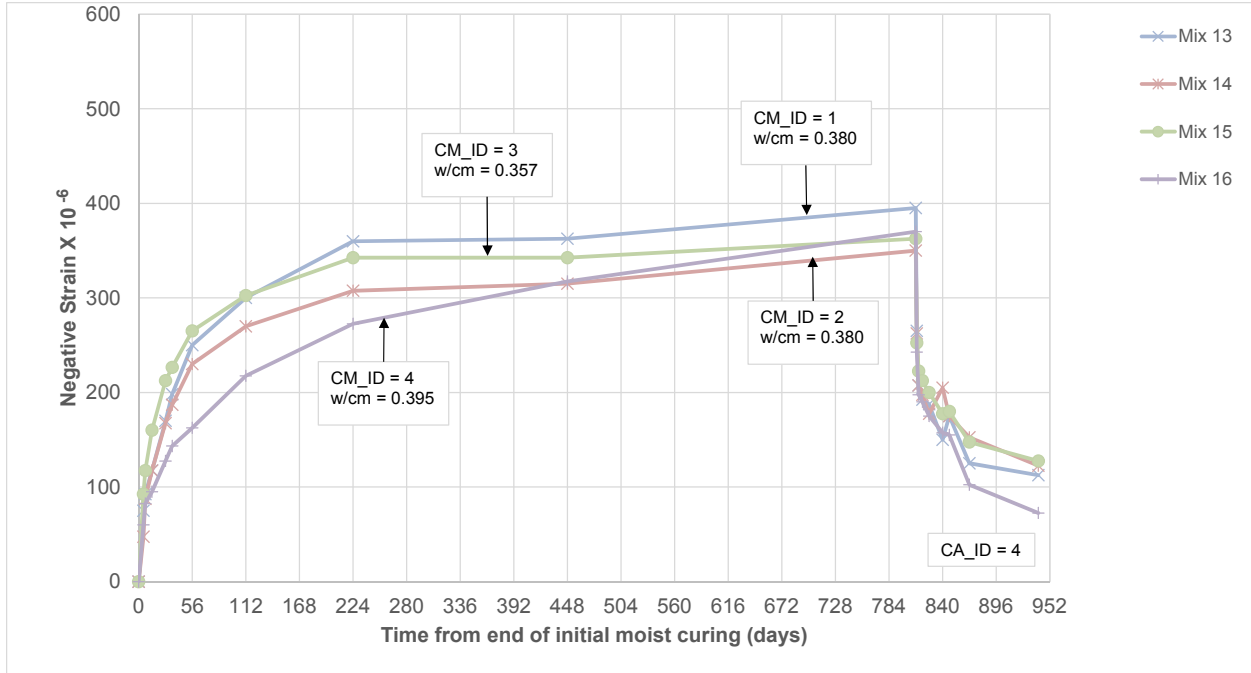


Figure 52. Negative Strain VS Drying Time - Mixes 13 through 16 (50% RH) (CA_ID4)

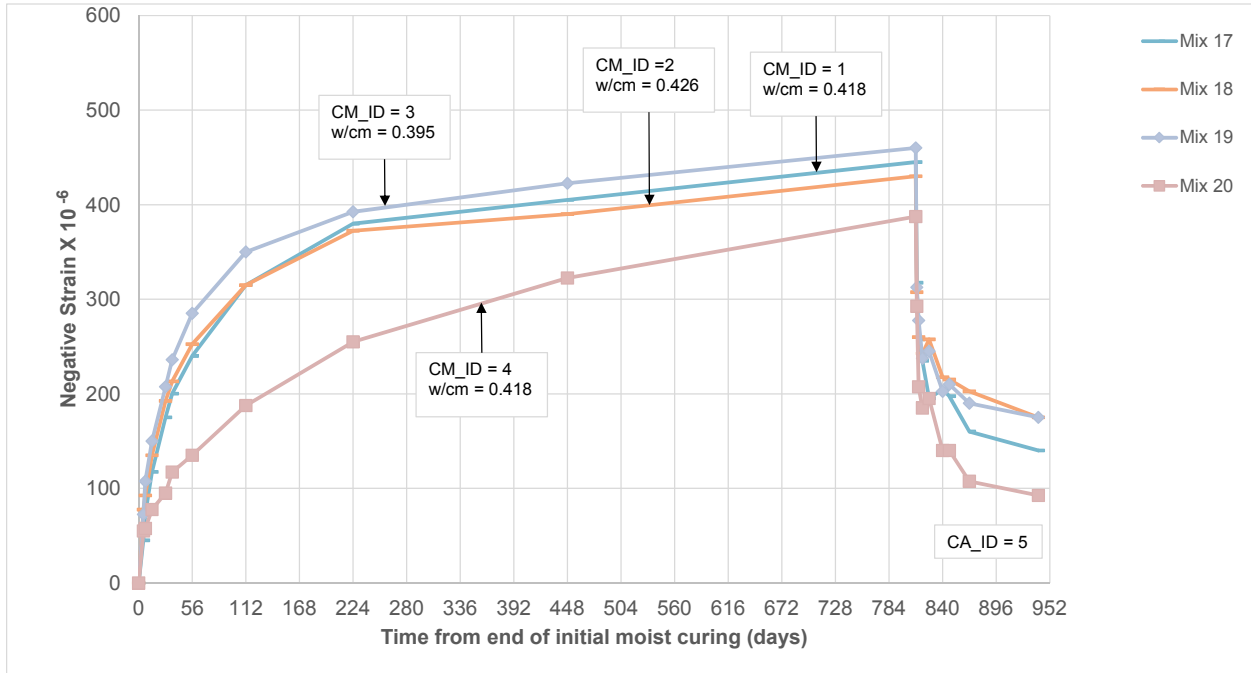


Figure 53. Negative Strain VS Drying Time - Mixes 17 through 20 (50% RH) (CA_ID5)

Shrinkage Strain (40% RH)

Length change specimens were stored in a control room with temperatures of $73^{\circ} \pm 3^{\circ}$ F and relative humidity of 50 ± 4 percent for drying. However, the standard RH according to MEPDG is 40 percent (Rao, 2014). ACI 209R-92 provides an equation to convert shrinkage calculations from 50 percent RH to 40 percent RH. To convert shrinkage strain that occurs when concrete is exposed to 50 percent RH to 40 percent RH divide the results by 0.89. An explanation of this conversion is provided in Chapter 4. The negative strain at 40 percent RH of each specimen is presented in Table 25. Negative shrinkage strain at 40 percent relative humidity calculated at 812 days from the end of initial 7-day moist curing period ranged from 393×10^{-6} (Mix 14) to a high of 545×10^{-6} (Mix 7).

Figure 54 presents graphs of shrinkage strain versus time from the end of initial 7-day moist curing period at 40 percent relative humidity. Figures 55 through 59 present graphs of shrinkage strain versus time from the end of initial 7-day moist curing period for each coarse aggregate source. The coarse aggregate source, cementitious blend, and w/cm ratio are noted within the figures.

Table 25. Negative Strain x 10⁻⁶ Measured From End of Initial 7-Day Moist Curing Period (40% RH)

Mix No.	Time after initial moist curing (days)																		
	Drying											Wetting							
	0	5	7	14	28	35	56	112	224	448	812	813	815	819	826	840	847	868	940
1	0	84	104	146	202	240	287	379	438	463	489	278	247	233	191	188	197	185	157
2	0	98	124	171	253	278	343	402	458	469	500	315	292	261	253	242	242	242	208
3	0	107	160	169	247	264	309	382	433	449	472	247	236	228	219	219	208	213	157
4	0	76	93	101	140	157	171	250	334	388	438	236	219	194	169	157	149	135	76
5	0	115	143	185	270	282	323	399	447	469	494	281	256	239	230	222	219	216	154
6	0	96	124	199	278	290	326	402	452	461	472	323	272	258	267	258	258	228	197
7	0	107	191	272	368	373	421	478	520	525	545	376	331	303	309	295	289	267	219
8	0	96	124	166	208	230	261	323	402	447	475	301	230	222	208	180	180	191	98
9	0	104	124	171	208	227	261	312	371	382	413	258	230	213	205	188	185	171	121
10	0	84	138	180	230	248	289	329	379	388	433	301	284	264	253	239	233	230	194
11	0	93	169	244	312	325	374	410	455	461	506	371	343	317	301	284	284	281	228
12	0	96	112	135	180	198	228	284	343	385	452	303	261	222	222	202	169	157	129
13	0	84	104	132	191	223	281	337	404	407	444	298	233	216	211	169	197	140	126
14	0	53	98	132	188	210	258	303	346	354	393	295	233	222	199	230	197	171	138
15	0	104	132	180	239	254	298	340	385	385	407	284	250	239	225	199	202	166	143
16	0	67	93	107	143	161	183	244	306	357	416	272	222	213	197	177	174	115	81
17	0	51	81	132	197	225	270	354	427	455	500	357	289	264	219	230	222	180	157
18	0	87	104	152	216	239	284	354	419	438	483	346	292	272	289	244	242	228	197
19	0	81	121	169	233	265	320	393	441	475	517	351	312	267	275	228	236	213	197
20	0	62	65	87	107	132	152	211	287	362	435	329	233	208	219	157	157	121	104

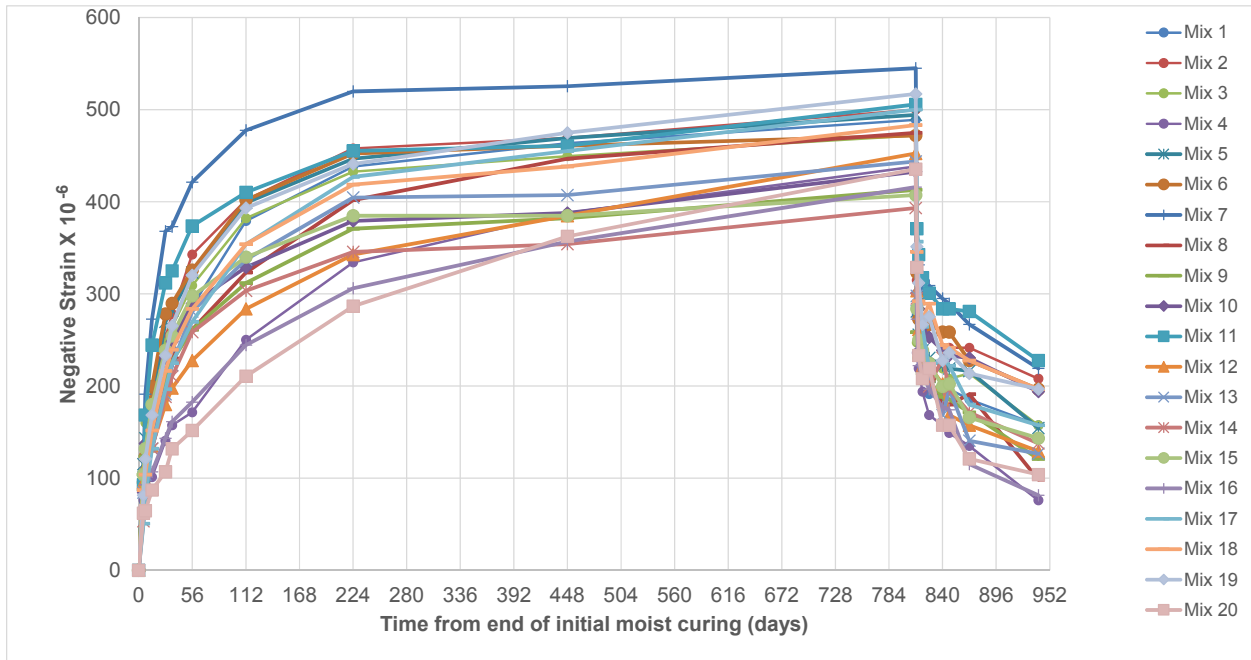


Figure 54. Negative Strain VS Drying Time - All Mixes (40% RH)

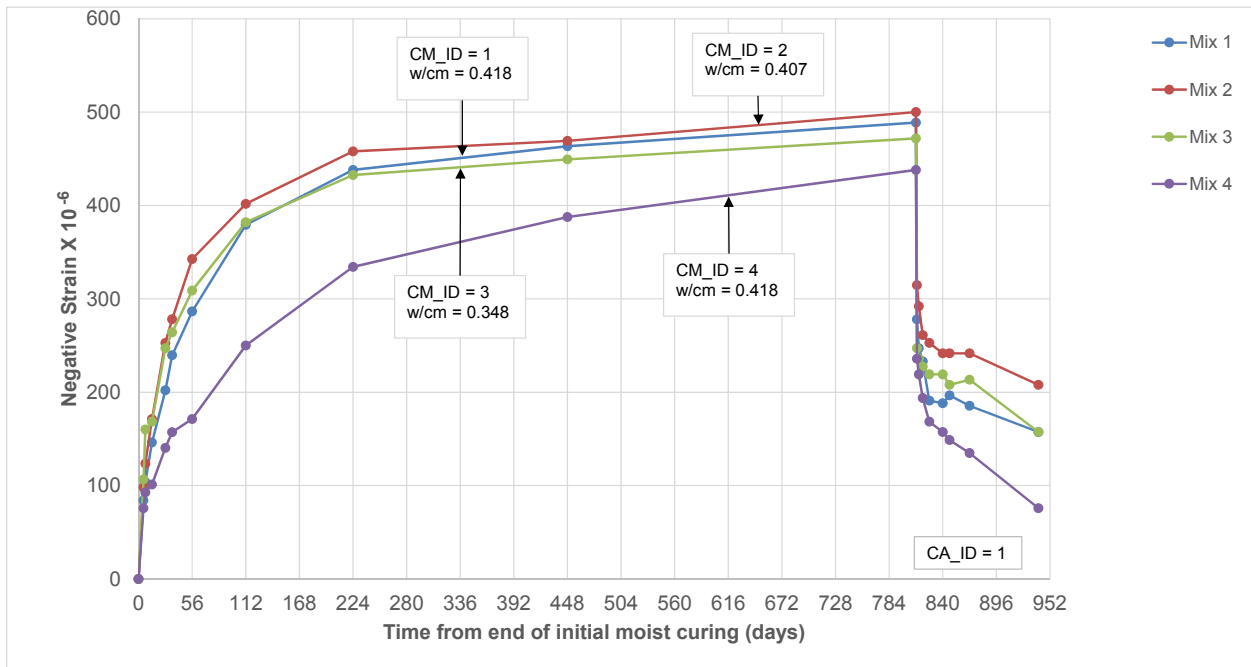


Figure 55. Negative Strain VS Drying Time - Mixes 1 through 4 (40% RH) (CA_ID1)

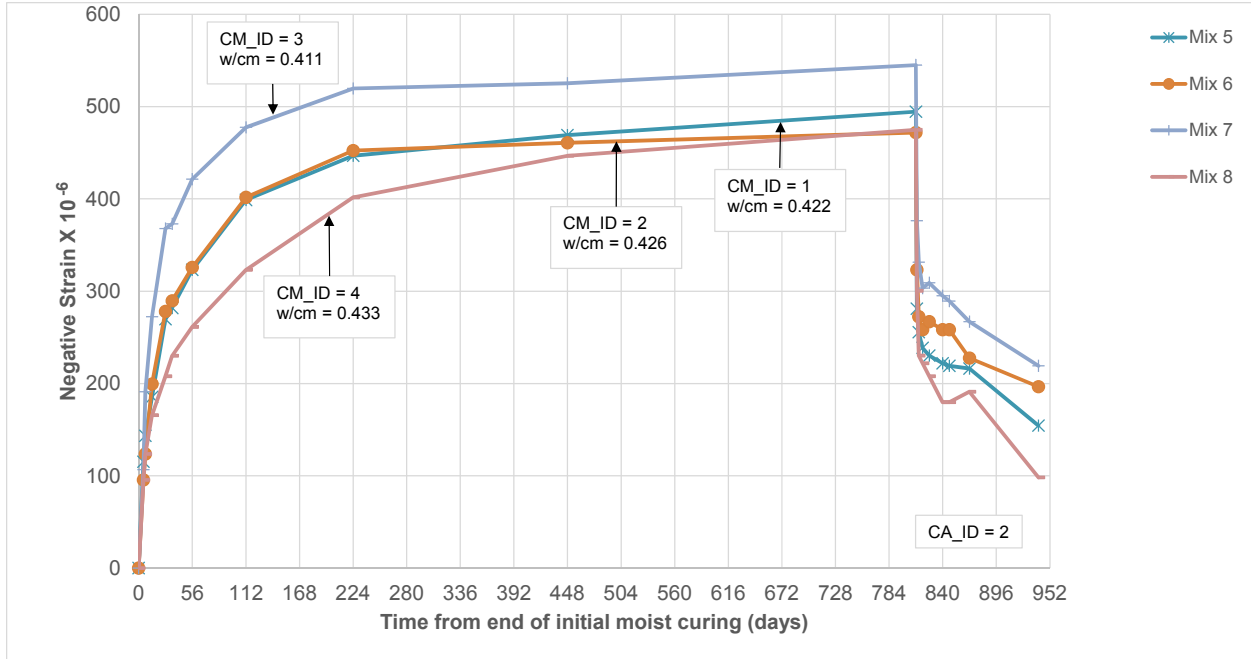


Figure 56. Negative Strain VS Drying Time - Mixes 5 through 8 (40% RH) (CA_ID2)

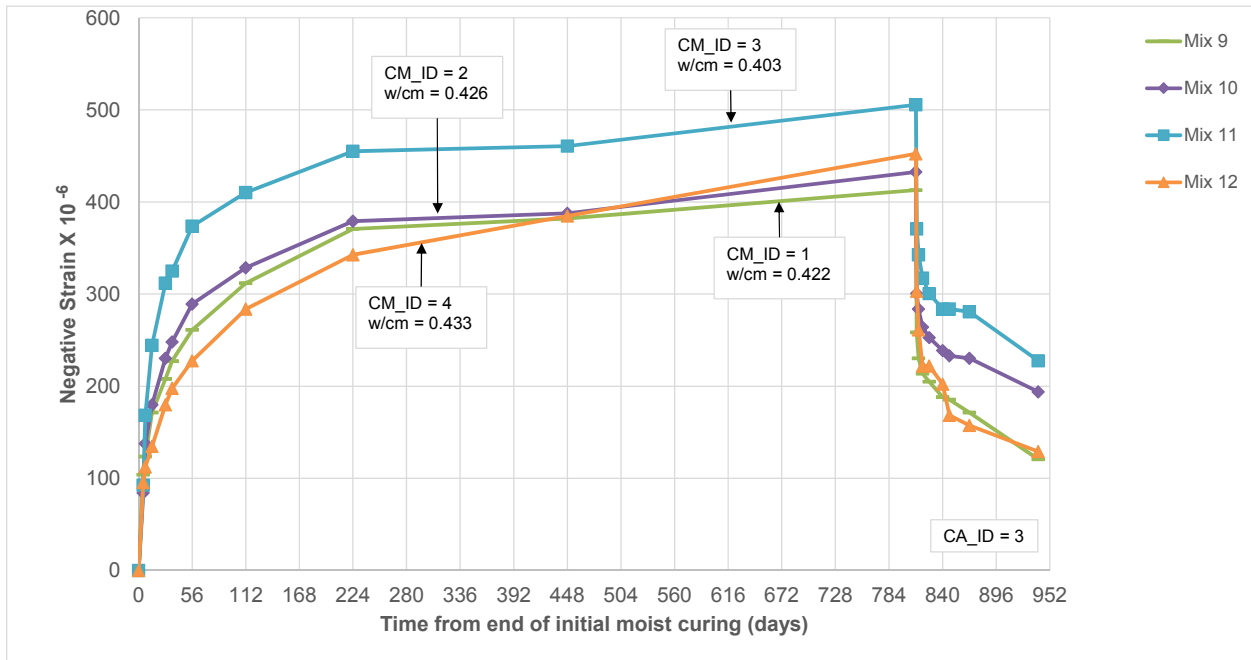


Figure 57. Negative Strain VS Drying Time - Mixes 9 through 12 (40% RH) (CA_ID3)

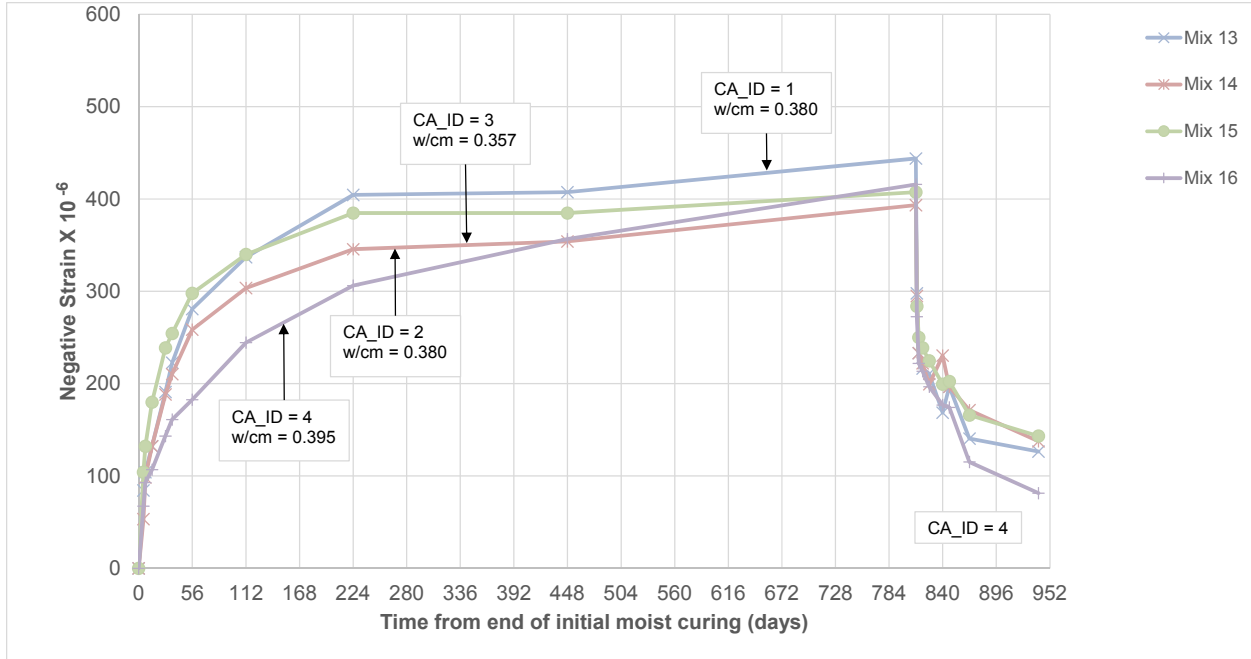


Figure 58. Negative Strain VS Drying Time - Mixes 13 through 16 (40% RH) (CA_ID4)

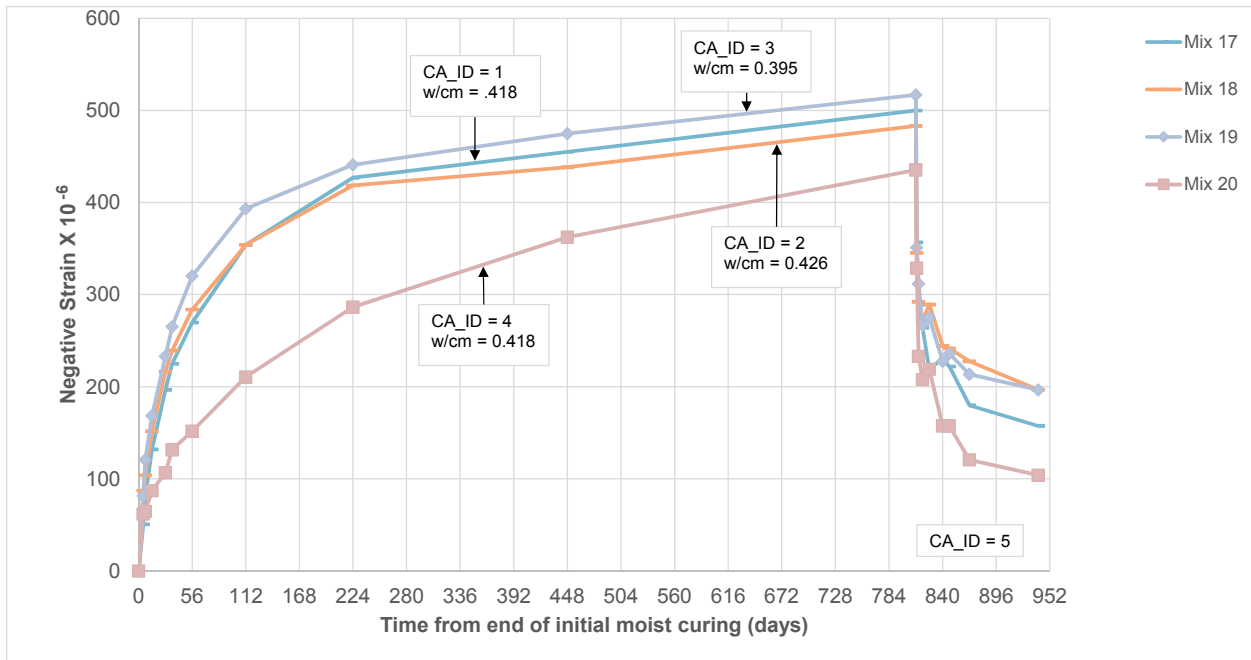


Figure 59. Negative Strain VS Drying Time - Mixes 17 through 20 (40% RH) (CA_ID5)

CHAPTER 6 – DISCUSSION OF RESULTS

PLASTIC PROPERTIES

Slump – Water Demand

Mixtures were proportioned to produce a slump within a range of 1 ¼ inches to 2 ¾ inches with the use of a type A water reducing admixture with a typical dosage rate of 27.4 oz. / yd³. The source of coarse aggregate and cementitious blend influenced the amount of water required to produce the target slump. Therefore, the quantity of mix water was adjusted to keep the slump within the target range. Water demand versus coarse aggregate source and cementitious blend is presented in Figure 60. The mixes proportioned with crushed limestone (mixes 5 through 12) (CA_ID2 and CA_ID3) required more water to produce the target slump than the gravel aggregate mixtures (mixes 1 through 4 and mixes 13 through 20) (CA_ID1, CA_ID4, and CA_ID5). The mixes with high absorption gravel (mixes 1 through 4: CA_ID1) and the small nominal maximum size gravel (mixes 17 through 20:CA_ID5) had higher water demand than mixes that utilized low absorption gravel (mixes 13 through 16:CA_ID4). Average water contents are illustrated by cementitious blend in Figure 61. Mixtures proportioned with Class C fly ash (CM_ID3) had the lowest water demand. Mixtures with Class F fly ash (CM_ID2) and slag cement (CM_ID4) generally required more water to produce the target slump range of 1 ¼ in. to 2 ¾ in. than similar mixtures proportioned with 100 percent portland cement (CM_ID1).

Unit Weight (Density)

The average unit weight of the fresh concrete ranged from 141.0 pcf (mix 18) to 149.3 pcf (mix 9). The unit weights are illustrated by coarse aggregate source and cementitious blend in Figure 62. Mixtures proportioned with Class F fly ash (CM_ID2) produced the lowest unit weight within a set of gravel aggregate mixes (CA_ID_1, CA_ID4, and CA_ID5). Mixes 9, 10, 11, and 12 (CA_ID3) had the highest unit weight representing each cementitious blends. These mixtures utilized crushed limestone from Alabama (CA_ID3) which had the highest DRUW (104 pcf) and the highest void content (38.8%). See Table 12 for a summary of dry rodded unit weights and void contents of coarse aggregates used in this study.

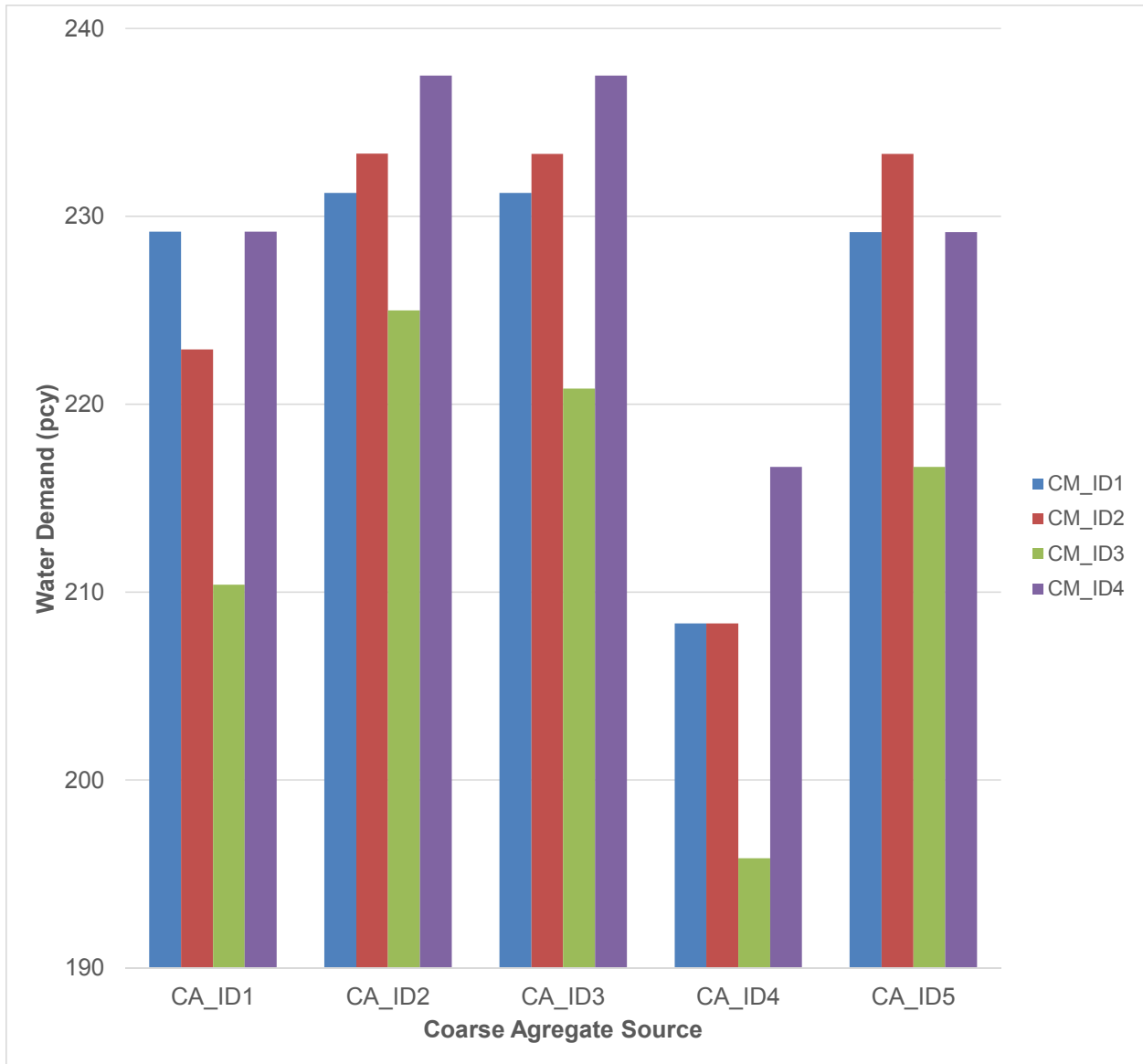


Figure 60. Water Demand VS Coarse Aggregate Source and Cementitious Materials Blend

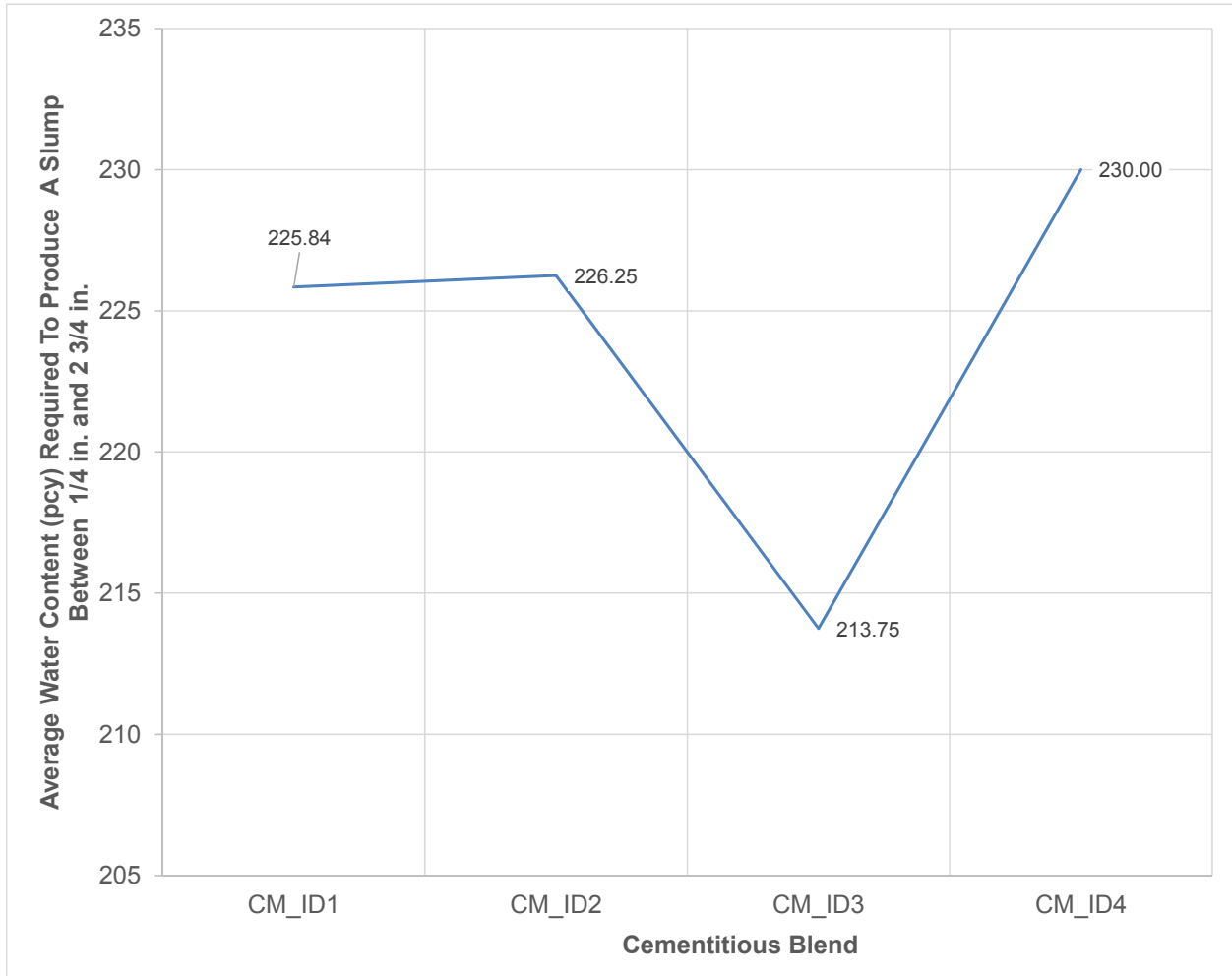


Figure 61. Average Water Content VS Cementitious Blend

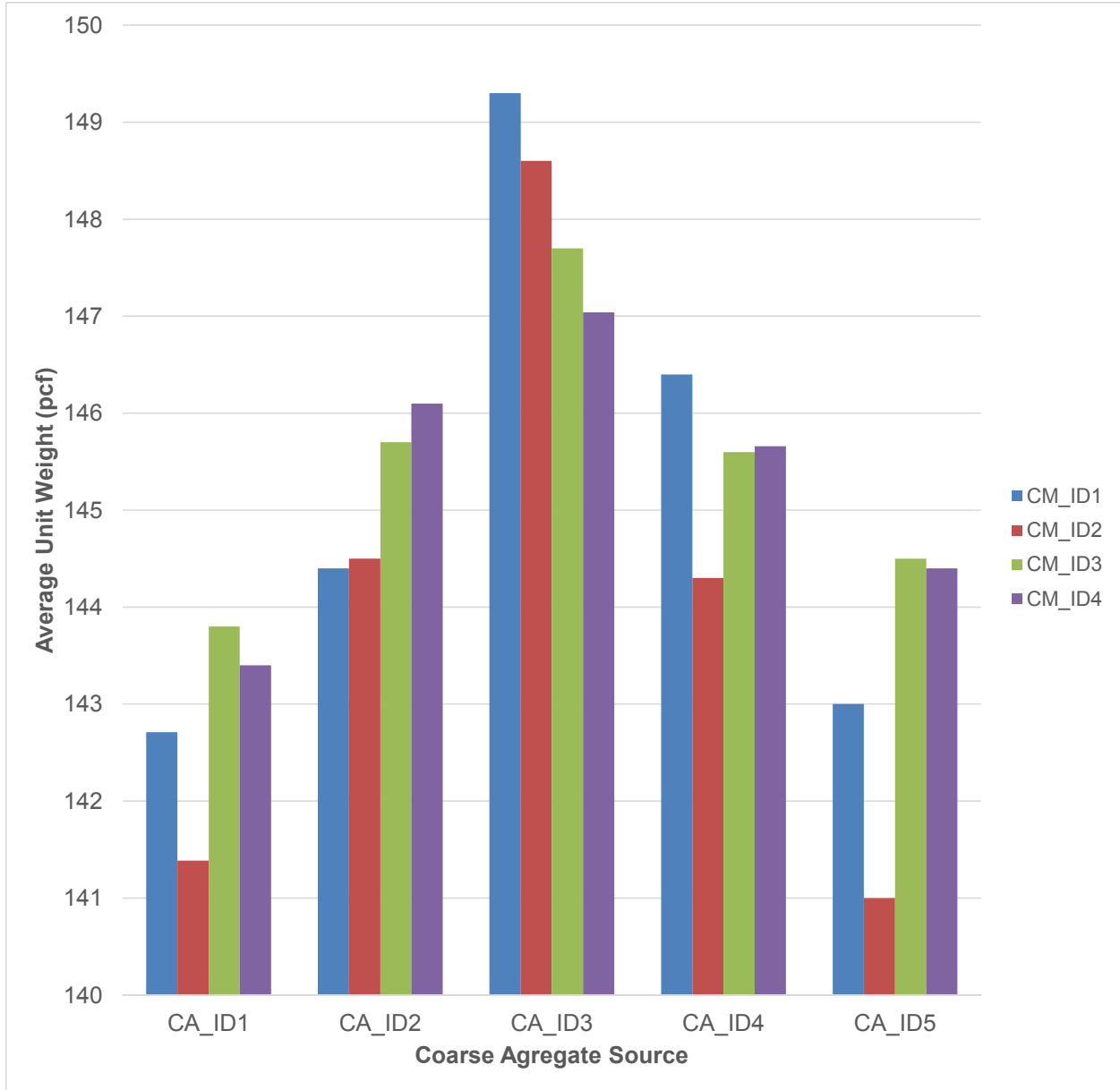


Figure 62. Average Unit Weight VS Coarse Aggregate Source

COMPRESSIVE STRENGTH

Figures 63 through 66 present compressive strength versus coarse aggregate source for 7-day, 14-day, 28-day, and 90-days results, respectfully. Mixtures utilizing Class C fly ash (CM_ID3) and slag cement (CM_ID4) generally exceeded the compressive strength of similar mixtures proportioned with 100 percent portland cement (CM_ID1). Exceptions include 7-day test and mixes proportioned with coarse aggregate source ID CA_ID3. Mixtures that utilized Class F fly ash (CM_ID2) had lower compressive strengths than similar mixtures proportioned with 100 percent portland cement (CM_ID1) except for the 90-day tests results. The Class F ash mixes (CM_ID2) exceeded the compressive strength of the 100 percent portland cement mixes (CM_ID1) at 90 days except for mixtures proportioned with coarse aggregates ID's CA_ID1 and CA_ID5. Mixes proportioned with Class C fly ash (CM_ID3) generally had the highest compressive strengths within the set of mixes produced from each coarse aggregate source.

The 28-day compressive strengths for each set of mixes representing a coarse aggregate source were averaged and a comparison made between the average compressive strength produced by each aggregate source. These averages include the following: CA_ID1 (6,640 psi), CA_ID2 (7,088 psi), CA_ID3 (7,175 psi), CA_ID4 (7,120 psi), and CA_ID5 (7,500 psi). These averages indicate that the No. 67 gravel source (CA_ID5) performed better than the No. 57 crushed limestone (CA_ID2 and CA_ID3) and the No. 57 gravel sources (CA_ID1 and CA_ID4) with respect to 28-day compressive strength.

The increase in compressive strength from 28 days to 90 days was calculated and the average increase in strength attributed to each cementitious blend was determined. These averages are as follows: 100% portland cement (9 percent); 25% Class F fly ash (24 percent); 25% Class C fly ash (15 percent); and 50% slag cement (9 percent). Mixes proportioned with Class F fly ash had the highest increase in compressive strength (24 percent) from 28 days to 90 days followed by mixtures proportioned with Class C fly ash (15 percent). The average compressive strengths are illustrated by cementitious blend and coarse aggregate type in Figure 67.

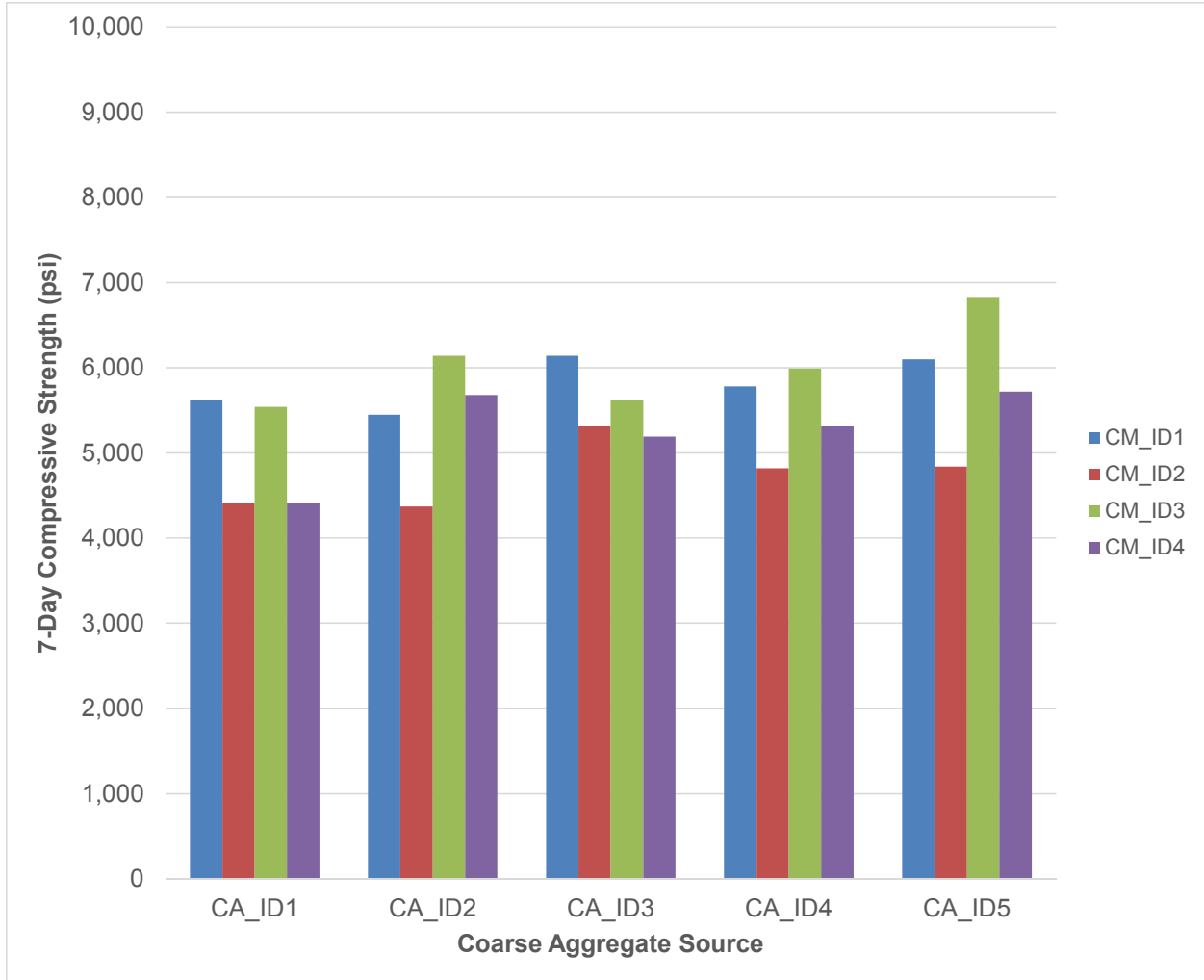


Figure 63. 7-Day Compressive Strength VS Coarse Aggregate Source

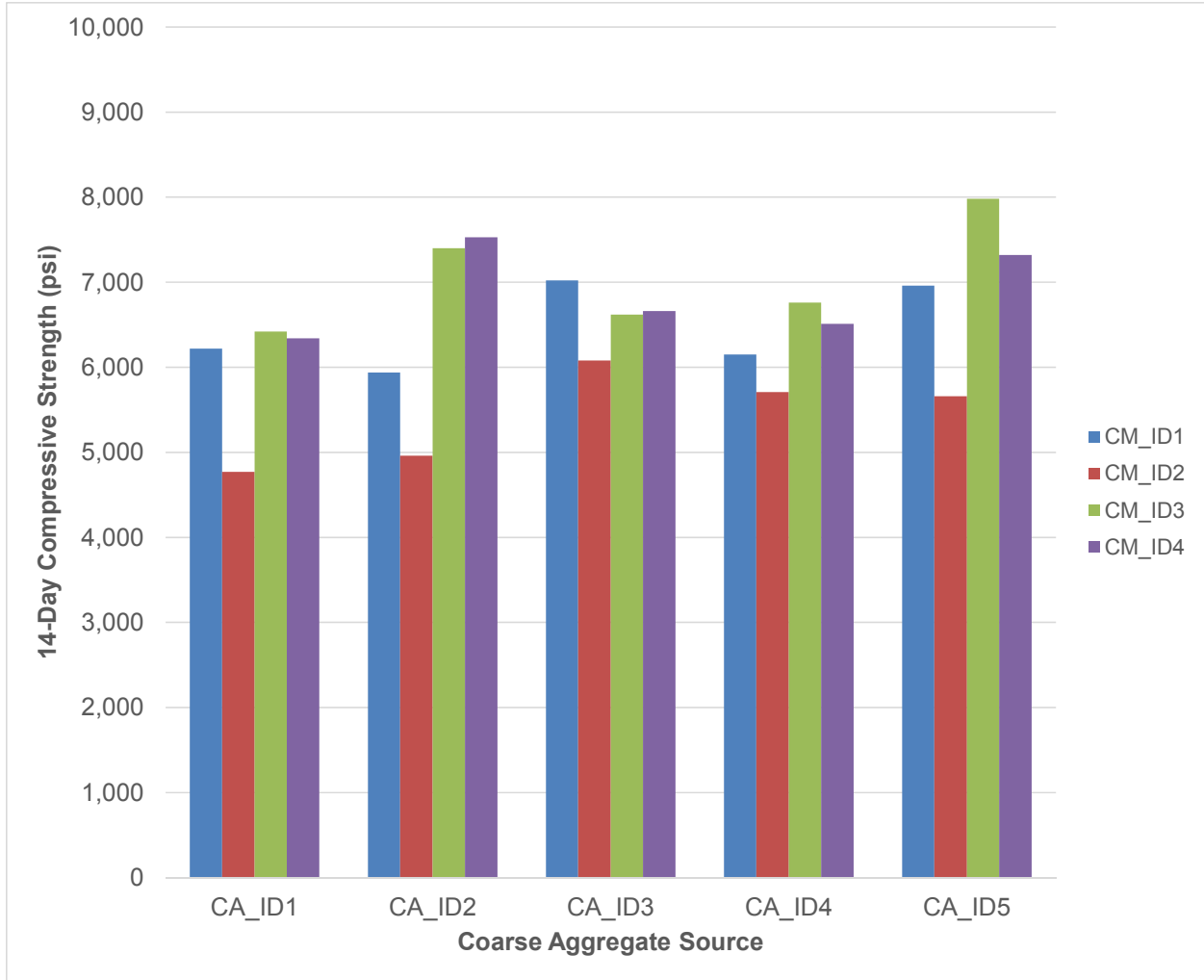


Figure 64. 14-Day Compressive Strength VS Coarse Aggregate Source

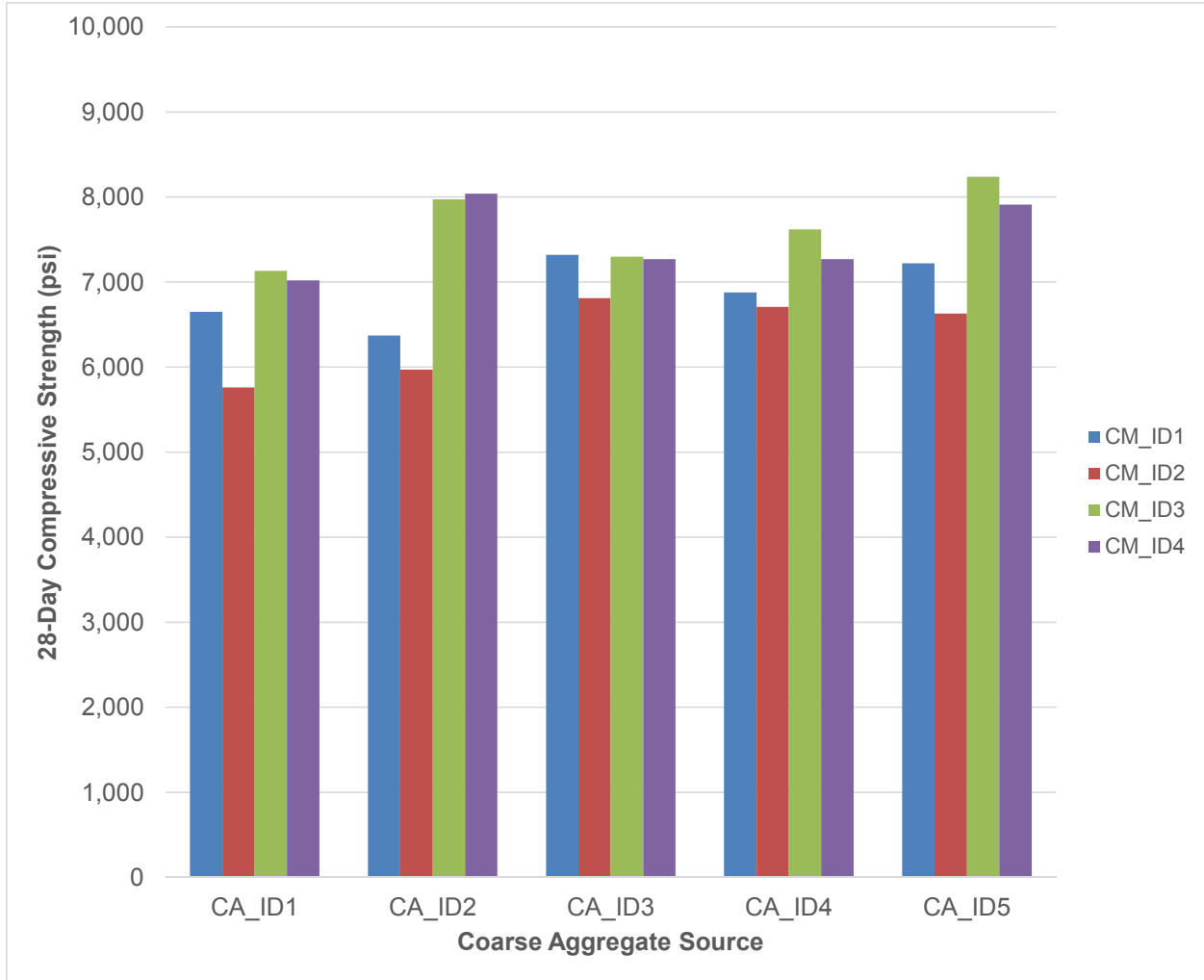


Figure 65. 28-Day Compressive Strength VS Coarse Aggregate Source

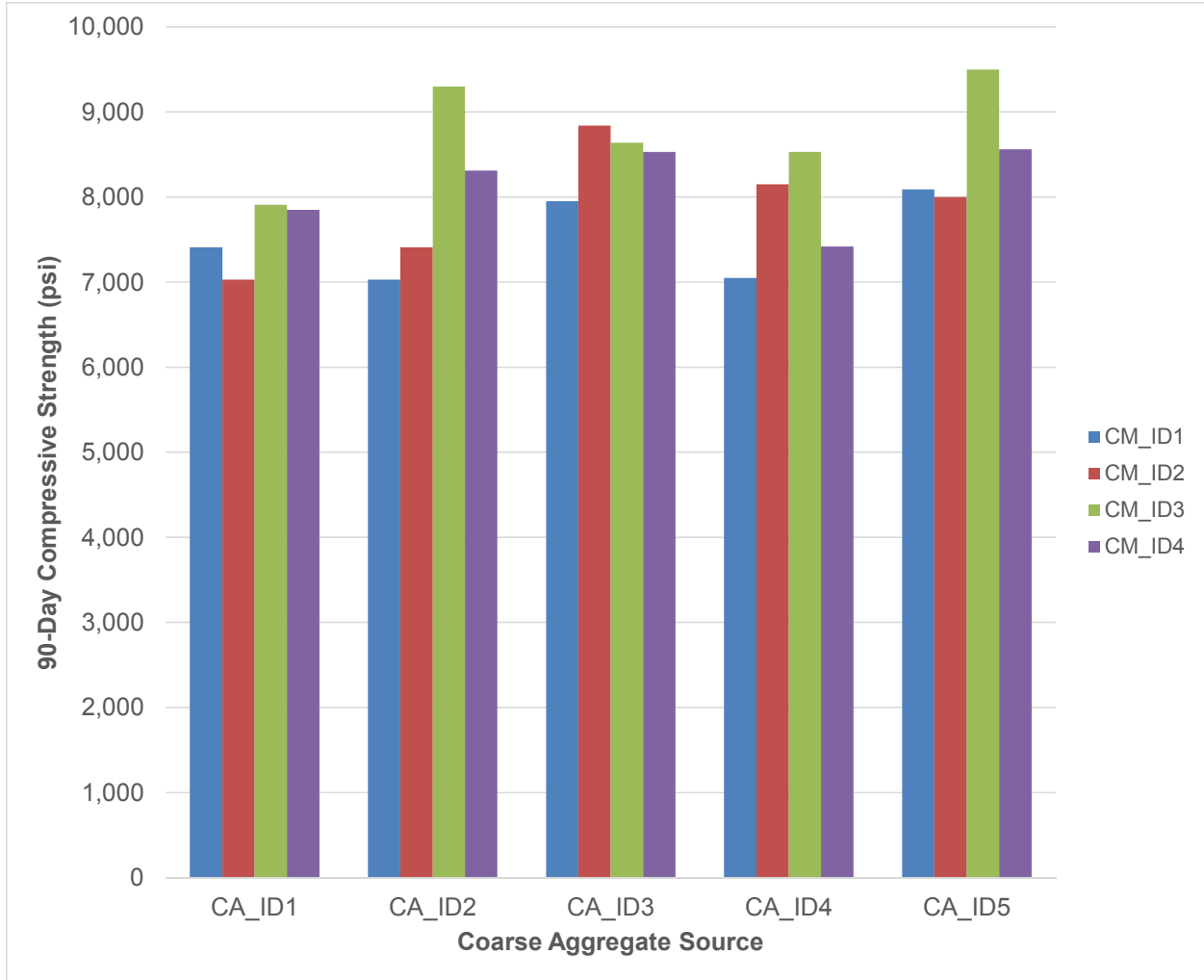


Figure 66. 90-Day Compressive Strength VS Coarse Aggregate Source

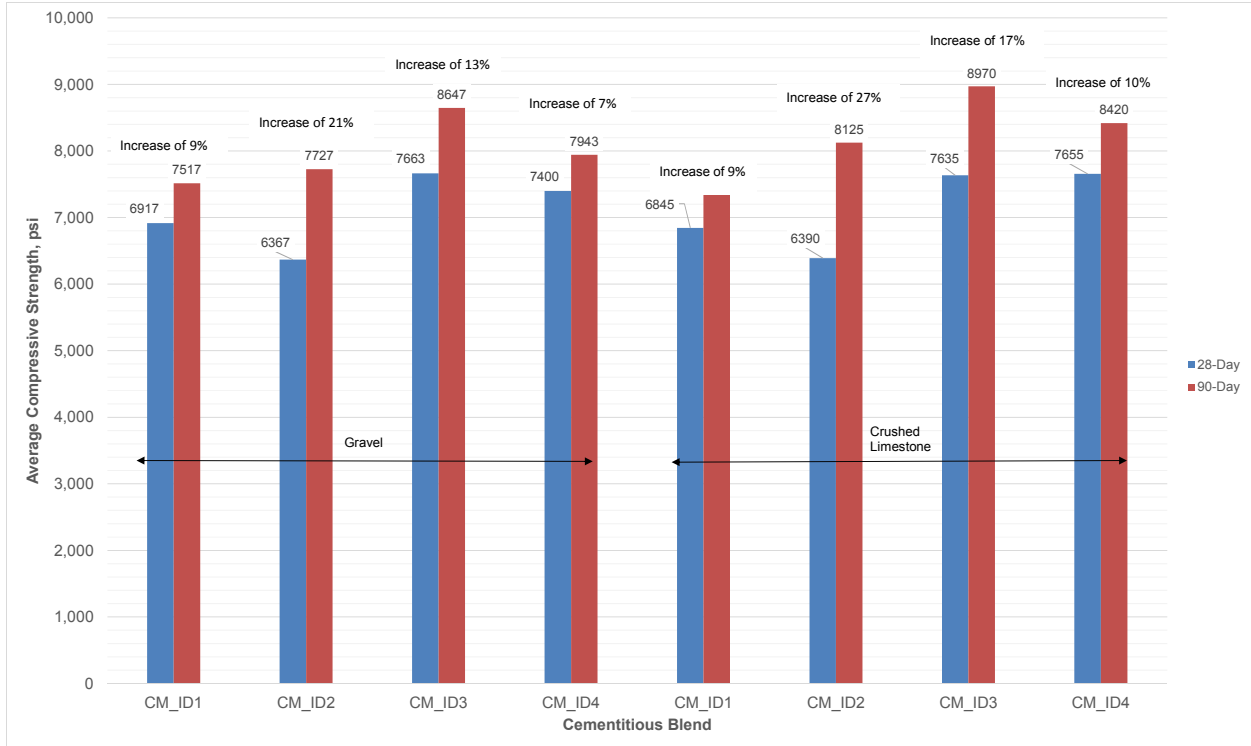


Figure 67. Average Increase in Compressive Strengths from 28 Days to 90 Days

FLEXURAL STRENGTH

Figures 68 through 71 present flexural strengths for each coarse aggregate source for specimen ages of 7-day, 14-day, 28-day, and 90-days, respectively. Mixtures that utilized slag cement (CM_ID4) generally exceeded the flexural strengths of similar mixtures proportioned with other blends of cementitious materials except for 7-day tests. The only exception is the 90-day results for mixes proportioned with high absorption gravel aggregate (CA_ID1). These results show little to no increase in flexural strength attributed by the use of any SCM. The tensile strength of the coarse aggregate materials may have had more influence in this case on flexural strength than the strength of the cementitious paste because of the following: 1) The average 90-day flexural strengths for the four cementitious blends proportioned with CA_ID1 are similar (875 psi, 885 psi, 875 psi, and 845 psi); 2) Mixes proportioned with all other coarse aggregate sources and SCMs experienced an increase in flexural strength with respect to similar mixes proportioned with 100% portland cement (CM_ID1); 3) The compressive strength of

mixes proportioned with Class C fly ash (CM_ID3) and slag cement (CM_ID4) showed an increase in strength over a similar mixture proportioned with 100% portland cement.

The 28-day average flexural strengths were calculated for each coarse aggregate source and a comparison made between the average compressive strength produced by each aggregate source. These averages were as follows: CA-ID1 (789 psi), CA_ID2 (796 psi), CA_ID3 (971 psi), CA_ID4 (904 psi), and CA_ID5 (838 psi). These data show that No. 57 crushed limestone from Alabama (CA_ID3) performed the best with respect to flexural strength followed by No. 57 low absorption gravel (CA_ID4). These data also indicate that No. 67 gravel (CA_ID5) performed better than the No 57 crushed limestone from Missouri (CA_ID2) and No. 57 high absorption gravel (CA_ID1) with respect to flexural strength.

The percent increase in flexural strength from 28 days to 90 days was calculated for each cementitious blend. The average percent increase in flexural strength from 28 days to 90 days is as follows: 100% portland cement (5 percent), 25% Class F fly ash (14 percent), 25 % Class C fly ash (8 percent), and 50% slag cement (4 percent). Mixes proportioned with Class F fly ash experienced the greatest increase in flexural strength from 28 to 90 days followed by mixes proportioned with Class C fly ash. Figure 72 presents average flexural strengths at 28-days and 90-days along with the percent increase in flexural strengths based on the cementitious blend and type of coarse aggregate utilized.

Part 2 of the MEPDG, “Design Inputs,” provides an equation from the American Concrete Institute (ACI) that can be used to estimate the flexural strength of concrete if the compressive strength is known. This equation is given below in Equation No. 7. Figure 73 presents flexural strength versus compressive strength for both measured flexural strength and flexural strength calculated with the use of Equation 7. Calculated flexural strengths were on average 95 percent of the measured flexural strengths indicating that this equation provides a conservative estimate of the flexural strength of typical PCC pavements in Mississippi.

$$MR = 9.5(f'c)^{1/2} \quad (7)$$

Where,

MR = PCC flexural strength, psi.

f'c = compressive strength of PCC, psi.

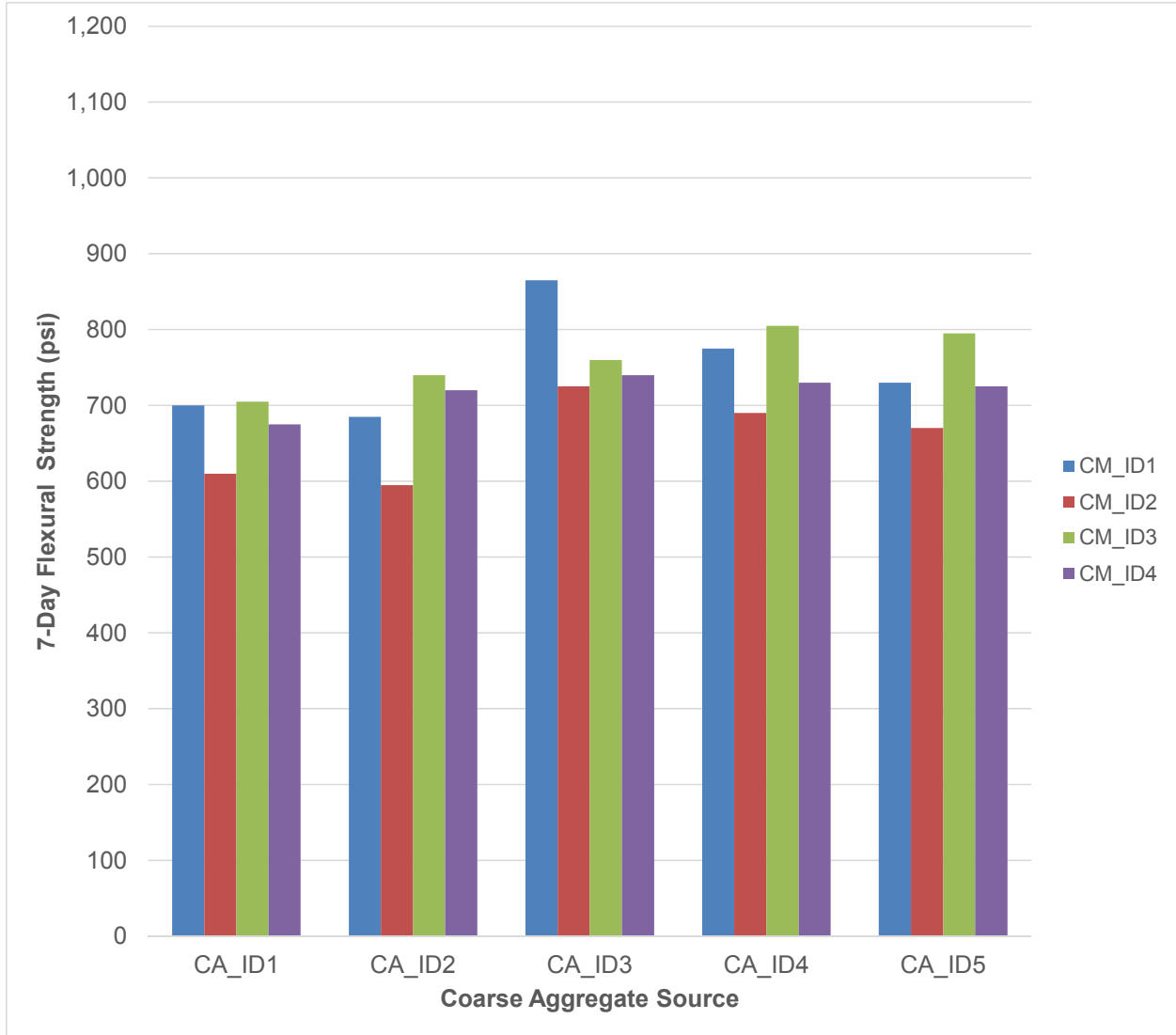


Figure 68. 7-Day Flexural Strength VS Coarse Aggregate Source

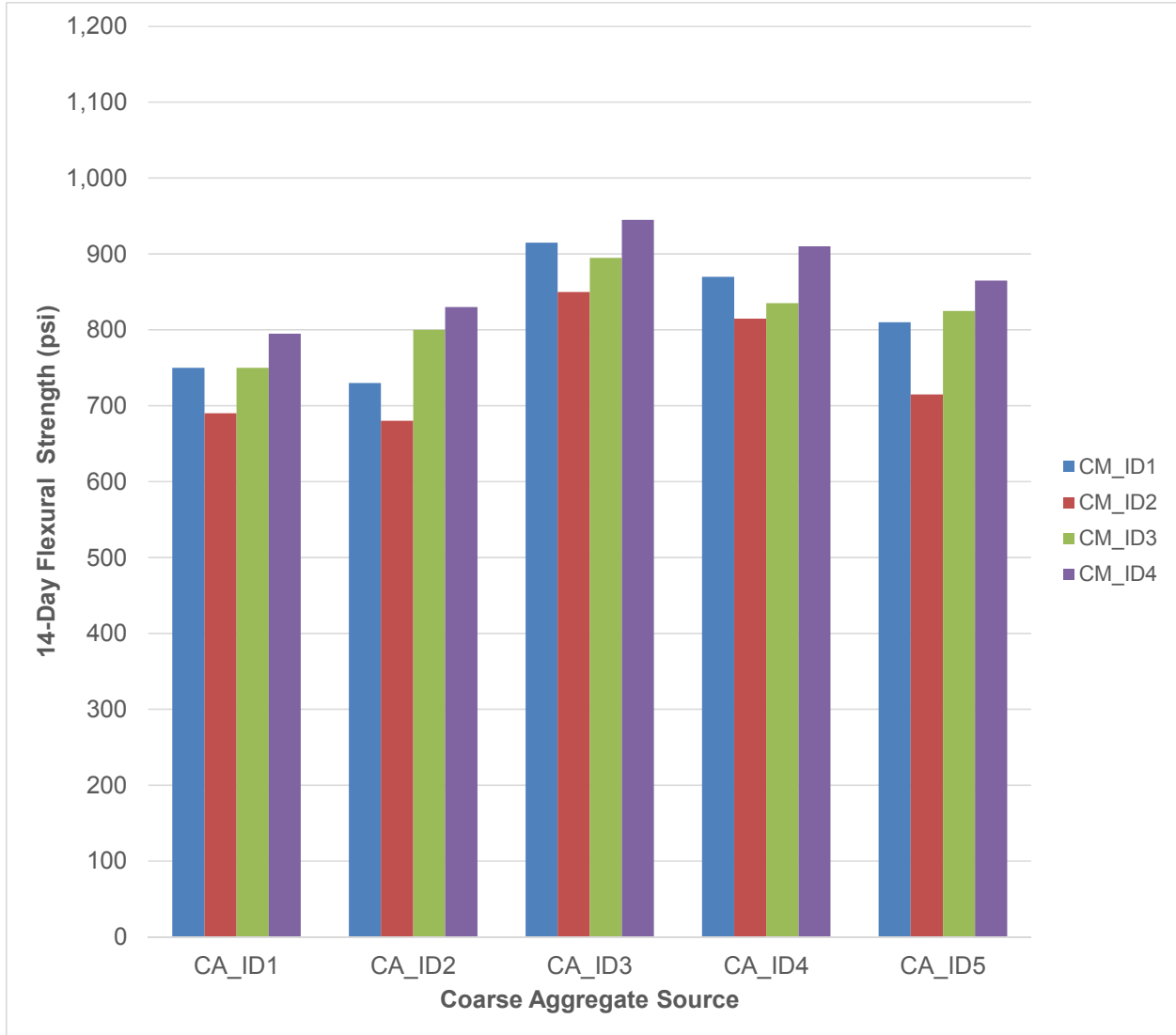


Figure 69. 14-Day Flexural Strength VS Coarse Aggregate Source

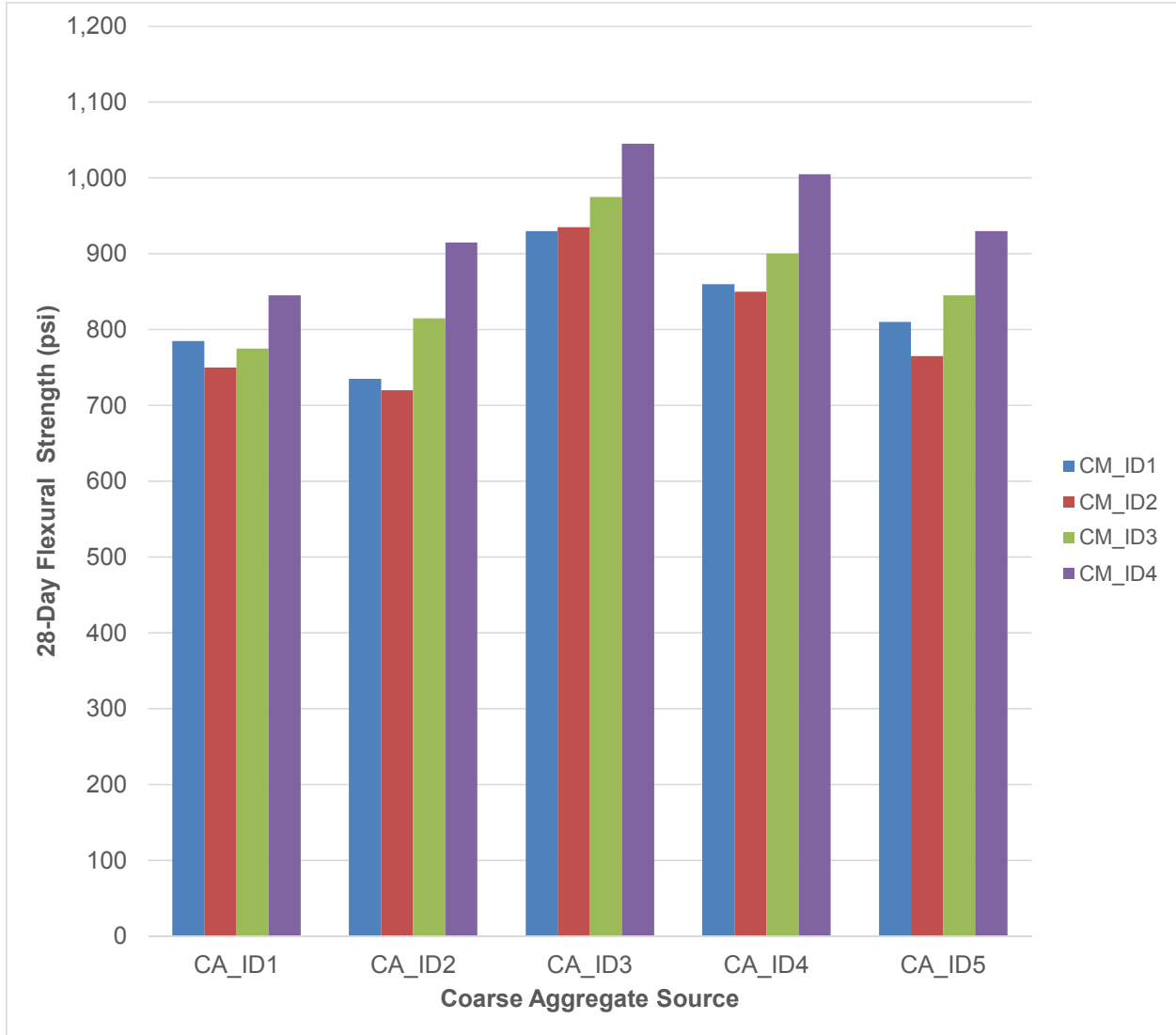


Figure 70. 28-Day Flexural Strength VS Coarse Aggregate Source

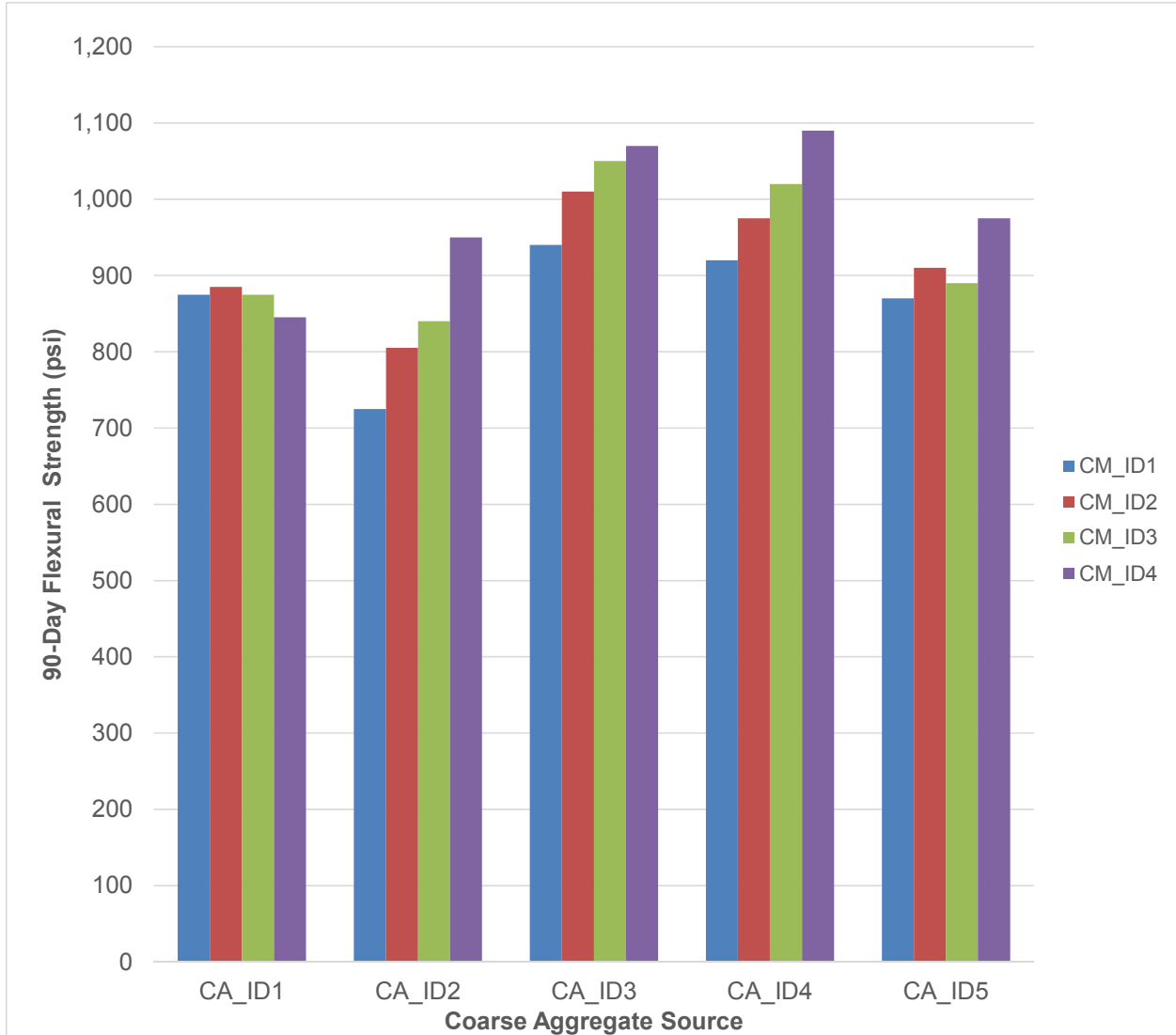


Figure 71. 90-Day Flexural Strength VS Coarse Aggregate Source

Final Report

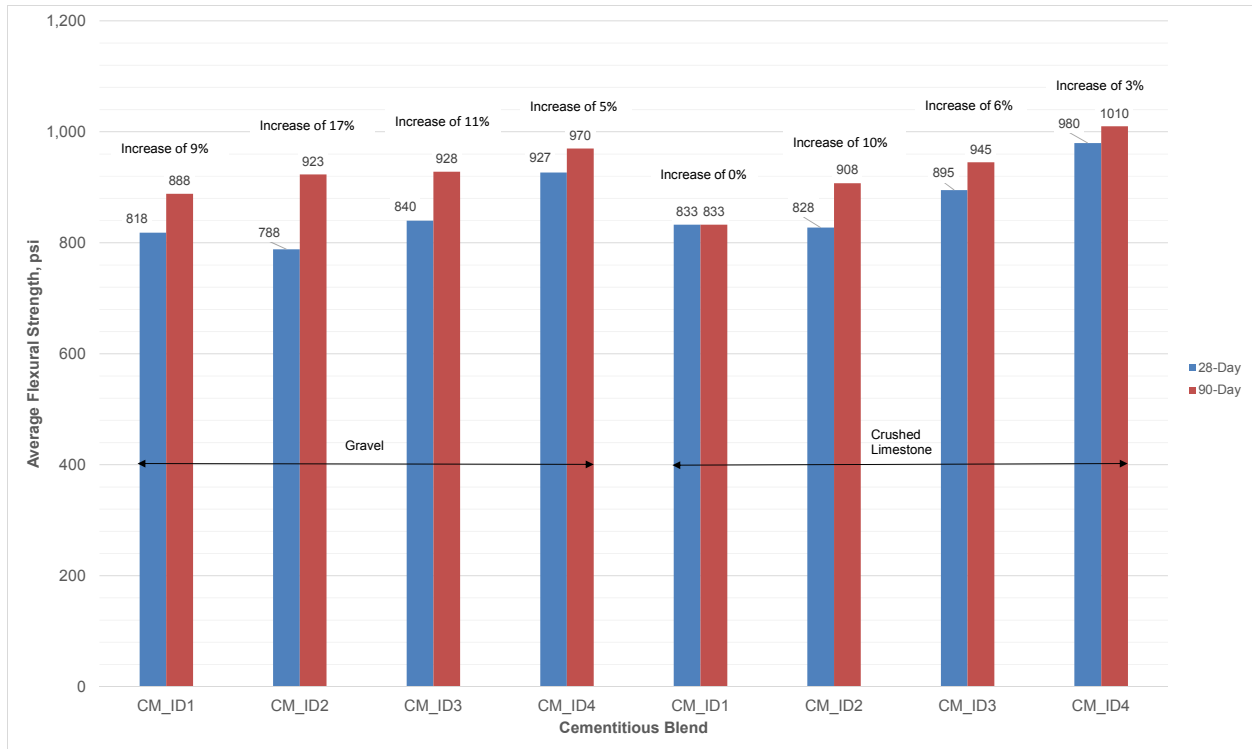


Figure 72. Average Increase in Flexural Strength from 28 Days to 90 Days

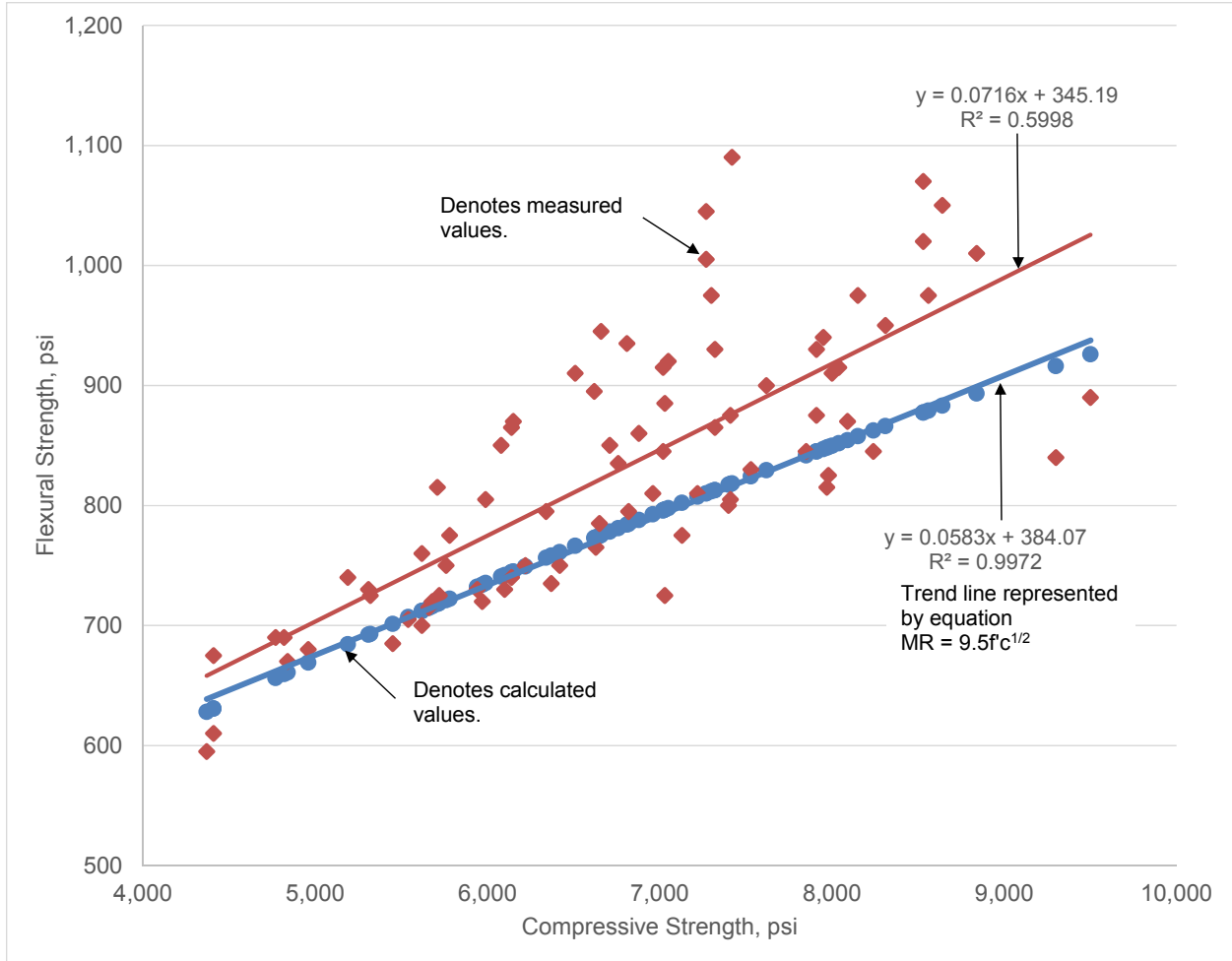


Figure 73. Flexural Strength VS Compressive Strength - Measured and Calculated Values

MODULUS OF ELASTICITY

Modulus of Elasticity (MOE) versus coarse aggregate source and cementitious blend are presented in Figures 74 through 77 for 7-day, 14-day, 28-day, and 90-days results, respectfully. The MOE was influenced by the coarse aggregate source. The higher DRUW values of 104 pcf (CA_ID3) and 103 pcf (CA_ID4) produced higher MOE values than mixes proportioned with lower DRUWs (96 pcf to 101 pcf). The highest MOE results were from mixes proportioned with No. 57 crushed limestone (CA_ID3) from Alabama (104 pcf). These data indicate that the No. 57 crushed stone (CA_ID3) from Alabama and the low absorption No. 57 gravel (CA_ID4) produced similar MOE.

The MEPDG provides an equation from ACI that can be used to estimate the modulus of elasticity from known properties of concrete mixtures including unit weight and compressive strength. This equation is presented below in Equation No. 8. Figure 78 presents modulus of elasticity versus compressive strength for both measured MOE and calculated MOE. MOE values calculated with the use of Equation 8 were on average 79 percent of the measured MOE values. As MOE or stiffness of PCC pavement increases, damage from a given traffic loading distribution increases. Therefore, pavement designers should use caution when Equation 8 is used to estimate MOE for use in thickness design of typical PCC pavements in Mississippi. Thickness design procedures such as the AASHTO 1993 design guide will produce slightly thicker PCC pavements with an increase in MOE.

$$E_c = 33\rho^{3/2}(f'c)^{1/2} \quad (8)$$

Where,

E_c = PCC elastic modulus, psi.

ρ = unit weight of concrete, pcf.

$f'c$ = compressive strength of PCC, psi.

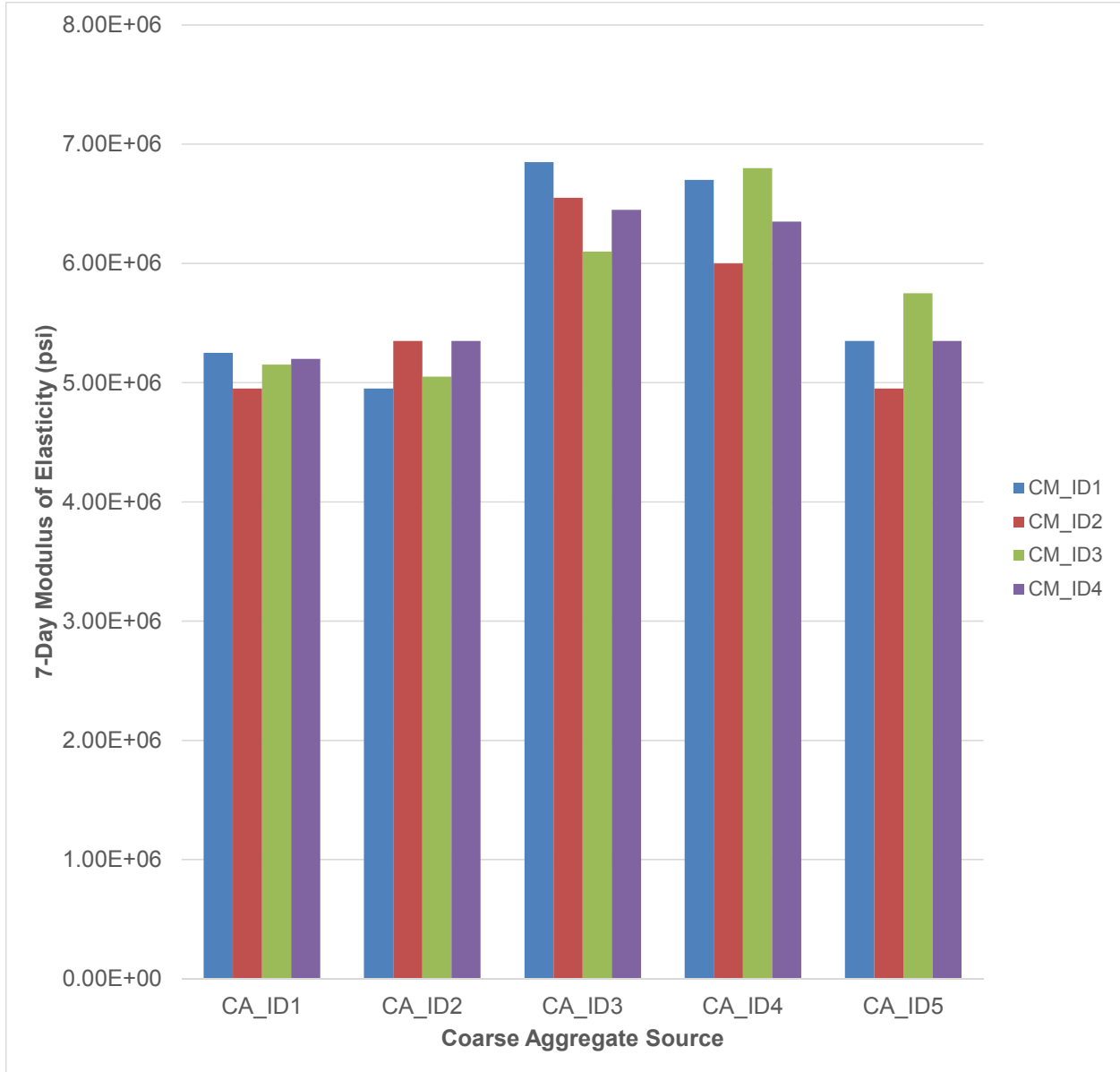


Figure 74. 7-Day MOE VS Coarse Aggregate Source

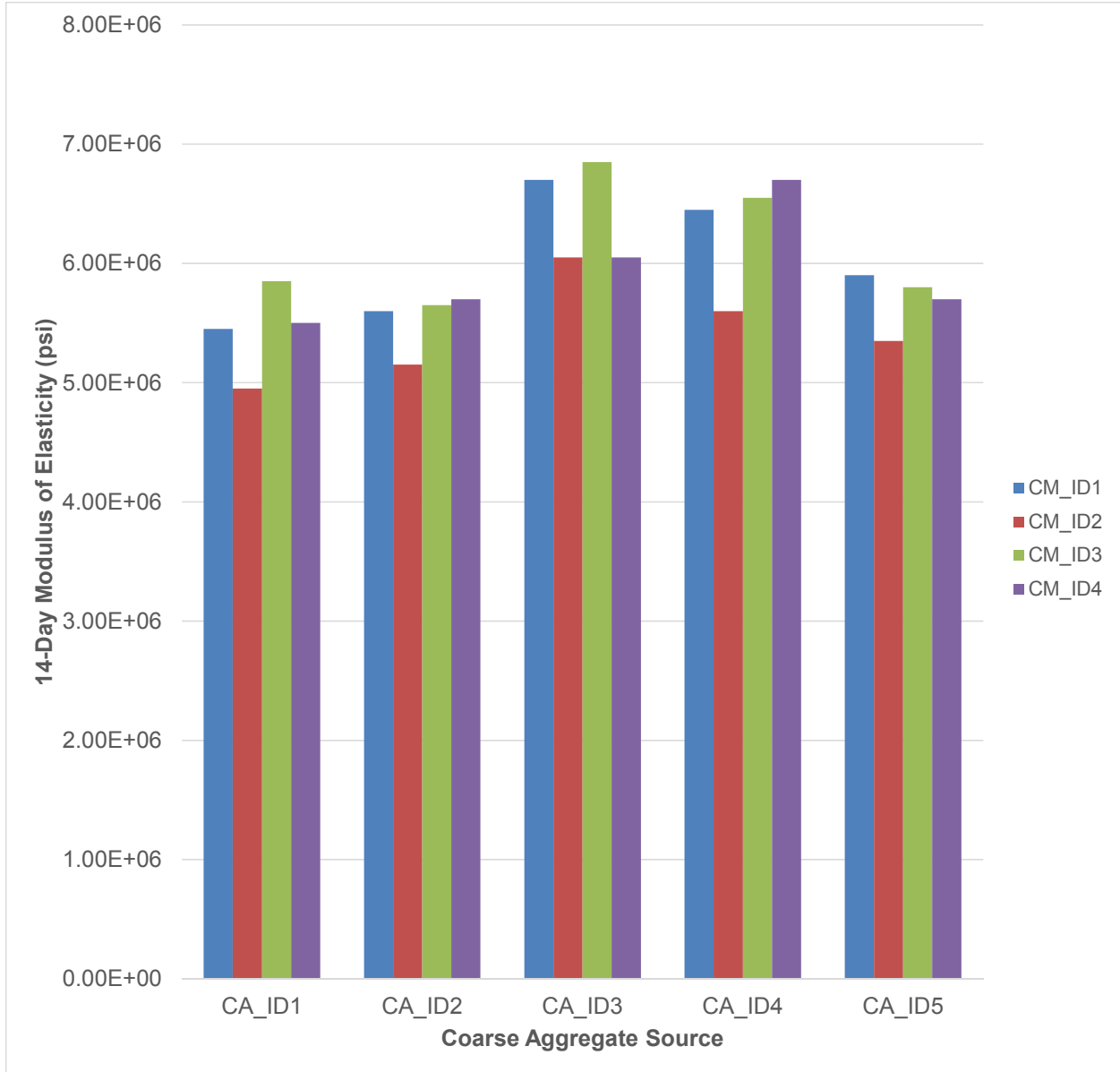


Figure 75. 14-Day MOE VS Coarse Aggregate Source

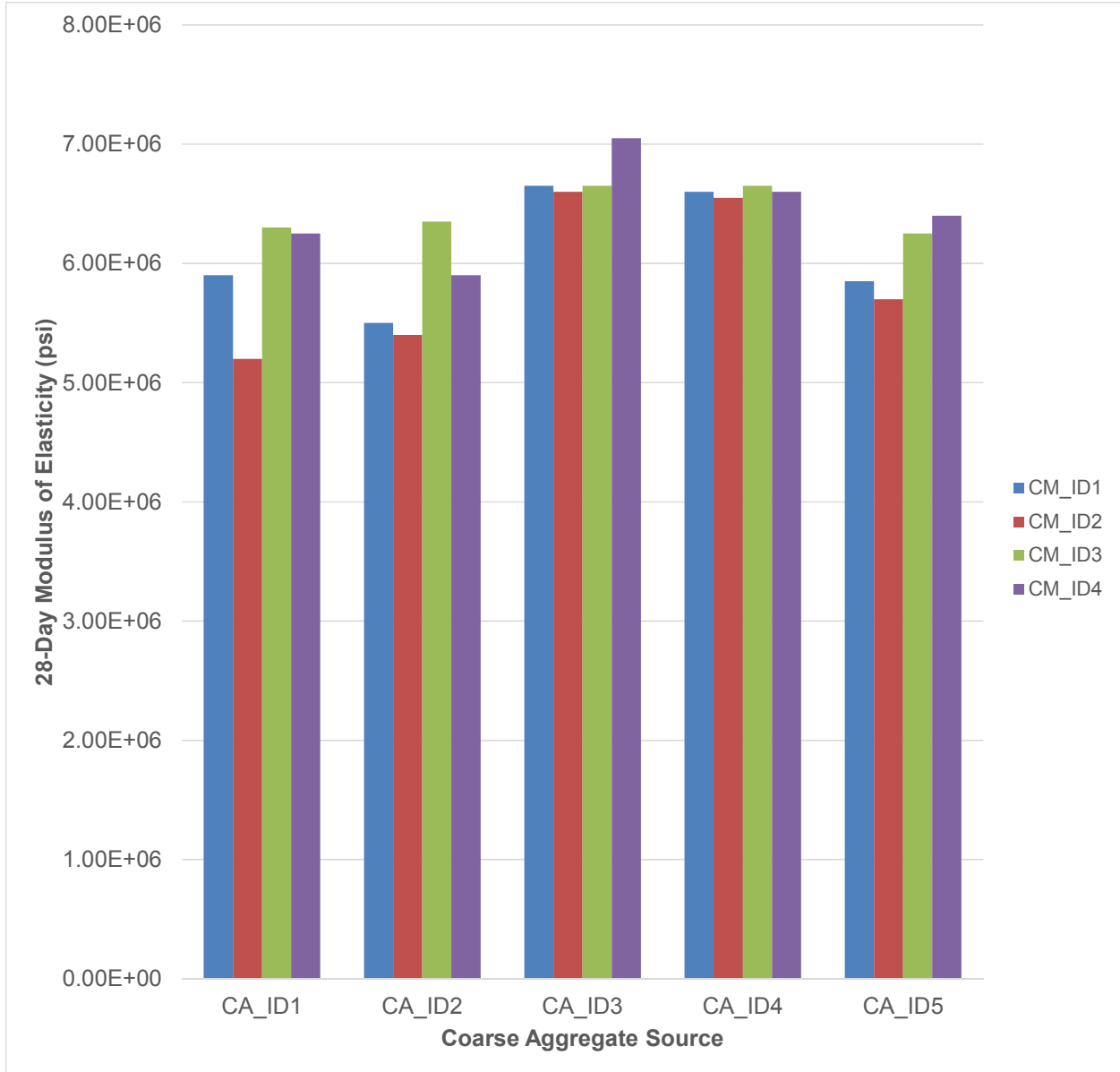


Figure 76. 28-Day MOE VS Coarse Aggregate Source

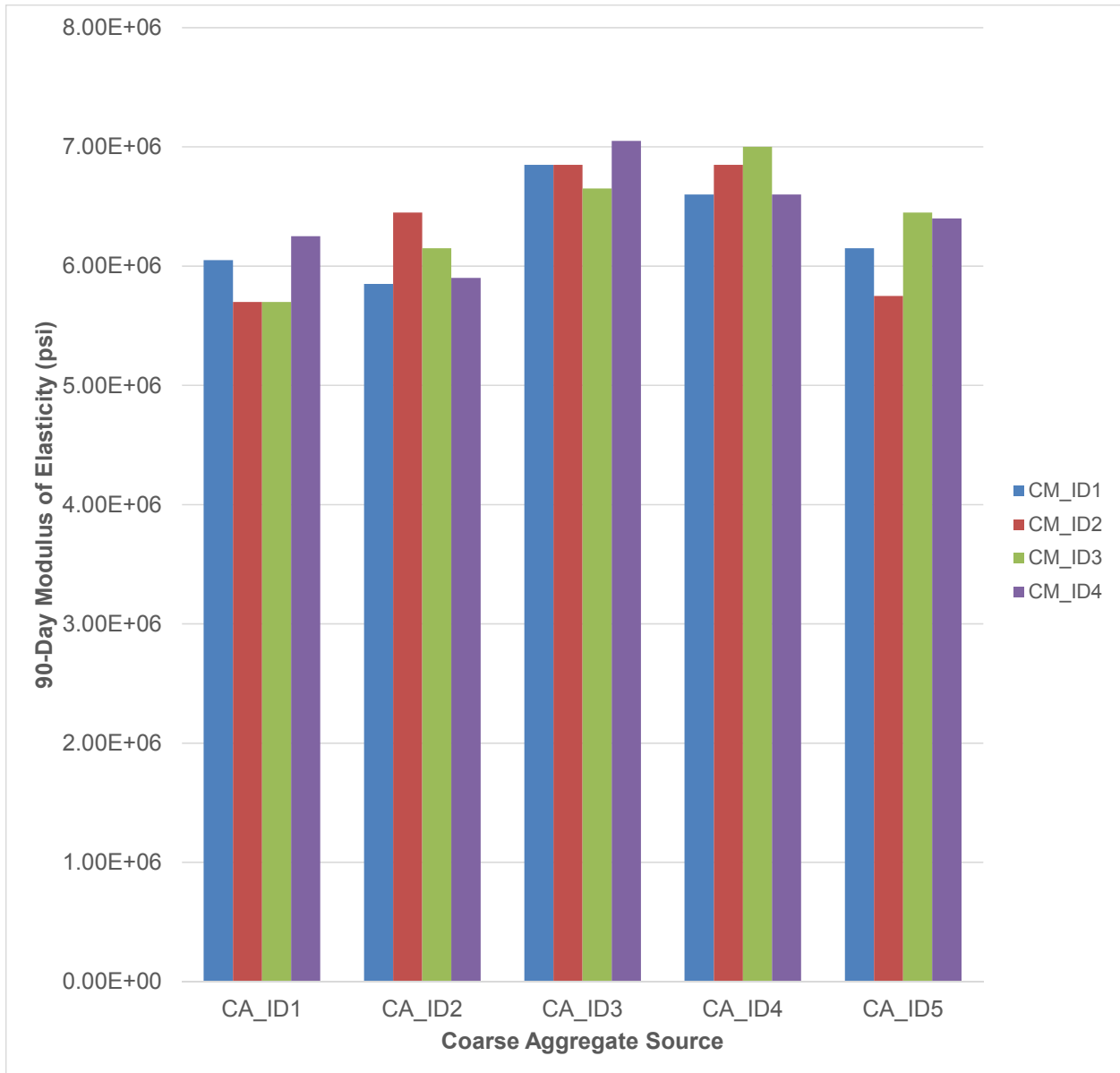


Figure 77. 90-Day MOE VS Coarse Aggregate Source

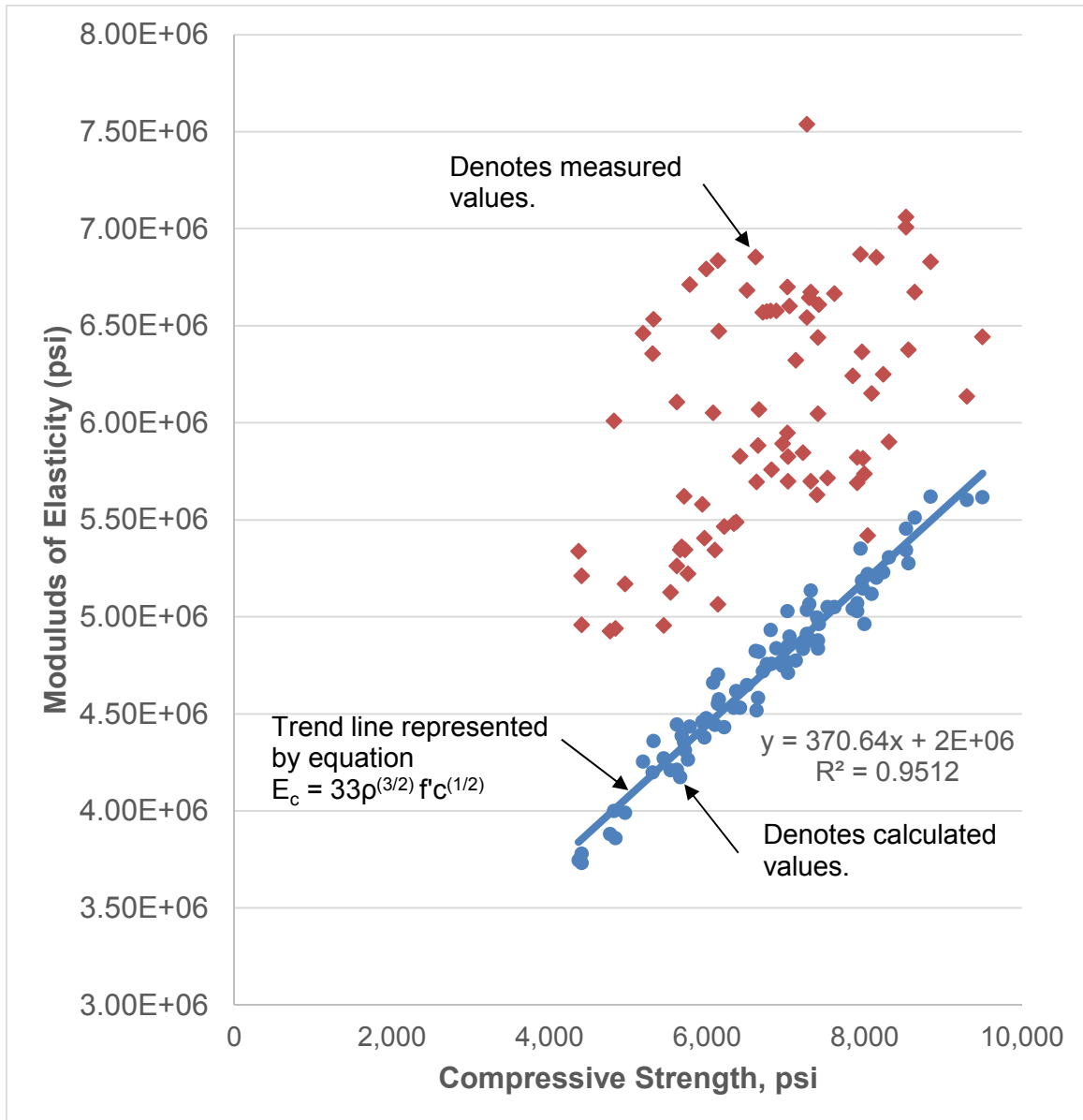


Figure 78. MOE VS Compressive Strength Using Measured and Calculated Values

POISSON’S RATIO

Poisson’s ratio versus coarse aggregate source and cementitious blend are presented in Figures 79 through 82 for 7-day, 14-day, 28-day, and 90-days results, respectfully. A typical value for Poisson’s ratio is within a range of 0.15 to 0.20 (Mindess, 2014). The crushed limestone mixes produced Poisson’s ratio results ranging from 0.19 to 0.24 for all test ages. The gravel aggregate mixes produced Poisson’s ratios within a range of 0.11 to 0.19. The Poisson’s ratios determined in this study were influenced primarily by the coarse aggregate type.

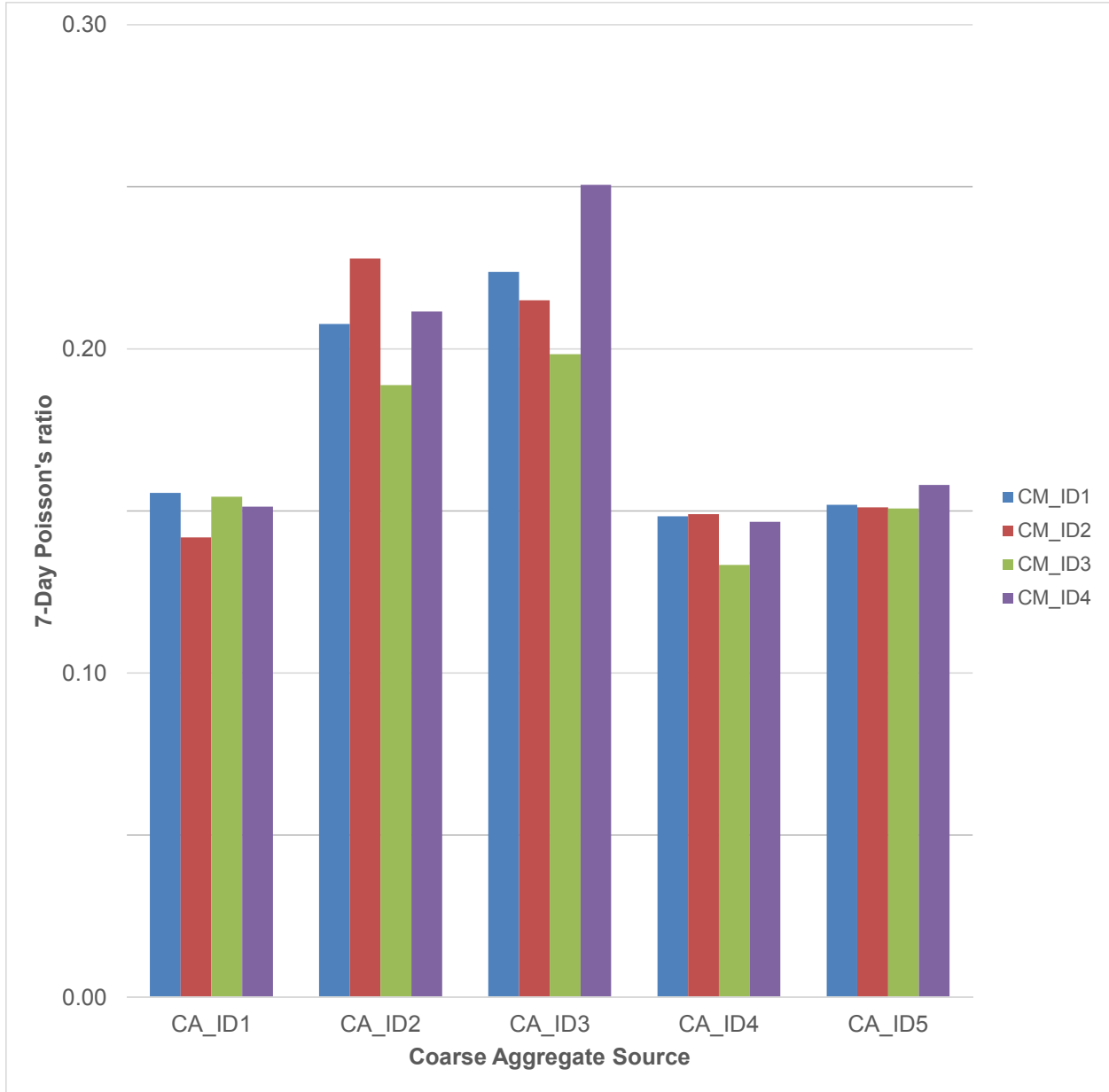


Figure 79. 7-Day Poisson's Ratio VS Coarse Aggregate Source

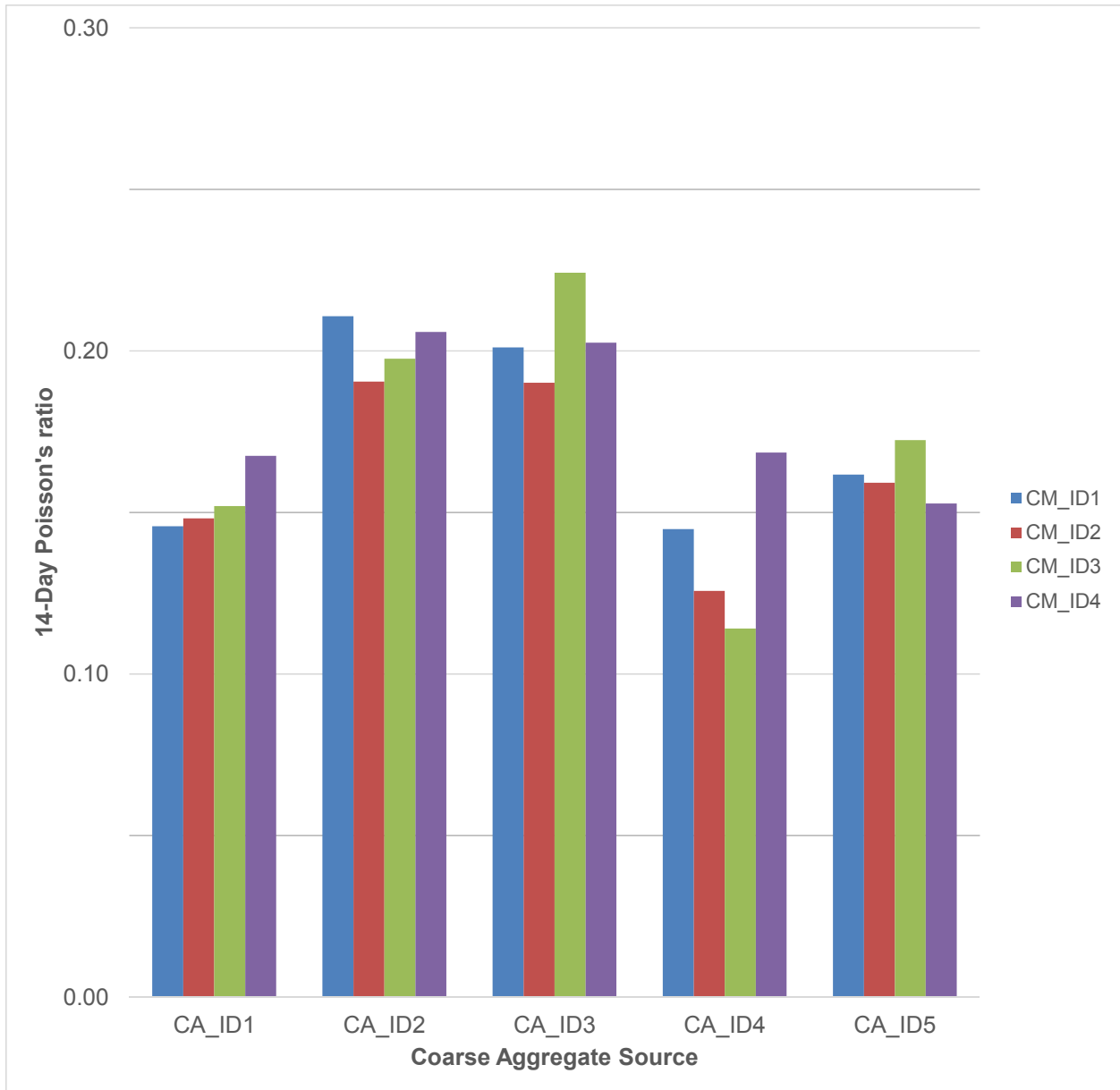


Figure 80. 14-Day Poisson's Ratio VS Coarse Aggregate Source

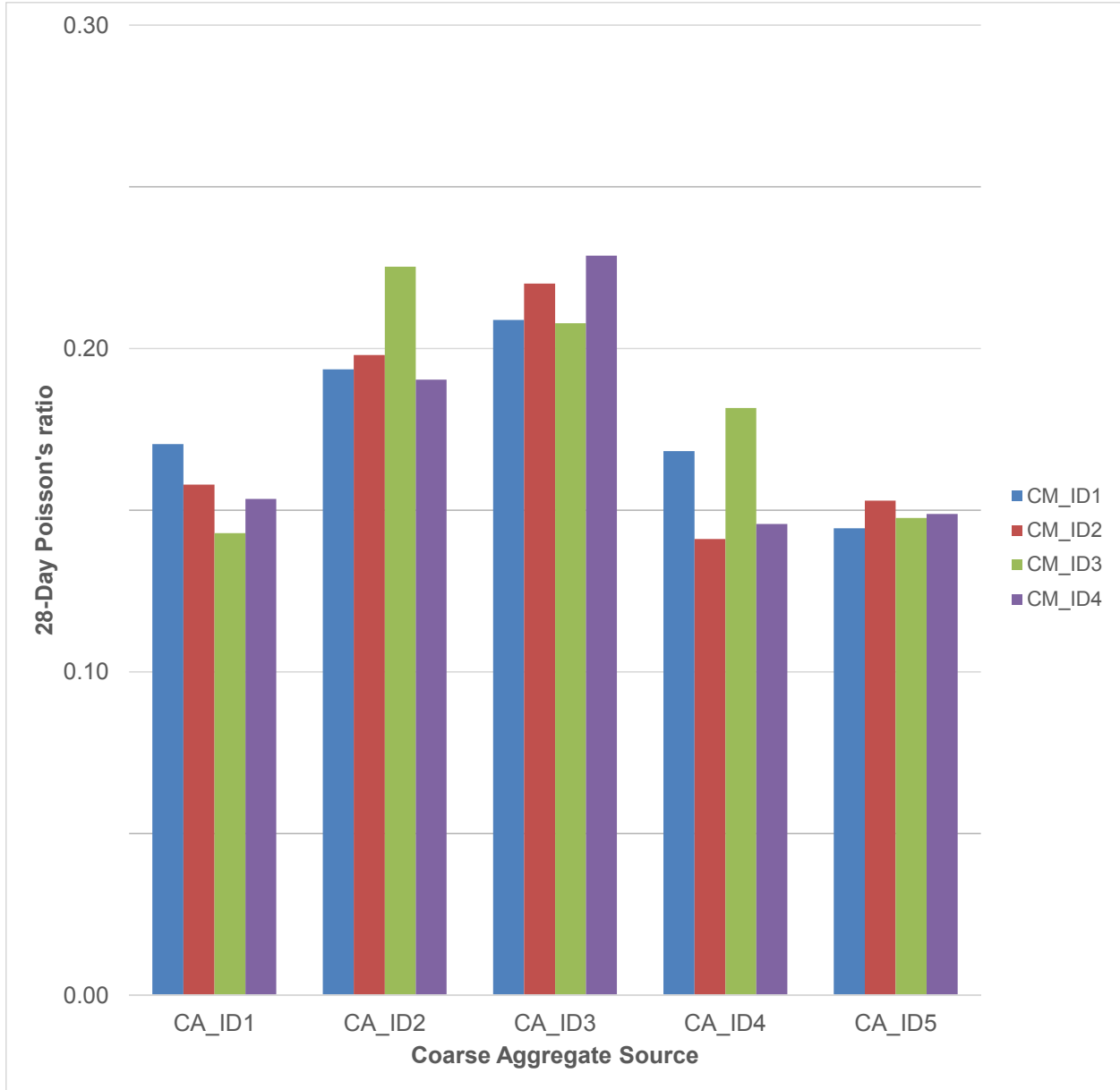


Figure 81. 28-Day Poisson's Ratio VS Coarse Aggregate Source

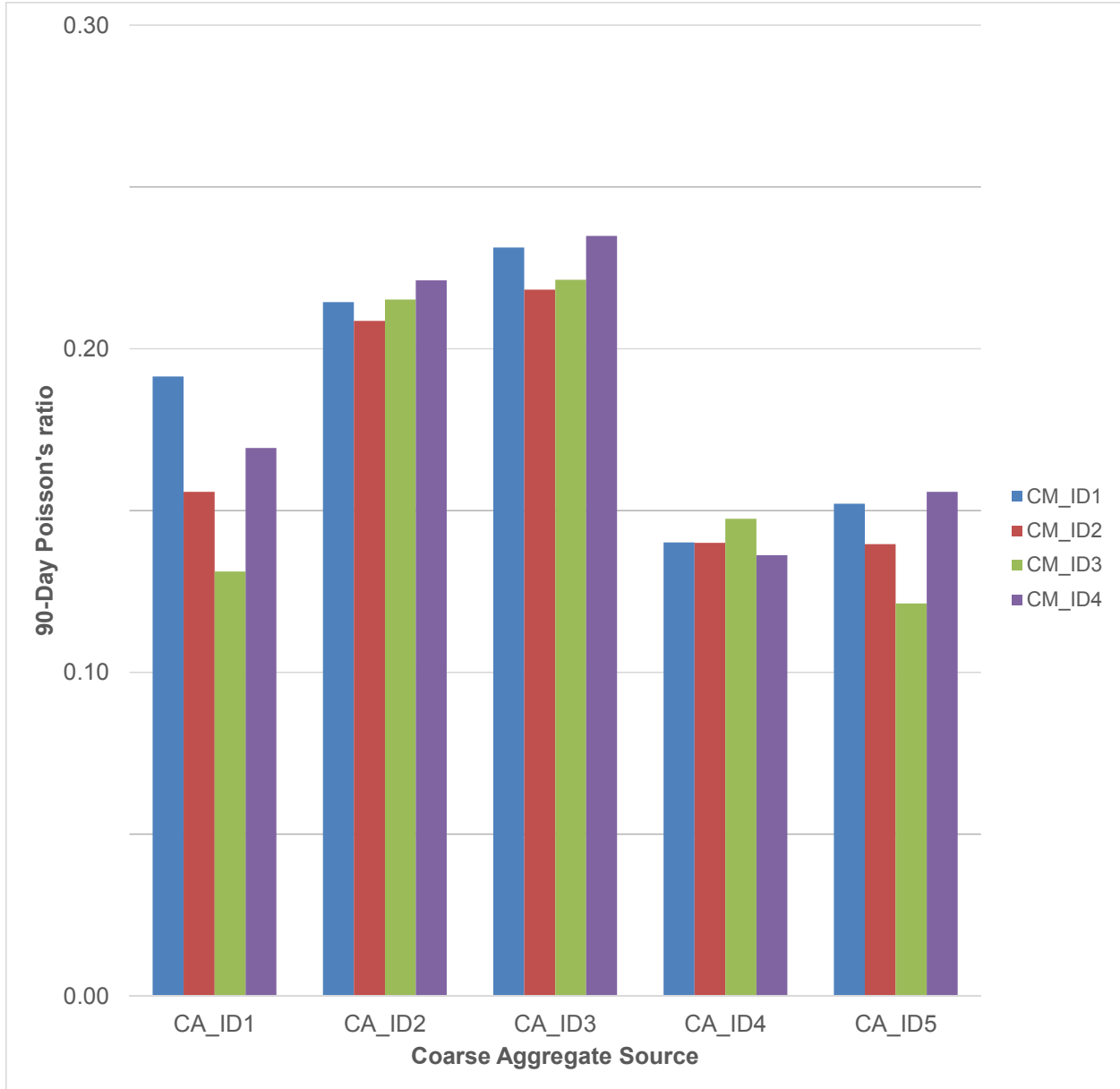


Figure 82. 90-Day Poisson's Ratio VS Coarse Aggregate Source

COEFFICIENT OF THERMAL EXPANSION (CTE)

Figure 83 presents CTE results for each coarse aggregate source and cementitious blend. The average CTE of all concrete mixtures proportioned with gravel aggregate (CA_ID1, CA_ID4, and CA_ID5) was 6.74 in./in. per °F. The average CTE of all concrete mixture proportioned with crushed limestone (CA_ID2 and CA_ID3) was 5.05 in./in. per °F. Data herein show that on average CTE values for gravel aggregate were 33 percent higher than mixes that

utilized crushed limestone aggregate. CTE was influenced primarily by the type of coarse aggregate.

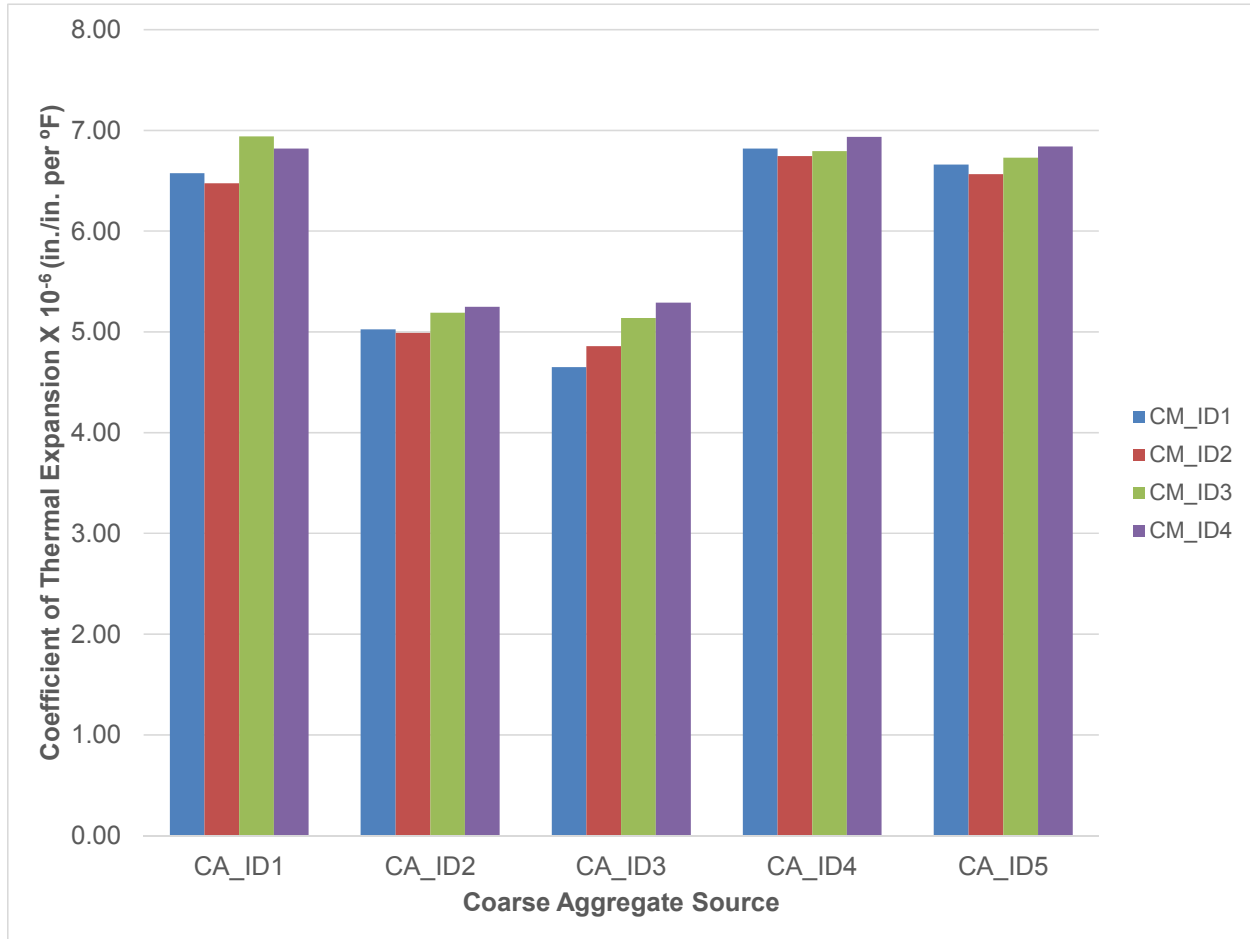


Figure 83. Coefficient of Thermal Expansion VS Coarse Aggregate Source

LENGTH CHANGE

Figure 84 presents 812-day length change results for each coarse aggregate source and cementitious blend. One trend observed in this figure is that mixes utilizing slag cement (CM_ID4) had less length change (shrinkage) than all other cementitious blends. This trend was observed for all coarse aggregate sources except for CA_ID3 where mixes utilizing slag cement had approximately the same shrinkage as mixes with 100 percent portland cement (CM_ID1) or Class F fly ash (CM_ID2). Mixes proportioned with slag cement or Class F fly ash had 87 percent and 96 percent, respectfully, of the shrinkage observed in mixes with 100 percent

portland cement (CM_ID1). There was a significant increase in shrinkage of mixes proportioned with Class C fly ash (CM_ID3) and crushed limestone (CA_ID2 and CA_ID3) with respect to the 100 percent portland cement mixes. This increase was 7 percent for CA_ID2 and 20 percent for CA_ID3 even though the water content of mixes proportioned with Class C fly ash was less than the water content of similar mixes utilizing 100 percent portland cement.

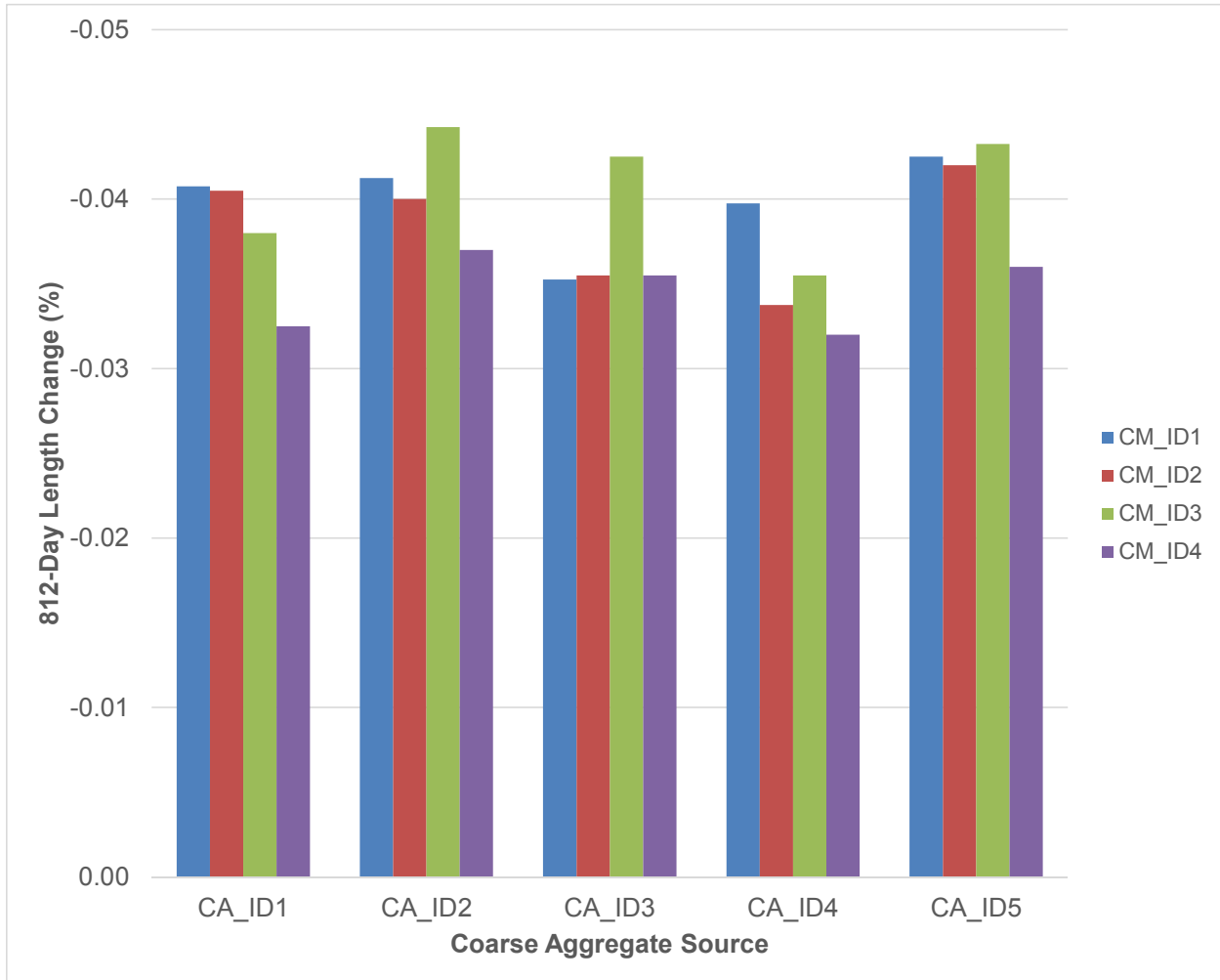


Figure 84. 812-Day Length Change (50% RH) VS Coarse Aggregate Source

Shrinkage Strain

Figure 85 presents 812-day shrinkage strain results for each coarse aggregate source and cementitious blend. Observations of these data are similar to the length change observations noted in the previous paragraph.

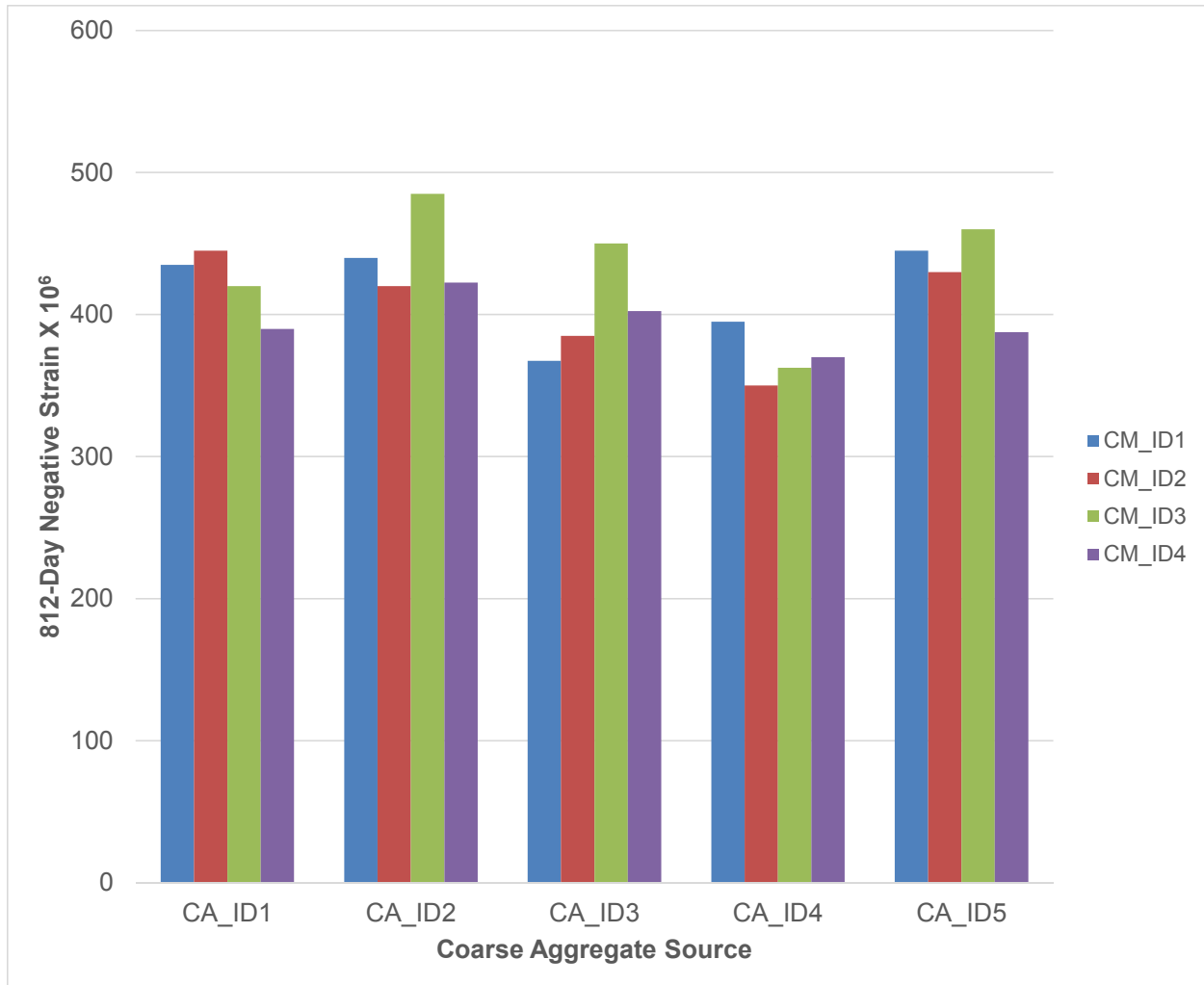


Figure 85. 812-Day Strain VS Coarse Aggregate Type

Estimating Ultimate Strain Based on PCC Mix Parameters

The MEPDG provides a formula for estimating ultimate strain based on PCC mix parameters. This formula is presented in Equation 9 and was used to estimate the ultimate strain. A comparison was made between the 812-day strain and the ultimate strain predicted by this equation and the results are summarized in Table 26 and presented in Figure 86. On average, the MEPDG equation provides a reasonable estimate of ultimate shrinkage strain of local PCC pavements. Figure 87 presents a scatter plot of 812-day strain and estimated ultimate strain. This figure shows that on average the MEPDG equation overestimated strain of mixes that utilize Class F fly ash or slag cement. On average, the MEPDG equation underestimates the strain of mixes that utilize 100% portland cement. Ultimate strain of PCC mixes utilizing Class C fly were significantly underestimated (up to 21.1 percent) when strain was based on PCC mix

parameters. The exception was mix 15 utilizing low absorption No. 57 gravel (CA_ID4). This mix had the lowest water demand (7.25 pcf) of all mixes of this study.

$$\varepsilon_{su} = C_1 * C_2 * \{26 * w^{2.1} * (f'_c)^{-0.28} + 270\} \quad (9)$$

where,

ε_{su} = ultimate shrinkage strain, x 10^{-6}

C1 = cement type factor:

1.0 for type I cement

0.85 for type II cement

1.1 for type III cement

C2 = type of curing factor:

0.75 if steam cured

1.0 if cured in water or 100% relative humidity

1.2 if sealed during curing (curing compound)

w = water content, pcf for the PCC mix under consideration

f'_c = 28-day PCC compressive strength, psi (determined from AASHTO T22)

Table 26. Comparison between Estimated Ultimate Shrinkage Strain Based on PCC Mix Parameters and 812-day Shrinkage Strain (40% RH)

Mix No.	812-day Shrinkage Strain 40% RH	Cement Factor C1	Curing Factor C2	Water Content pcy	Water Content pcf	28 Day Compressive Strength (psi)	Estimated Ultimate Shrinkage Strain Based on PCC Mix Parameters	Difference Between Estimated Ultimate Shrinkage Strain and 812-day Shrinkage (%)
1	489	1	1	229.19	8.49	6650	467	-4.66
2	500	1	1	222.92	8.26	5760	464	-7.76
3	472	1	1	210.40	7.79	7130	432	-9.24
4	438	1	1	229.19	8.49	7020	464	5.56
5	494	1	1	231.25	8.56	6370	473	-4.52
6	472	1	1	233.34	8.64	5970	481	1.89
7	545	1	1	225.00	8.33	7970	450	-21.10
8	475	1	1	237.50	8.80	8040	472	-0.58
9	413	1	1	231.25	8.56	7320	466	11.39
10	433	1	1	233.33	8.64	6810	474	8.74
11	506	1	1	220.83	8.18	7300	448	-12.86
12	452	1	1	237.50	8.80	7270	477	5.19
13	444	1	1	208.33	7.72	6880	430	-3.21
14	393	1	1	208.33	7.72	6710	431	8.76
15	407	1	1	195.83	7.25	7620	406	-0.32
16	416	1	1	216.66	8.02	7270	441	5.73
17	500	1	1	229.17	8.49	7220	463	-7.99
18	483	1	1	233.33	8.64	6630	475	-1.71
19	517	1	1	216.67	8.02	8240	435	-18.82
20	435	1	1	229.17	8.49	7910	458	4.94
							Average	-2.03

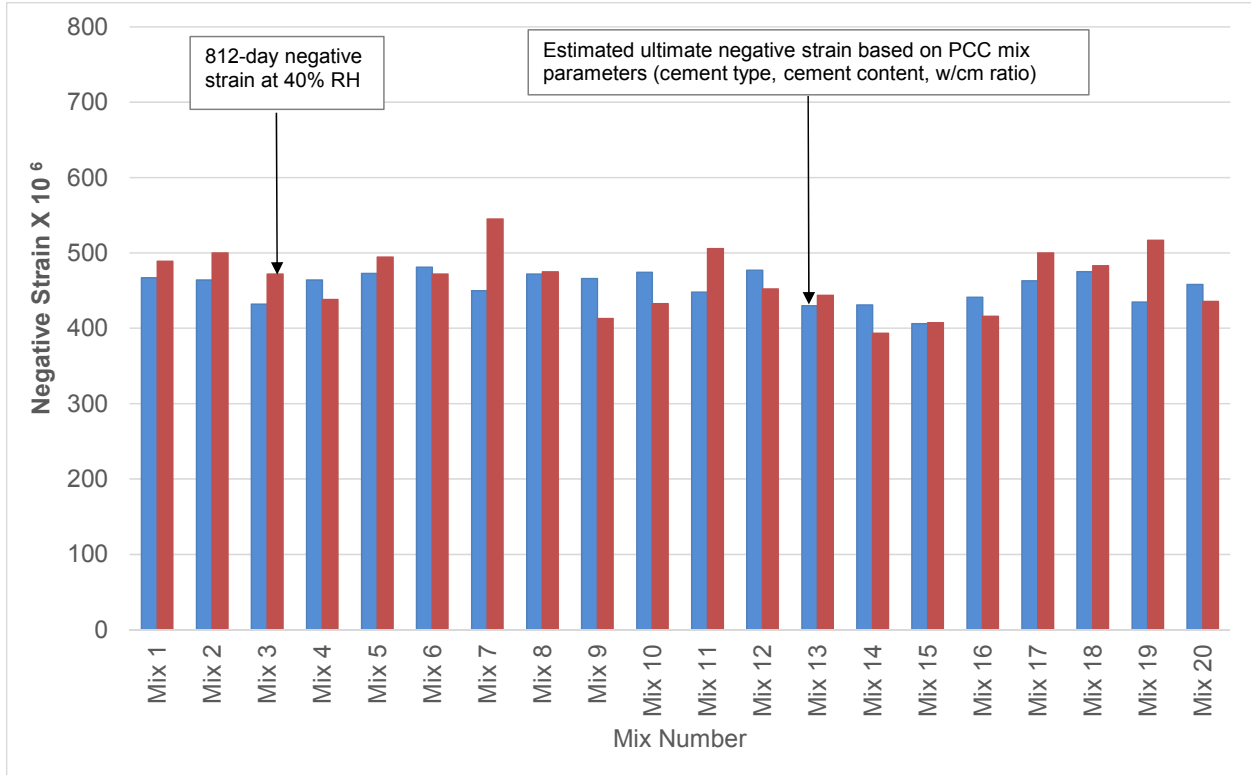


Figure 86. Estimated Ultimate Negative Strain and 812-Day Negative Strain (40% RH) VS Mix Number

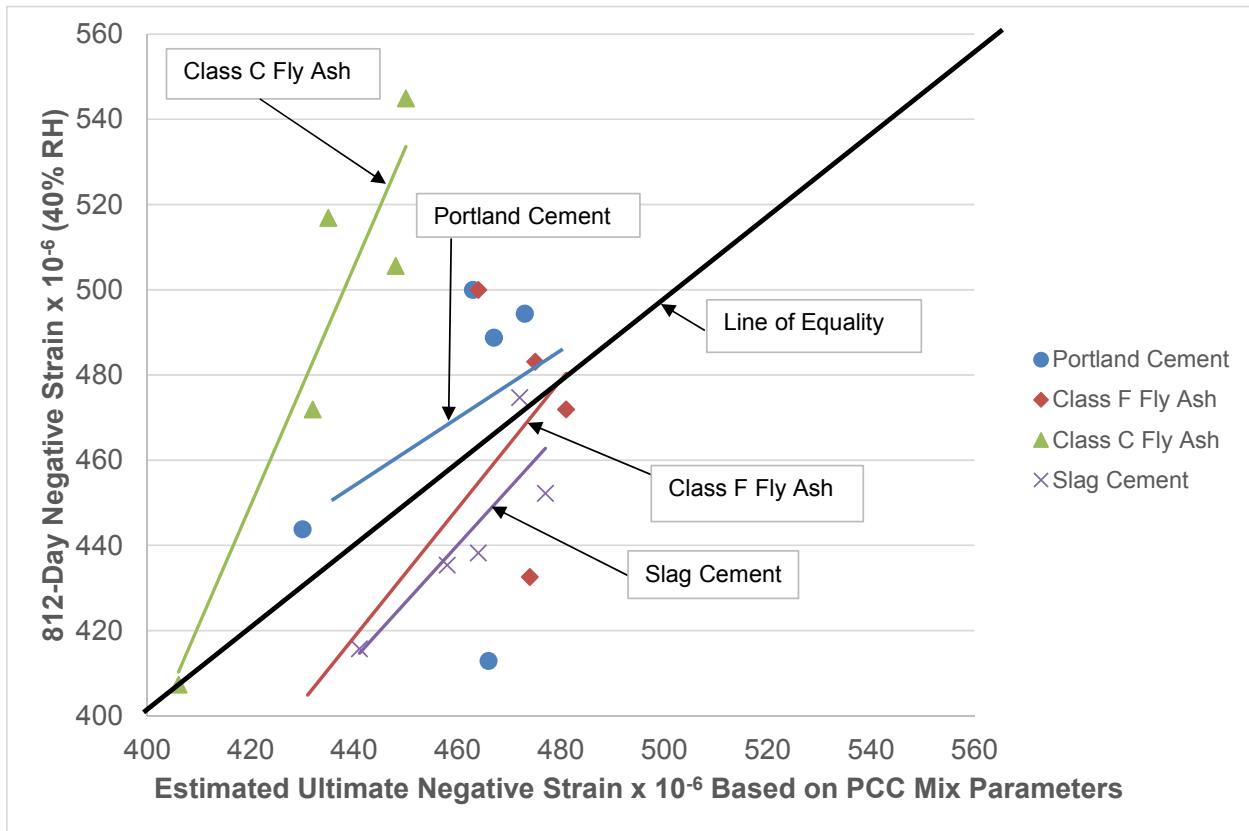


Figure 87. 812-Day Negative Strain (40% RH) VS Estimated Ultimate Negative Strain Based on PCC Mix Parameters

Estimating Ultimate Strain Based on 35-Day Strain

The MEPDG indicates that 50 percent of ultimate strain occurs at 35 days measured from the end of the initial 7-day moist curing period. The equation for estimating ultimate shrinkage is equation 2-9 of ACI 209R-92. While comparator readings were not taken at 35 days from the end of initial 7-day moist curing period, regression analysis was used to develop equations to calculate the 35-day strain. A discussion of how these equations were developed can be found in Chapter 4. A comparison between the 35-day shrinkage strain and 812-day shrinkage strain is presented in Table 27 and Figure 88. On average, the 35-day shrinkage is 47.7 percent of the 812-day shrinkage determined by testing. On average, the 35-day strain is 51.7 percent of the 812-day strain determined by testing. Figure 89 presents a scatter plot of 812-day negative strain and estimated ultimate strain based on 35-day strain. This figure shows that on average the

MEPDG equation overestimates the strain of mixes that utilize Class F fly ash or Class C fly ash. On average, the MEPDG equation underestimates the strain of mixes that utilize slag cement. On average, the MEPDG equation provided a reasonable estimate of mixes utilizing 100% portland cement.

Table 27. Comparison between 812-Day Shrinkage and 35-Day Shrinkage

Mix No.	Percent Shrinkage 50% RH			Negative Strain 50% RH			Negative Strain 40% RH		
	35-Day	812-Day	%	35-Day	812-Day	%	35-Day	812-Day	%
1	-0.0186	-0.0408	45.6	213	435	49.0	240	489	49.1
2	-0.0208	-0.0405	51.3	248	445	55.6	278	500	55.6
3	-0.0196	-0.0380	51.5	235	420	56.0	264	472	55.9
4	-0.0076	-0.0325	23.3	140	390	35.9	157	438	35.8
5	-0.0223	-0.0413	54.0	251	440	57.0	282	494	57.0
6	-0.0238	-0.0400	59.6	258	420	61.4	290	472	61.5
7	-0.0289	-0.0443	65.3	332	485	68.4	373	545	68.4
8	-0.0153	-0.0370	41.3	205	423	48.5	230	475	48.4
9	-0.0188	-0.0353	53.5	202	368	55.1	227	413	55.0
10	-0.0190	-0.0355	53.5	221	385	57.3	248	433	57.3
11	-0.0264	-0.0425	62.1	289	450	64.3	325	506	64.3
12	-0.0129	-0.0355	36.2	176	403	43.7	198	452	43.8
13	-0.0201	-0.0398	50.4	198	395	50.2	223	444	50.2
14	-0.0175	-0.0338	51.9	187	350	53.4	210	393	53.4
15	-0.0219	-0.0355	61.7	226	363	62.5	254	407	62.4
16	-0.0093	-0.0320	29.1	143	370	38.8	161	416	38.7
17	-0.0180	-0.0425	42.3	200	445	45.0	225	500	45.0
18	-0.0204	-0.0420	48.5	213	430	49.6	239	483	49.5
19	-0.0208	-0.0433	48.0	236	460	51.3	265	517	51.3
20	-0.0089	-0.0360	24.7	117	387	30.2	132	435	30.3
	Average		47.7	Average		51.7	Average		51.7

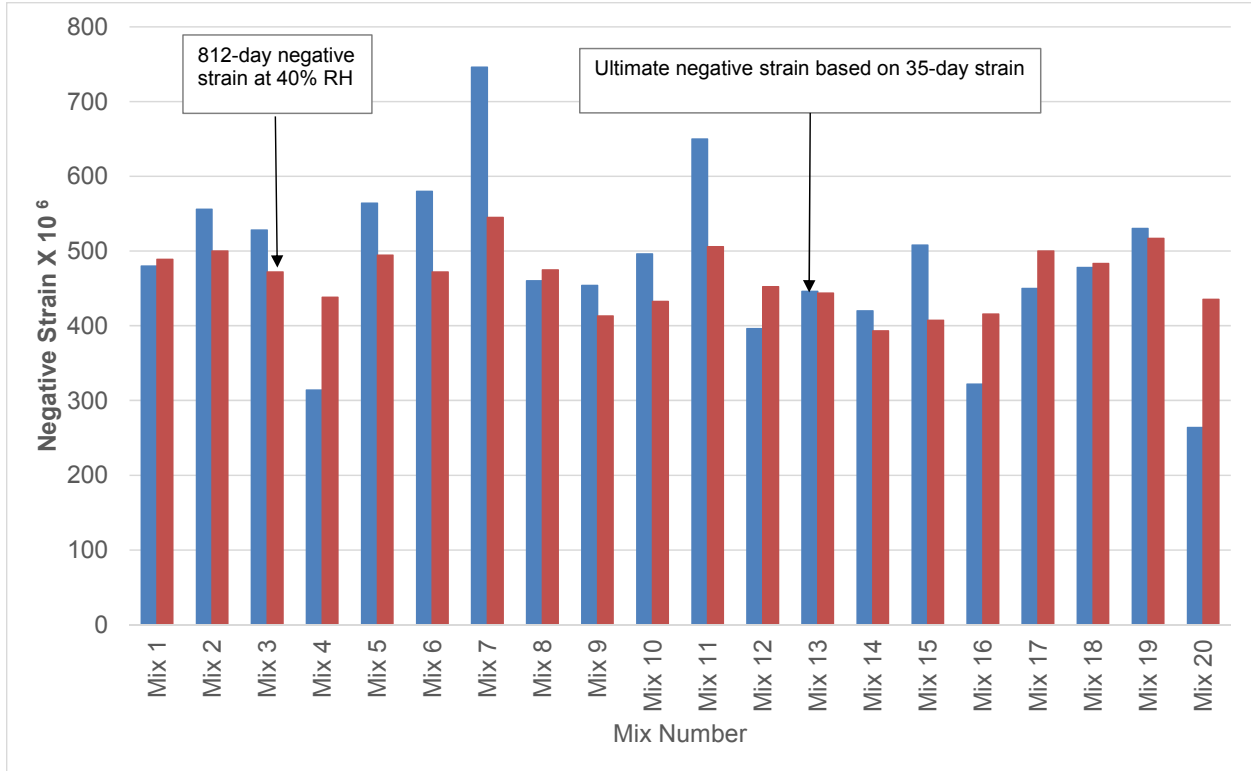


Figure 88. Estimated Ultimate Negative Strain and 812-Day Negative Strain (40% RH) VS Mix Number

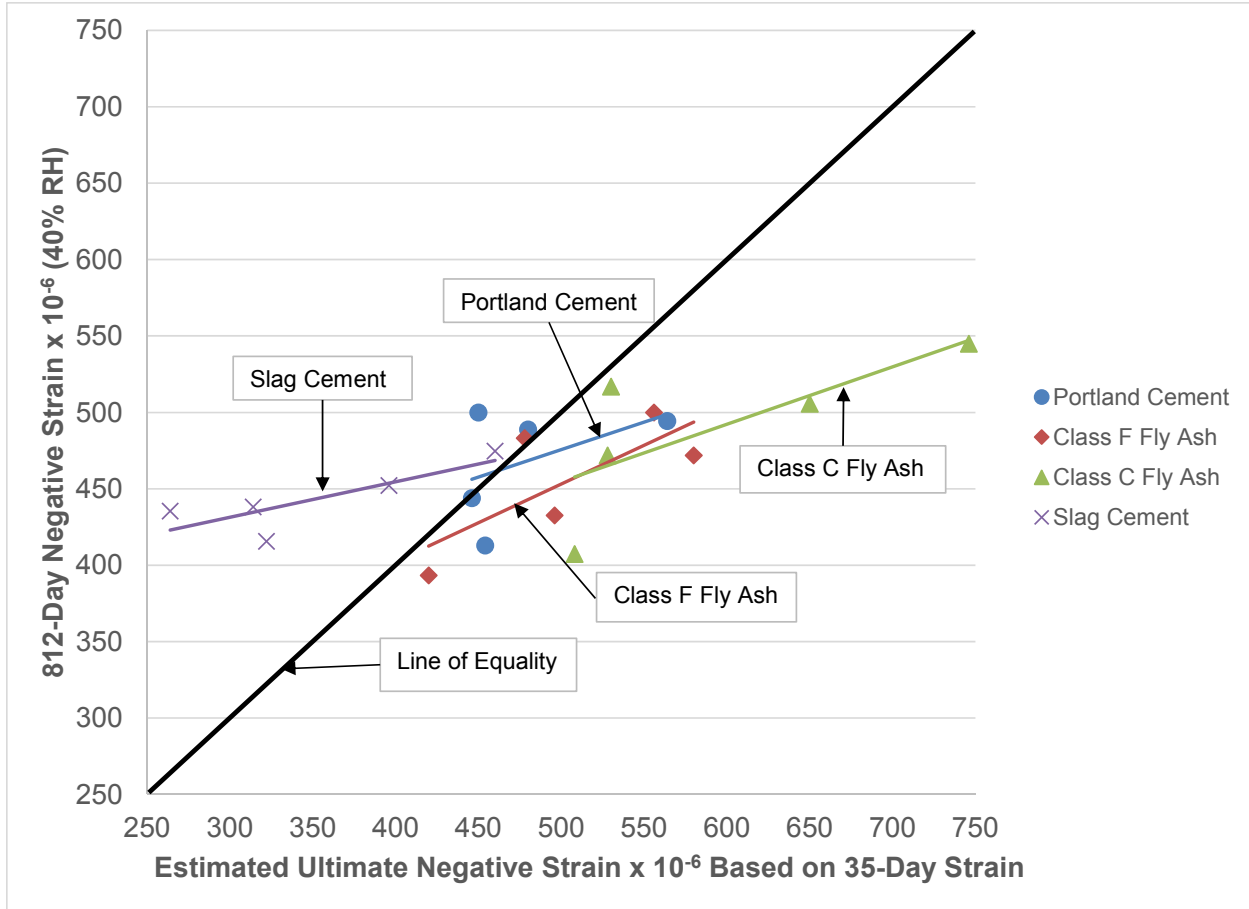


Figure 89. 812-Day Strain (40% RH) VS Estimated Ultimate Negative Strain Based on 35-Day Strain

Reversible Shrinkage Strain

The MEPDG states “At all input levels, unless more reliable information is available, a value to 50 percent is recommended” for anticipated amount of reversible shrinkage (ARA, 2004). Table 28 and Figure 90 presents a summary of reversible shrinkage. In all cases, the mixes of this study produced reversible shrinkage that exceeded 50 percent. The overall average of reversible shrinkage was 67.1 percent. Mixes that utilized slag cement (mixes 4, 8, 12, 16, and 20) experienced the most reversible shrinkage with an average of 78.0 percent. Mixes utilizing Class F fly ash (mixes 2, 6, 10, 14, and 18) and Class C fly ash (mixes 3, 7, 11, 15, and 19) had reversible shrinkage of 59.3 and 61.6, respectively. Mixes utilizing 100 percent portland cement (mixes 1, 5, 9, 13, and 17) had an average reversible shrinkage of 69.5 percent.

Table 28. Summary of Reversible Shrinkage Strain (40% RH)

Mix No.	812-Day Negative Strain x 10 ⁻⁶	940-Day Negative Strain x 10 ⁻⁶	Reversible Shrinkage (%)
1	489	157	67.8
2	500	208	58.4
3	472	157	66.7
4	438	76	82.7
5	494	154	68.8
6	472	197	58.3
7	545	219	59.8
8	475	98	79.3
9	413	121	70.7
10	433	194	55.2
11	506	228	55.0
12	452	129	71.4
13	444	126	71.5
14	393	138	65.0
15	407	143	64.8
16	416	81	80.4
17	500	157	68.5
18	483	197	59.3
19	517	197	62.0
20	435	104	76.1
		Average	67.1

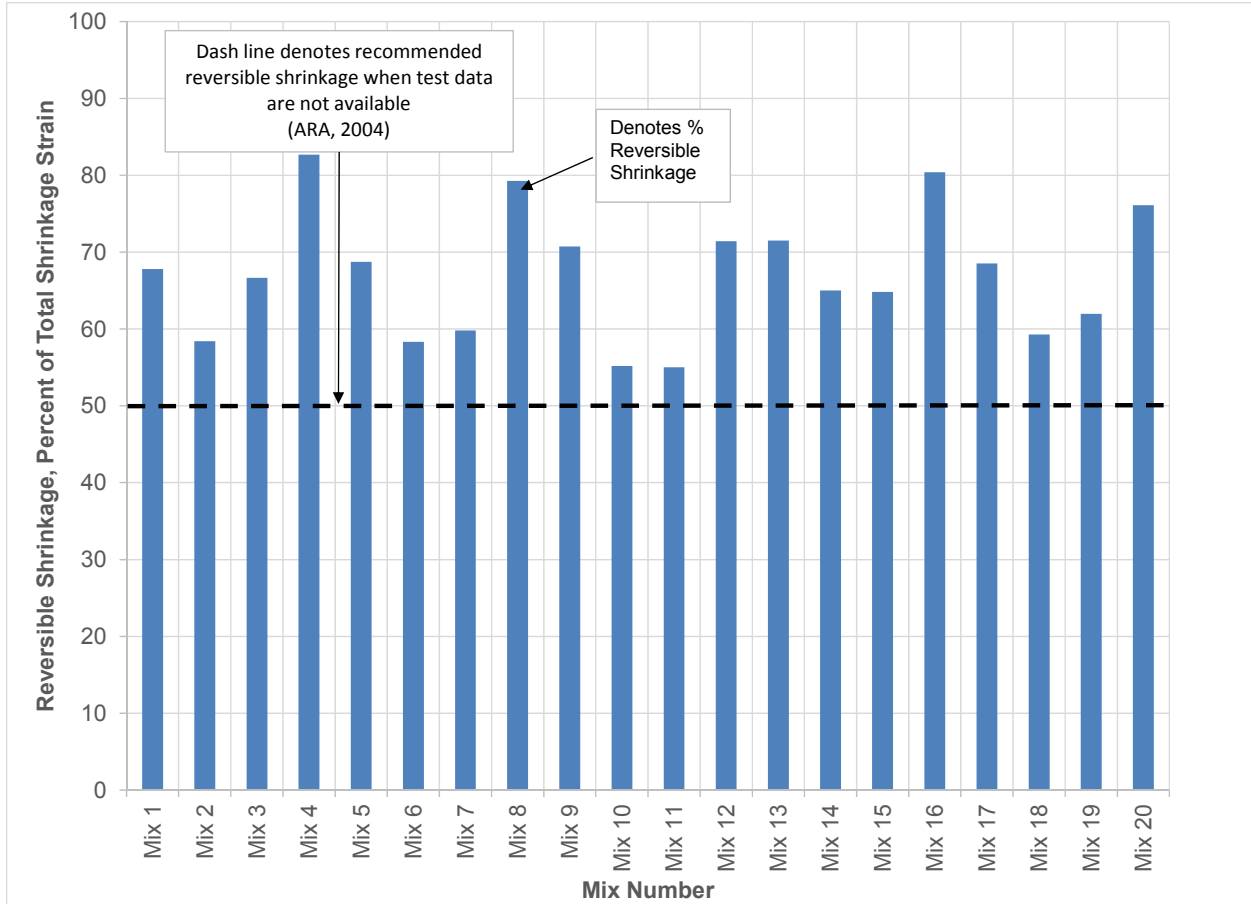


Figure 90. Comparison of Estimated Reversible Shrinkage and Measured Reversible Shrinkage

Time to Develop 50 Percent of 812-Day Shrinkage

The MEPDG states “unless more reliable information is available, a value of 35 days, as recommended by the ACI Committee 209, is recommended for the time required to develop 50 percent of ultimate shrinkage” (ARA, 2004). In order to determine the time required to reach 50 percent of the 812-day shrinkage for mixes tested in this study, scatter plots with best fitting curves were drawn for each mix and time was calculated. These data are summarized in Table 29 and presented in Figure 91. The time to reach 50 percent of the 812-day shrinkage ranged from 15.1 days (mix 7) to 80.1 days (mix 20). This time was influenced by cementitious blend and the type of coarse aggregate. On average, mixes utilizing limestone required 26 days to develop 50 percent of the 812-day shrinkage while mixes utilizing gravel required 40 days on average. Mixes proportioned with slag cement required the most time to develop 50 percent of

the 812-day shrinkage with an average of 54 days. Mixes proportion with 100 percent portland cement required the next longest time (32 days) followed by mixes proportioned with Class F fly ash (31 days), then Class C fly ash (25 days).

Table 29. Summary of Time to Develop 50% of 812-Day Shrinkage

Mix No.	812-Day Negative Strain x 10 ⁻⁶	50% of 812-Day Negative Strain x 10 ⁻⁶	Time to Develop 50% of 812-Day Shrinkage (Days)
1	489	244	35.1
2	500	250	27.1
3	472	236	23.7
4	438	219	58.0
5	494	247	23.9
6	472	236	21.4
7	545	272	15.1
8	475	237	34.6
9	413	206	24.6
10	433	216	24.4
11	506	253	18.5
12	452	226	44.2
13	444	222	33.0
14	393	197	31.5
15	407	204	18.1
16	416	208	55.0
17	500	250	44.6
18	483	242	35.4
19	517	258	33.6
20	435	218	80.1
		Average	34.1

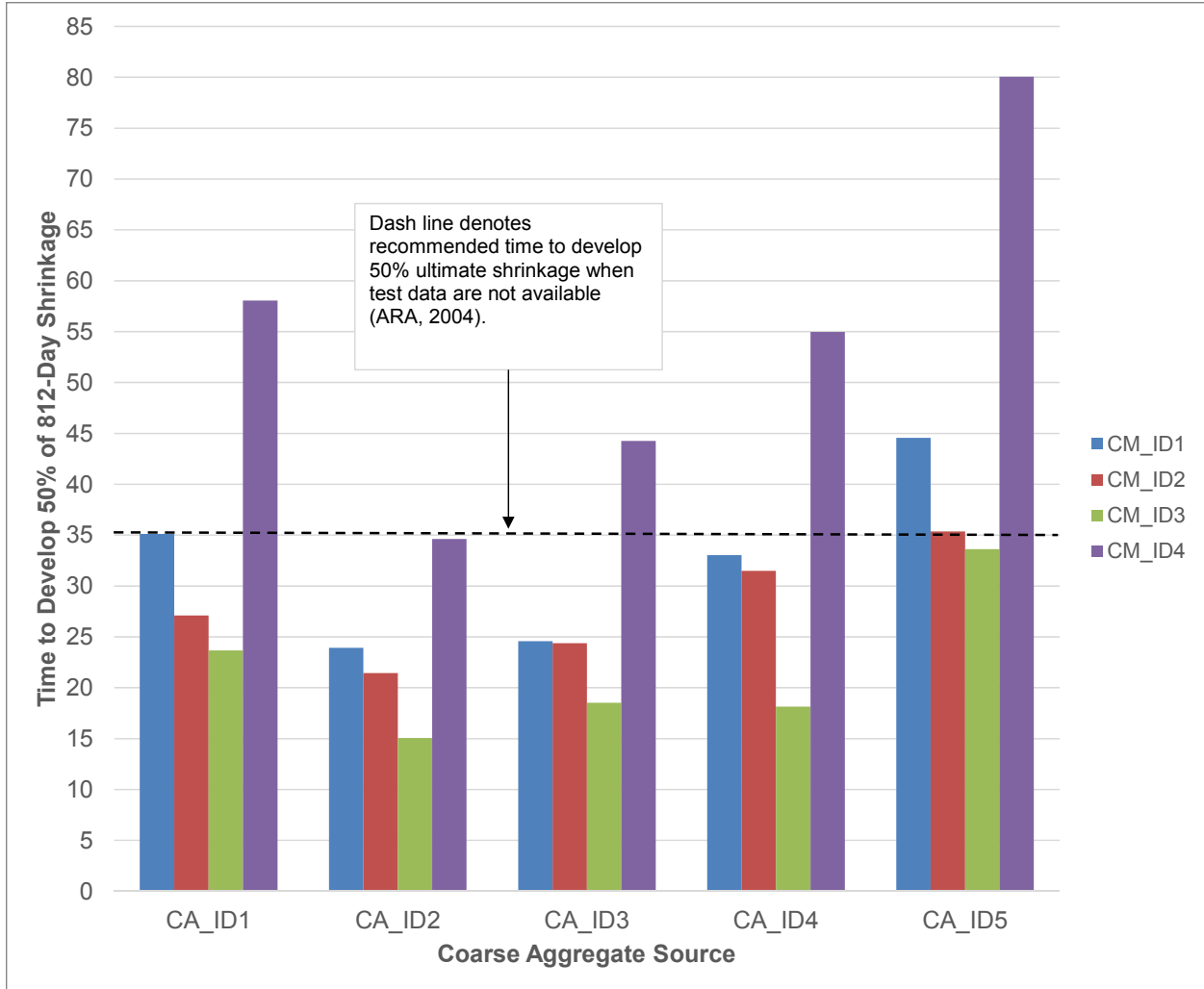


Figure 91. Time Required To Develop 50 Percent of 812-Day Shrinkage VS Coarse Aggregate Source

PCC PAVEMENT PROPERTIES

This study documents concrete properties from testing twenty laboratory mixes that represent typical concrete pavements in Mississippi. These data are useful in the implementation of the MEPDG for PCC pavements. Data from this study including; compressive strength, flexural strength, modulus of elasticity, Poisson’s ratio, coefficient of thermal expansion, and shrinkage up to a specimen age of 119 days were provided to MDOT and Rao Research and Consulting, LLC in December 2014. These data were used to develop guidelines for PCC inputs to the AASHTOWare Pavement ME. More information on the implementation of the MEPDG for concrete pavements can be found in “Guidelines for PCC Inputs to AASHTOWare Pavement

ME” (Rao, 2014). Long-term shrinkage shown herein were not available for Rao Research and Consulting to include in their report.

Concrete properties are specific to individual mixes and these properties are influenced by mix proportions and sources of constituent materials. The use of average concrete properties for pavements may produce overly conservative pavement designs or may produce designs that are not adequate for the intended use. However, average values for concrete properties determined in this study may be useful for estimating purposes when concrete mix properties are unavailable. Average properties of the mixes in this study are presented in Table 30.

Table 30. Average PCC Pavement Properties

Description	Variable	Mississippi Gravel				Crushed Limestone			
		100% Portland Cement	25% Class F Fly Ash	25% Class C Fly Ash	50% Slag Cement	100% Portland Cement	25% Class F Fly Ash	25% Class C Fly Ash	50% Slag Cement
Fresh Property	Unit Weight (pcf)	144.0	142.2	144.6	144.5	146.9	146.6	146.7	146.6
Mechanical Properties	28-Day Compressive Strength (psi)	6,920	6,370	7,660	7,400	6,840	6,390	7,630	7,650
	28-Day Flexural Strength (psi)	815	785	840	925	830	825	895	980
	28-Day Modulus of Elasticity (psi)	6,100,000	5,850,000	6,400,000	6,450,000	6,100,000	6,000,000	6,500,000	6,000,000
	28-Day Poisson's Ratio	0.16	0.15	0.16	0.15	0.20	0.21	0.22	0.21
Volume Change Properties	28-Day Coefficient of Thermal Expansion X 10 ⁻⁶ (in./in./° F)	6.7	6.6	6.8	6.9	4.8	4.9	5.2	5.3
	812-Day shrinkage at 40% RH (Negative Strain x 10 ⁻⁶)	478	459	465	430	454	452	525	464
	Reversible Shrinkage (% of 812-Day Shrinkage)	69	61	65	80	70	57	57	75
	Time to Develop 50% of 812-Day Shrinkage (days)	37.6	31.3	25.1	64.4	24.2	22.9	16.8	39.4

CHAPTER 7 - CONCLUSIONS

A total of twenty mixtures were tested to provide MDOT with data useful for the implementation of the MEPDG for thickness determination of PCC pavements. Five sources of coarse aggregate were used including two sources of crushed limestone and three sources of Mississippi gravel. One of the gravel aggregate sources was also used for the fine aggregate that was utilized in all mixes. One source of portland cement, one source of Class C fly ash, one source of Class F fly ash, and one source of slag cement was utilized for the cementitious materials. Fly ash was introduced at a replacement rate of 25 percent. A replacement rate of 50 percent was utilized for slag cement. A mixture proportioned with 100 percent portland cement was also utilized for each coarse aggregate source. These four cementitious blends in combination with five sources of coarse aggregate were used to produce twenty mixtures to determine concrete properties for this report. Therefore, this data set is limited and should be used by professionals who understand the limitations of its use. General observations of the data are as follows:

Observations:

Water Demand:

1. The use of Class C fly ash reduces the amount of water needed to produce a target slump compared to similar mixtures utilizing 100 percent portland cement. The use of Class F fly ash has less influence on water demand than Class C fly ash. Slag cement has little to no influence on water demand.
2. Water demand was higher for crushed limestone than similar mixtures utilizing Mississippi gravel.
3. The low absorption gravel required the least amount of water to produce the target slump.

Unit Weight:

1. Mixtures proportioned with Class F fly ash produced the lowest unit weight within a set of gravel aggregate mixes.

2. Mixes 9, 10, 11, and 12 had the highest unit weights for all cementitious blends. These mixtures utilized crushed limestone from Alabama which had the highest dry rodded unit weight (104 pcf) and the highest void content (38.8%).

Compressive Strength:

1. Mixes proportioned with Class C fly ash, in general, had the highest compressive strength for all test ages.
2. On average, the No. 67 gravel source produced higher 28-day compressive strengths than the No. 57 crushed limestone or the No. 57 gravel sources. This performance may be due to the increased surface area of the smaller size coarse aggregate provided for increased paste aggregate bond strength.
3. The compressive strengths increased from 28 to 90 days as follows: 100% portland cement (9 percent), 25% Class F fly ash (24 percent), 25 % Class C fly ash (15 percent), and 50% slag cement (8 percent). Mixes proportioned with Class F fly ash produced the highest increase in compressive strength from 28 days to 90 days followed by mixtures proportioned with Class C fly ash.

Flexural Strength:

1. The No. 57 crushed limestone from Alabama produced the highest flexural strength followed by No. 57 low absorption gravel (CA_ID4).
2. The flexural strength increased from 28 days to 90 days as follows: 100% portland cement (5 percent), 25% Class F fly ash (14 percent), 25 % Class C fly ash (8 percent), and 50% slag cement (4 percent). Mixes proportioned with Class F fly ash produced the greatest increase in flexural strength from 28 days to 90 days followed by mixes proportioned with Class C fly ash.
3. Flexural strengths calculated using Equation 7 were on average 95 percent of the measured flexural strengths. This indicates that Equation 7 provides a conservative estimate of the flexural strength of typical PCC pavements in Mississippi.

Modulus of Elasticity:

1. The higher dry rodded unit weights of CA_ID3 (104 pcf) and CA_ID4 (103 pcf) produced higher MOE results than mixes utilizing lower dry rodded unit weights.
2. MOE values calculated with Equation 8 were on average 79 percent of the measured MOE values which is lower than typical default values. MOE determined for PCC pavements in Mississippi ranged from 5×10^6 to 7.0×10^6 which is higher than a value of 4×10^6 that is often used for PCC pavement thickness design. Higher MOE values result in slightly thicker PCC pavements when using design procedures such as AASHTO 1993 for thickness determination.

Poisson's Ratio:

1. PCC pavements that utilize crushed limestone have a higher Poisson's ratio than similar mixes that utilize Mississippi gravel. The crushed limestone mixes produced Poisson's ratio results ranging from 0.19 to 0.24 for all test ages. The gravel aggregate mixes produced Poisson's ratios within a range of 0.11 to 0.19.

Coefficient of Thermal Expansion:

1. PCC pavements that utilize Mississippi gravel aggregate had a higher coefficient of thermal expansion than mixes that utilized crushed limestone. The average CTE of all concrete mixtures proportioned with gravel aggregate was 6.74 in./in. per °F. The average CTE of all concrete mixture proportioned with crushed limestone was 5.05 in./in. per °F. CTE influences the extent of expansion and contraction of PCC pavement panels along with curling/ warping. These influences may require shorter joint spacing for PCC pavements utilizing gravel aggregates than pavements utilizing crushed limestone aggregates.

Length Change:

1. Mixes utilizing slag cement had less shrinkage than all other cementitious blends used in this study. This trend was observed in all coarse aggregate sources except for the crushed limestone from Alabama where mixes utilizing slag cement had approximately the same shrinkage as mixes that utilized 100 percent portland cement or Class F fly ash.
2. There was an increase in shrinkage for mixes utilizing Class C fly ash and crushed limestone with respect to all other cementitious blends.
3. The MEPDG formula shown in Equation 9 provided a reasonable estimate of the ultimate shrinkage strain for PCC pavements in Mississippi with exception of mixes proportioned with Class C fly ash.
4. The MEPDG indicates that 50 percent of ultimate strain occurs at 35 days measured from the end of the initial 7-day moist curing period. The MEPDG equation overestimated the strain of mixes that utilize Class F fly ash or Class C fly ash in this study and underestimated the strain of mixes that utilize slag cement. The MEPDG equation provided a reasonable estimate of the 812-day strain for mixes utilizing 100 percent portland cement.
5. The MEPDG recommends using a value of 50 percent for reversible shrinkage unless more reliable information is available. In all cases, the amount of reversible shrinkage of mixes in this study exceeded 50 percent. Mixes utilizing either Class C or Class F fly ash on average experienced a reversible shrinkage of 60.5 percent which was closer to the recommended value than reversible shrinkage achieved with other cementitious blends.
6. The MEPDG recommends using a value of 35 days for the time to reach 50 percent of ultimate shrinkage unless more reliable information is available. Time to reach 50 percent of the 812-day shrinkage ranged from 15.1 days to 80.1 days. This time was influenced by cementitious blend and the type of coarse aggregate.

REFERENCES

1. Rao, Chetana. Guidelines for PCC Inputs to AASHTOWare Pavement ME, Report No. FHWA/MS-DOT-RD-015-260, Rao Research and Consulting, LLC. Champaign, IL. 2014.
2. Applied Research Associates, Inc, *Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures*, Final Report, NCHRP Project 1-37A, Part 2 Design Inputs, Chapter 2 Material Characterization, National Cooperative Highway Research Program, Transportation Research Board, National Research Council, Washington, DC, 2004.
3. Mindess, S. and J. F. Young. Concrete. Prentice-Hall Inc. Englewood Cliffs, New Jersey. 1981.
4. American Concrete Institute Committee 209, “Prediction of creep, shrinkage and temperature effects in concrete structures,” ACI 209-92, Detroit 1992.

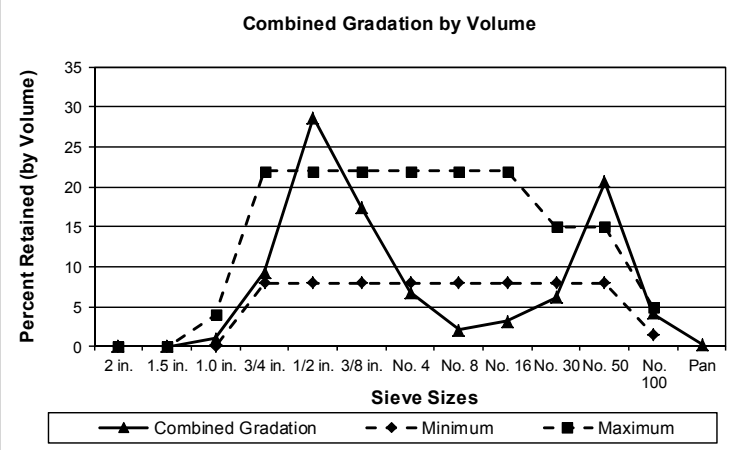
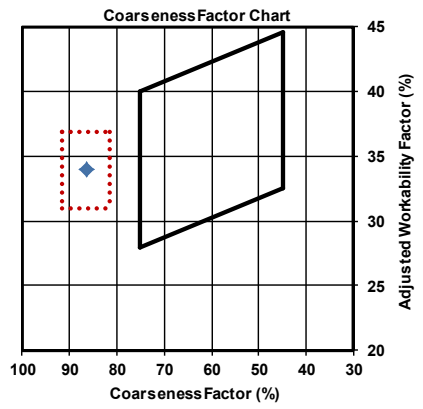
APPENDIX A

Raw Data:

Draft Report

BCD 140241										Notes:	
Customer: MDOT		Project: SP-9999-09(110)/106812-101000				Lab #: BCD		First slump 3/4 in. Added 0.93 lbs of water to 1 1/4 in. slump. Added 9 ml of air.			
MIX NUMBER		Mix 1.1		Set #: 1		Factor: 0.22					
Date: 4/16/2014		Mix Code:		Mix 1	fc:	3,500 psi	Size(c.f.):	6.00			
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source		SSD Specific Gravity	Agg. absorption	Agg. FM	
Material	Vol. (c.f.)										
Cement 1:	2.79	548.00	121.78	121.78	121.78	Type I-II Cement		3.15			
Cement 2:	0.00	0.00	0.00	0.00				0.00			
Fly Ash:	0.00	0.00	0.00	0.00				2.42			
Slag:	0.00	0.00	0.00	0.00				0.00			
Sand 1:	6.90	1135.12	252.25	265.37	265.37	Sand		2.636	0.52%		
Coarse Aggregate 1:	12.49	1929.00	428.67	432.90	432.90	CA_ID1 - 57 Gravel High Absorption		2.475	3.37%		
Coarse Aggregate 2:	0.00	0.00	0.00	0.00				1.000	1.00%		
Coarse Aggregate 3:	0.00	0.00	0.00	0.00				1.000	1.00%		
Coarse Aggregate 4:	0.00	0.00	0.00	0.00				1.000	1.00%		
Air:	4.50%	1.22	0.00	0.00	0.00						
Water:	3.67	229.19	50.93	33.58	33.58			1.00			
"+-Air:	0.50%										
Total:	27.07	3841.31	853.62	853.62							
UW w/o Air:		148.59	148.97	148.97							
ADMIX INFORMATION							Aggregate Moistures				
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)			
Air	0.75	4.1	121.5	27.0	27.0	Air	Sand:	5.23%	13.12		
Water Reducer	5.00	27.4	810.3	180.1	180.1	Water Reducer	CA 1	1.02%	4.23		
							CA 2	0.00%	0.00		
							CA 3	0.00%	0.00		
							CA 4	0.00%	0.00		
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg. Grad., by vol.			
Batch Time	1:45 PM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4				
Sample Time	1:55 PM		35.59	64.41	0	0	0				
Slump, in.	1.25	2 in.	0.0	0.0	0.0	0.0	0.0	0.0			
Mix Temp.	69.1	1.5 in.	0.0	0.0	0.0	0.0	0.0	0.0			
Air Temp.	70.0	1.0 in.	0.0	1.5	0.0	0.0	0.0	1.0			
ACF Air %	5.8	3/4 in.	0.0	14.5	0.0	0.0	0.0	9.3			
Unit Weight (pcf)	142.60	1/2 in.	0.0	44.6	0.0	0.0	0.0	28.7			
Design Unit Wt.	141.92	3/8 in.	0.0	27.1	0.0	0.0	0.0	17.5			
Yield	5.99	No. 4	0.4	10.4	0.0	0.0	0.0	6.8			
Relative Yield	1.00	No. 8	4.5	0.7	0.0	0.0	0.0	2.1			
Design w/c	0.418	No. 16	8.4	0.3	0.0	0.0	0.0	3.2			
Actual w/c	0.418	No. 30	17.0	0.1	0.0	0.0	0.0	6.1			
Fine/Coarse	0.59	No. 50	57.8	0.1	0.0	0.0	0.0	20.7			
Bag Factor	5.83	No. 100	11.3	0.1	0.0	0.0	0.0	4.1			
Theoretical Air (%)	4.03	Pan	0.2	0.4	0.0	0.0	0.0	0.3			

Coarseness and Workability (volume)
 Cumulative % retained on 3/8" 56.51
 Cumulative % retained on No 8 65.38
 Cumulative % passing No 8 34.34
Coarseness Factor 86.43
Workability Factor 34.34
Adjusted Workability Factor 33.91



Draft Report

**BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength**

278 COMMERCE PARK DRIVE
RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
Fax: (601) 856-3552

Mix ID: _____ Mix 1

BDC Project NO. 140241

Made Date: _____ Wednesday, April 16, 2014

COMPRESSION TESTS RESULTS

Specimen No.	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	4/23/2014	5.98	6.00	12.00	12.05	12.00	28.15	143.64	28.18	149630	5310	3	5620
6	7	4/23/2014	5.98	5.99	12.00	12.05	12.05	28.20	143.94	28.13	156440	5561	4	
7	7	4/23/2014	5.95	5.99	11.95	12.00	12.00	28.15	144.27	27.99	154870	5533	3	
8	7	4/23/2014	6.02	5.93	11.95	11.95	12.00	28.15	144.97	28.04	161870	5773	4	
9	7	4/23/2014	6.01	5.97	11.95	12.05	12.00	28.20	144.10	28.18	166280	5901	3	
11	14	4/30/2014	6.03	6.03	12.10	12.15	12.10	28.71	143.37	28.56	175260	6137	3	6220
12	14	4/30/2014	6.01	6.03	12.10	12.10	12.10	28.61	143.54	28.46	171570	6028	3	
13	14	4/30/2014	6.01	6.02	12.10	12.15	12.10	28.76	144.34	28.42	177490	6245	3	
14	14	4/30/2014	6.03	6.02	12.10	12.05	12.05	28.75	144.40	28.51	179200	6286	1	
15	14	4/30/2014	5.99	6.02	12.00	12.00	12.00	28.64	145.61	28.32	181290	6401	1	
17	28	5/14/2014	6.01	6.02	12.10	12.05	12.10	28.75	144.68	28.42	176480	6210	3	6650
18	28	5/14/2014	6.02	6.01	12.10	12.05	12.05	28.67	144.48	28.42	196900	6928	3	
19	28	5/14/2014	6.00	6.04	12.10	12.10	12.10	28.82	144.60	28.46	195780	6879	3	
20	28	5/14/2014	6.02	6.01	12.10	12.15	12.15	28.70	143.84	28.42	186950	6578	1	
21	28	5/14/2014	5.99	6.02	12.15	12.15	12.15	28.73	144.27	28.32	188250	6647	3	
23	90	7/15/2014	6.03	6.04	12.05	12.10	12.05	28.92	144.78	28.61	218940	7653	3	7410
24	90	7/15/2014	6.02	6.04	12.05	12.10	12.05	28.56	143.21	28.56	205590	7199	3	
25	90	7/15/2014	6.01	6.02	12.15	12.10	12.10	28.54	143.23	28.42	206210	7256	3	
26	90	7/15/2014	6.00	6.02	12.10	12.10	12.05	28.60	144.17	28.37	213590	7529	3	
27	90	7/15/2014	6.01	6.00	12.00	12.05	12.05	28.54	144.70	28.32	209670	7404	3	

Reported By: _____ Scott Bivings _____ Date: _____

Reviewed By: _____ Robert Varner _____ Date: 8/27/2014

Draft Report

BURNS COOLEY DENNIS, INC.
 CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
 AASHTO T97 Flexural Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID: _____ Mix 1

BDC Project NO. 140241

Made Date: _____ Wednesday, April 16, 2014

Specimen No.	Specimen Age	Test Date	Depth 1 (0.05 in)	Depth 2 (0.05 in)	Depth 3 (0.05 in)	Avg Depth (in.)	Width 1 (0.05 in)	Width 2 (0.05 in)	Width 3 (0.05 in)	Avg Width (in.)	Max Load	Flex Strength (psi)	Avg (psi)
29	7	4/23/2014	6.10	6.05	6.00	6.05	5.95	6.00	6.05	6.00	8620	707	700
30	7	4/23/2014	6.10	6.15	6.10	6.12	6.05	6.05	6.10	6.07	8540	676	
31	7	4/23/2014	6.05	6.05	6.05	6.05	6.05	6.05	6.05	6.05	8730	710	
32	14	4/30/2014	6.10	6.10	6.10	6.10	6.00	6.00	6.00	6.00	9310	751	750
33	14	4/30/2014	6.05	6.10	6.10	6.08	6.00	6.00	6.00	6.00	8950	726	
34	14	4/30/2014	6.05	6.10	6.11	6.09	6.00	6.00	5.95	5.98	9590	778	
35	28	5/14/2014	6.00	6.05	6.10	6.05	5.95	6.00	6.05	6.00	9170	752	785
36	28	5/14/2014	6.05	6.05	6.00	6.03	6.05	6.05	6.05	6.05	9620	787	
37	28	5/14/2014	6.05	6.05	6.10	6.07	6.00	5.95	6.00	5.98	9900	809	
38	90	7/15/2014	6.00	6.00	6.00	6.00	5.95	5.95	5.95	5.95	10120	850	875
39	90	7/15/2014	6.05	6.05	6.00	6.03	6.00	6.05	6.05	6.03	11370	933	
40	90	7/15/2014	6.05	6.05	6.05	6.05	6.00	5.95	6.05	6.00	10350	848	

Reported By: _____ Scott Bivings

Date: _____

Reviewed By: _____ Robert Varner

Date: 8/27/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 1 _____

Project No. 140241

Mix Date Wednesday, April 16, 2014

Mix Time: 1:45 PM

7 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	5.99	28.18	12.24	149630
6	5.99	28.13	12.17	156440
7	5.97	27.99	12.16	
8	5.98	28.04	12.18	
9	5.99	28.18	12.23	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 61214

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
7	8300	0.00085	0.00000	0.000000	297	61214	0.00685	0.00075	0.00041	0.000056	2187	5258424.8	5.25E+06	0.16
7	7760	0.00085	0.00005	0.000004	277	61214	0.00715	0.00085	0.00043	0.000064	2187	5059678.1	5.05E+06	0.16
7	7900	0.00085	0.00005	0.000004	282	61214	0.00690	0.00080	0.00041	0.000060	2187	5254487.4	5.25E+06	0.15
Average	7987	0.00085	0.00003	0.000002	285	61214	0.00697	0.00080	0.00042	0.000060	2187	5190863.4	5.20E+06	0.16
8	9450	0.00085	0.00005	0.000004	337	61214	0.00670	0.00080	0.00040	0.000060	2183	5266328.3	5.25E+06	0.16
8	9070	0.00085	0.00010	0.000007	323	61214	0.00685	0.00085	0.00041	0.000063	2183	5172664.5	5.15E+06	0.16
8	9590	0.00085	0.00005	0.000004	342	61214	0.00675	0.00075	0.00040	0.000056	2183	5207678.5	5.20E+06	0.15
Average	9370	0.00085	0.00007	0.000005	334	61214	0.00677	0.00080	0.00040	0.000060	2183	5215557.1	5.20E+06	0.15
9	9240	0.00085	0.00005	0.000004	328	61214	0.00650	0.00075	0.00039	0.000056	2172	5447220.2	5.45E+06	0.15
9	9000	0.00085	0.00010	0.000007	319	61214	0.00665	0.00080	0.00040	0.000060	2172	5331178.8	5.35E+06	0.15
9	9590	0.00085	0.00010	0.000007	340	61214	0.00655	0.00085	0.00039	0.000063	2172	5363190.3	5.35E+06	0.16
Average	9277	0.00085	0.00008	0.000006	329	61214	0.00657	0.00080	0.00039	0.000060	2172	5380529.8	5.40E+06	0.16
Overall Average	8878	0.00085	0.00006	0.000005	316	61214	0.00677	0.00080	0.00040	0.000060	2181	5262316.8	5.25E+06	0.16

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/27/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 1

Project No. 140241

Mix Date Wednesday, April 16, 2014

Mix Time: 1:45 PM

14 DAY CYLINDER DATA

Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	6.03	28.56		175260
12	6.02	28.46		171570
13	6.02	28.42		
14	6.03	28.51		
15	6.01	28.32		

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95
 Longitudinal gage to yoke supports (0.01 in.) 5.40
 Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91
 Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**
 Longitudinal gage reading, **G_{long}**
 Longitudinal Strain, **ε_{long}**
 Transverse gage reading, **G_{tran}**
 Transverse Strain, **ε_{tran}**
 Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 69366

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	27950	0.00085	0.00045	0.000033	983	69400	0.00535	0.00110	0.00032	0.000082	2442	5405041.5	5.40E+06	0.18
13	28490	0.00085	0.00035	0.000026	1002	69400	0.00530	0.00100	0.00032	0.000074	2442	5394382.5	5.40E+06	0.18
13	28340	0.00085	0.00040	0.000030	997	69400	0.00515	0.00100	0.00031	0.000074	2442	5602430.5	5.60E+06	0.17
Average	28260	0.00085	0.00040	0.000030	994	69400	0.00527	0.00103	0.00031	0.000077	2442	5467284.8	5.45E+06	0.18
14	10320	0.00085	0.00010	0.000007	362	69400	0.00755	0.00085	0.00045	0.000063	2434	5163100.7	5.15E+06	0.14
14	8360	0.00085	0.00005	0.000004	293	69400	0.00788	0.00040	0.00047	0.000030	2434	5084468	5.10E+06	0.06
14	8640	0.00085	0.00000	0.000000	303	69400	0.00780	0.00050	0.00047	0.000037	2434	5119288.5	5.10E+06	0.09
Average	9107	0.00085	0.00005	0.000004	319	69400	0.00774	0.00058	0.00046	0.000043	2434	5122285.7	5.10E+06	0.10
15	16860	0.00085	0.00020	0.000015	595	69400	0.00625	0.00090	0.00037	0.000067	2451	5732352.3	5.75E+06	0.16
15	17430	0.00085	0.00025	0.000019	615	69400	0.00610	0.00095	0.00036	0.000071	2451	5831747.7	5.85E+06	0.17
15	17250	0.00085	0.00010	0.000007	609	69400	0.00610	0.00080	0.00036	0.000059	2451	5851946.2	5.85E+06	0.17
Average	17180	0.00085	0.00018	0.000014	607	69400	0.00615	0.00088	0.00037	0.000066	2451	5805348.7	5.80E+06	0.16
Overall Average	18182	0.00085	0.00021	0.000016	640	69400	0.00639	0.00083	0.00038	0.000062	2442	5464973.1	5.45E+06	0.15

Reported By: Scott Bivings

Date:

Reviewed By: Robert Varner

Date: 8/27/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 1 _____

Project No. 140241

Mix Date Wednesday, April 16, 2014

Mix Time: 1:45 PM

28 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	6.02	28.42	12.33	176480
18	6.02	28.42	12.36	196900
19	6.02	28.46	12.27	
20	6.02	28.42	12.32	
21	6.01	28.32	12.36	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 74676

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	10900	0.00085	0.00005	0.000004	383	74676	0.00690	0.00095	0.00041	0.000070	2624	6181791.7	6.20E+06	0.18
19	9520	0.00085	0.00005	0.000004	335	74676	0.00720	0.00075	0.00043	0.000056	2624	6017821.5	6.00E+06	0.14
19	9950	0.00085	0.00005	0.000004	350	74676	0.00715	0.00080	0.00043	0.000059	2624	6025449.4	6.05E+06	0.15
Average	10123	0.00085	0.00005	0.000004	356	74676	0.00708	0.00083	0.00042	0.000062	2624	6075020.9	6.10E+06	0.16
20	10050	0.00085	0.00005	0.000004	354	74676	0.00768	0.00100	0.00046	0.000074	2628	5558036.8	5.55E+06	0.17
20	9230	0.00085	0.00005	0.000004	325	74676	0.00765	0.00100	0.00046	0.000074	2628	5653341.5	5.65E+06	0.17
20	8790	0.00085	0.00000	0.000000	309	74676	0.00775	0.00095	0.00046	0.000070	2628	5609028.8	5.60E+06	0.17
Average	9357	0.00085	0.00003	0.000002	329	74676	0.00769	0.00098	0.00046	0.000073	2628	5606802.4	5.60E+06	0.17
21	9830	0.00085	0.00010	0.000007	347	74676	0.00725	0.00100	0.00043	0.000074	2637	5971875.5	5.95E+06	0.17
21	9140	0.00085	0.00015	0.000011	323	74676	0.00735	0.00110	0.00044	0.000082	2637	5942761.6	5.95E+06	0.18
21	10110	0.00085	0.00010	0.000007	357	74676	0.00720	0.00110	0.00043	0.000082	2637	5992808.7	6.00E+06	0.20
Average	9693	0.00085	0.00012	0.000009	342	74676	0.00727	0.00107	0.00043	0.000079	2637	5969148.6	5.95E+06	0.18
Overall Average	9724	0.00085	0.00007	0.000005	342	74676	0.00735	0.00096	0.00044	0.000071	2629	5883657.3	5.90E+06	0.17

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/27/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 1 _____

Project No. 140241

Mix Date Wednesday, April 16, 2014

Mix Time: 1:45 PM

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	6.04	28.61	12.22	218940
24	6.03	28.56	12.23	205590
25	6.02	28.42	12.27	
26	6.01	28.37	12.27	
27	6.01	28.32	12.22	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 84906

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	10300	0.00085	0.00020	0.000015	362	84906	0.00865	0.00130	0.00052	0.000096	2988	5619809.9	5.60E+06	0.17
25	10330	0.00085	0.00020	0.000015	363	84906	0.00900	0.00110	0.00054	0.000082	2988	5376708.6	5.40E+06	0.14
25	10880	0.00085	0.00000	0.000000	383	84906	0.00835	0.00090	0.00050	0.000067	2988	5798760.5	5.80E+06	0.15
Average	10503	0.00085	0.00013	0.000010	370	84906	0.00867	0.00110	0.00052	0.000082	2988	5598426.3	5.60E+06	0.15
26	10590	0.00085	0.00020	0.000015	373	84906	0.00825	0.00120	0.00049	0.000089	2993	5910399.6	5.90E+06	0.17
26	11070	0.00085	0.00010	0.000007	390	84906	0.00830	0.00110	0.00050	0.000082	2993	5832886	5.85E+06	0.17
26	10110	0.00085	0.00000	0.000000	356	84906	0.00835	0.00130	0.00050	0.000097	2993	5869404	5.85E+06	0.21
Average	10590	0.00085	0.00010	0.000007	373	84906	0.00830	0.00120	0.00050	0.000089	2993	5870896.6	5.85E+06	0.18
27	10190	0.00085	0.00015	0.000011	360	84906	0.00760	0.00175	0.00045	0.000130	2998	6524770.7	6.50E+06	0.29
27	10690	0.00085	0.00010	0.000007	377	84906	0.00720	0.00130	0.00043	0.000097	2998	6888490.7	6.90E+06	0.23
27	10490	0.00085	0.00010	0.000007	370	84906	0.00750	0.00110	0.00045	0.000082	2998	6596095.3	6.60E+06	0.19
Average	10457	0.00085	0.00012	0.000009	369	84906	0.00743	0.00138	0.00044	0.000103	2998	6669785.6	6.65E+06	0.24
Overall Average	10517	0.00085	0.00012	0.000009	371	84906	0.00813	0.00123	0.00049	0.000091	2993	6046369.5	6.05E+06	0.19

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/27/2014

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241

Mix Number Mix 1 Set No: 1
Mix Date Wednesday, April 16, 2014
Mix Time 1:45 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
1	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
2	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
3	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
4	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
10		Specimen 1	Reference Bar 1	Δ Length 1	Specimen 2	Reference Bar 2	Δ Length 2	Specimen 3	Reference Bar 3	Δ Length 3	Specimen 4	Reference Bar 4	Δ Length 4	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Thursday, April 17, 2014	0.1055	0.0983	0.0072	0.1023	0.0983	0.0040	0.1852	0.0983	0.0869	0.0920	0.0983	-0.0063	0.0230
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
		Specimen 1	Reference Bar 1	Δ Length 1	Specimen 2	Reference Bar 2	Δ Length 2	Specimen 3	Reference Bar 3	Δ Length 3	Specimen 4	Reference Bar 4	Δ Length 4	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001%)
7	Wednesday, April 23, 2014	0.1057	0.0982	0.0030	0.1025	0.0982	0.0030	0.1853	0.0982	0.0020	0.0922	0.0982	0.0030	0.0028
12	Monday, April 28, 2014	0.1049	0.0982	-0.0050	0.1018	0.0982	-0.0040	0.1845	0.0982	-0.0060	0.0915	0.0982	-0.0040	-0.0048
14	Wednesday, April 30, 2014	0.1048	0.0982	-0.0060	0.1016	0.0982	-0.0060	0.1843	0.0982	-0.0080	0.0913	0.0982	-0.0060	-0.0065
21	Wednesday, May 07, 2014	0.1044	0.0982	-0.0100	0.1013	0.0982	-0.0090	0.1839	0.0982	-0.0120	0.0909	0.0982	-0.0100	-0.0102
35	Wednesday, May 21, 2014	0.1037	0.0980	-0.0150	0.1006	0.0980	-0.0140	0.1832	0.0980	-0.0170	0.0902	0.0980	-0.0150	-0.0153
63	Wednesday, June 18, 2014	0.1027	0.0978	-0.0230	0.0996	0.0978	-0.0220	0.1822	0.0978	-0.0250	0.0894	0.0978	-0.0210	-0.0228
119	Wednesday, August 13, 2014	0.1018	0.0976	-0.0300	0.0985	0.0976	-0.0310	0.1811	0.0976	-0.0340	0.0884	0.0976	-0.0290	-0.0310
231	Wednesday, December 03, 2014	0.1011	0.0975	-0.0360	0.0979	0.0975	-0.0360	0.1805	0.0975	-0.0390	0.0878	0.0975	-0.0340	-0.0363
455	Wednesday, July 15, 2015	0.1006	0.0972	-0.0380	0.0973	0.0972	-0.0390	0.1800	0.0972	-0.0410	0.0873	0.0972	-0.0360	-0.0385
42	Calculated 35 Day Shrinkage			-0.0182			-0.0177			-0.0207			-0.0177	-0.0186
Note: Lowest Reading Value Recorded (Minimum)														
Reported by: <u>Scott Bivings</u>					Reviewed by: <u>Robert Varner 10/7/2015</u>									

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

BUS: (601) 856-2332
 FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 1 Set No: 1
 Mix Date Wednesday, April 16, 2014
 Mix Time 1:45 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
1	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
2	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
3	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
4	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

	Reference Bar Length (in.)	INITIAL READINGS												
	10	Specimen 1	Reference Bar 1	Δ Length 1	Specimen 2	Reference Bar 2	Δ Length 2	Specimen 3	Reference Bar 3	Δ Length 3	Specimen 4	Reference Bar 4	Δ Length 4	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
819	Wednesday, July 13, 2016	0.1002	0.0970	-0.0400	0.0969	0.0970	-0.0410	0.1795	0.0970	-0.0440	0.0869	0.0970	-0.0380	-0.0408

LENGTH CHANGE CALCULATIONS

	Reintroduce to Waterbath	Specimen 1	Reference Bar 1	Δ Length 1	Specimen 2	Reference Bar 2	Δ Length 2	Specimen 3	Reference Bar 3	Δ Length 3	Specimen 4	Reference Bar 4	Δ Length 4	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
820	Thursday, July 14, 2016	0.1019	0.0968	-0.0210	0.0985	0.0968	-0.0230	0.1812	0.0968	-0.0250	0.0886	0.0968	-0.0190	-0.0220
822	Saturday, July 16, 2016	0.1023	0.0970	-0.0190	0.0991	0.0970	-0.0190	0.1817	0.0970	-0.0220	0.0890	0.0970	-0.0170	-0.0193
826	Wednesday, July 20, 2016	0.1025	0.0970	-0.0170	0.0991	0.0970	-0.0190	0.1819	0.0970	-0.0200	0.0891	0.0970	-0.0160	-0.0180
833	Wednesday, July 27, 2016	0.1028	0.0970	-0.0140	0.0996	0.0970	-0.0140	0.1822	0.0970	-0.0170	0.0895	0.0970	-0.0120	-0.0143
847	Wednesday, August 10, 2016	0.1029	0.0971	-0.0140	0.0998	0.0971	-0.0130	0.1823	0.0971	-0.0170	0.0896	0.0971	-0.0120	-0.0140
854	Wednesday, August 17, 2016	0.1029	0.0971	-0.0140	0.0996	0.0971	-0.0150	0.1823	0.0971	-0.0170	0.0895	0.0971	-0.0130	-0.0148
875	Wednesday, September 07, 2016	0.1030	0.0971	-0.0130	0.0998	0.0971	-0.0130	0.1823	0.0971	-0.0170	0.0896	0.0971	-0.0120	-0.0138
988	Thursday, December 29, 2016	0.1029	0.0968	-0.0110	0.0997	0.0968	-0.0110	0.1823	0.0968	-0.0140	0.0896	0.0968	-0.0090	-0.0113

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:		
Customer: MDOT		Project: SP-9999-09(110)/106812-101000				Lab #: BCD						
MIX NUMBER		Mix 2.1				Set #: 2						
Date: 4/18/2014		Mix Code: Mix 1		f _c : 3,500 psi		Size(c.f.): 6.25		Factor: 0.23				
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorption	Agg. FM			
Cement 1:	2.09	411.00	95.14	95.14	95.14	Type I-II Cement	3.15			Roller Meter Air 5.5		
Cement 2:	0.00	0.00	0.00	0.00			0.00			Coarseness and Workability (volume)		
Fly Ash:	1.01	137.00	31.71	31.71	31.71	Class F Fly Ash	2.18			Cumulative % retained on 3/8" 57.32		
Slag:	0.00	0.00	0.00	0.00			0.00			Cumulative % retained on No 8 66.25		
Sand 1:	6.62	1089.59	252.22	263.44	263.44	Sand	2.636	0.52%		Cumulative % passing No 8 33.47		
Coarse Aggregate 1:	12.49	1929.00	446.53	450.93	450.93	CA_ID1 - 57 Gravel High Absorption	2.475	3.37%		Coarseness Factor 86.52		
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%		Workability Factor 33.47		
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%		Adjusted Workability Factor 33.04		
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%				
Air:	4.50%	1.22	0.00	0.00	0.00							
Water:	3.57	222.92	51.60	35.98	35.98		1.00					
"±-Air:	0.50%											
Total:	27.00	3789.51	877.20	877.20								
UW w/o Air:		146.97	146.97	146.97								
ADMIX INFORMATION							Aggregate Moistures					
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)				
Air	1.50	8.2	243.1	56.3	56.3	Air	Sand: 4.47%	11.22				
Water Reducer	5.00	27.4	810.3	187.6	187.6	Water Reducer	CA 1 1.02%	4.41				
							CA 2 0.00%	0.00				
							CA 3 0.00%	0.00				
							CA 4 0.00%	0.00				
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.				
Batch Time	10:00 AM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4					
Sample Time	10:10 AM		34.66	65.34	0	0	0					
Slump, in.	1.50	2 in.	0.0	0.0	0.0	0.0	0.0					
Mix Temp.	71.0	1.5 in.	0.0	0.0	0.0	0.0	0.0					
Air Temp.	63.0	1.0 in.	0.0	1.5	0.0	0.0	0.0					
ACF Air %	4.9	3/4 in.	0.0	14.5	0.0	0.0	0.0					
Unit Weight (pcf)	142.60	1/2 in.	0.0	44.6	0.0	0.0	0.0					
Design Unit Wt.	140.35	3/8 in.	0.0	27.1	0.0	0.0	0.0					
Yield	6.15	No. 4	0.4	10.4	0.0	0.0	0.0					
Relative Yield	0.98	No. 8	4.5	0.7	0.0	0.0	0.0					
Design w/c	0.407	No. 16	8.4	0.3	0.0	0.0	0.0					
Actual w/c	0.407	No. 30	17.0	0.1	0.0	0.0	0.0					
Fine/Coarse	0.56	No. 50	57.8	0.1	0.0	0.0	0.0					
Bag Factor	5.83	No. 100	11.3	0.1	0.0	0.0	0.0					
Theoretical Air (%)	2.97	Pan	0.2	0.4	0.0	0.0	0.0					

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
 Fax: (601) 856-3552

Mix ID: _____ Mix 2

BDC Project NO. 140241

Made Date: _____ Friday, April 18, 2014

COMPRESSION TESTS RESULTS

Specimen No.	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	4/25/2014	6.00	5.98	12.10	12.10	12.05	28.28	143.51	28.18	129250	4587	3	4410
6	7	4/25/2014	5.97	5.95	11.95	12.05	12.05	27.82	143.39	27.90	126050	4518	4	
7	7	4/25/2014	5.97	5.99	11.95	11.95	12.10	28.00	143.55	28.09	118800	4229	3	
8	7	4/25/2014	5.96	5.95	12.00	12.00	12.00	28.03	144.92	27.85	122000	4381	3	
9	7	4/25/2014	5.94	5.95	12.00	12.00	12.05	28.00	145.05	27.76	120910	4356	3	
11	14	5/2/2014	5.97	5.97	12.00	12.00	12.05	27.81	142.86	27.99	131830	4710	3	4770
12	14	5/2/2014	6.02	5.91	12.00	12.00	11.95	27.74	143.14	27.95	135620	4852	3	
13	14	5/2/2014	5.98	5.96	12.05	12.05	12.05	27.91	142.98	27.99	132900	4748	2	
14	14	5/2/2014	5.97	5.96	12.00	12.00	12.05	27.68	142.43	27.95	129590	4636	1	
15	14	5/2/2014	6.00	5.95	11.95	11.95	11.95	27.69	142.80	28.04	137810	4915	3	
17	28	5/16/2014	5.94	5.99	12.05	12.05	12.10	28.03	143.63	27.95	160910	5757	1	5760
18	28	5/16/2014	5.98	5.93	12.00	12.00	12.00	27.85	143.99	27.85	155650	5589	3	
19	28	5/16/2014	5.98	5.98	12.00	12.00	12.05	27.74	142.02	28.09	159280	5670	1	
20	28	5/16/2014	5.97	5.97	12.10	12.00	12.00	27.89	143.07	27.99	163980	5859	1	
21	28	5/16/2014	5.98	5.99	12.10	12.10	12.05	27.99	142.27	28.13	166060	5903	1	
23	90	7/17/2014	5.95	5.98	12.05	12.05	12.00	27.83	143.00	27.95	196110	7016	3	7030
24	90	7/17/2014	5.97	5.94	12.05	12.05	12.00	27.71	142.87	27.85	192730	6920	3	
25	90	7/17/2014	5.97	5.94	12.00	12.00	12.00	27.83	143.88	27.85	194990	7001	3	
26	90	7/17/2014	5.98	5.98	12.00	12.00	12.00	27.79	142.48	28.09	192560	6855	3	
27	90	7/17/2014	5.95	5.94	12.05	12.05	12.05	27.75	143.35	27.76	203990	7348	3	

Reported By: _____ Scott Bivings _____ Date: _____

Reviewed By: _____ Robert Varner _____ Date: 8/27/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
 AASHTO T97 Flexural Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID: _____ Mix 2
 Made Date: _____ Friday, April 18, 2014

BDC Project NO. 140241

Specimen No.	Specimen Age	Test Date	Depth 1 (0.05 in)	Depth 2 (0.05 in)	Depth 3 (0.05 in)	Avg Depth (in.)	Width 1 (0.05 in)	Width 2 (0.05 in)	Width 3 (0.05 in)	Avg Width (in.)	Max Load	Flex Strength (psi)	Avg (psi)
29	7	4/25/2014	6.10	6.10	6.10	6.10	6.00	5.90	5.95	5.95	7790	633	610
30	7	4/25/2014	6.05	6.05	6.05	6.05	6.00	6.05	6.00	6.02	7470	610	
31	7	4/25/2014	6.05	6.10	6.10	6.08	6.10	6.05	6.10	6.08	7270	582	
32	14	5/2/2014	6.15	6.10	6.50	6.25	6.00	6.00	6.00	6.00	8780	674	690
33	14	5/2/2014	6.05	6.10	6.10	6.08	6.05	6.00	6.05	6.03	8450	682	
34	14	5/2/2014	6.00	6.05	6.05	6.03	6.05	6.00	6.00	6.02	8600	707	
35	28	5/16/2014	6.05	6.05	6.05	6.05	6.10	6.10	6.05	6.08	9020	730	750
36	28	5/16/2014	6.10	6.10	6.05	6.08	6.05	6.00	5.95	6.00	9180	745	
37	28	5/16/2014	6.05	6.10	6.15	6.10	6.00	6.00	6.05	6.02	9630	774	
38	90	7/17/2014	6.00	6.00	6.00	6.00	5.95	6.00	6.00	5.98	10200	853	885
39	90	7/17/2014	6.05	6.10	6.05	6.07	6.05	6.00	6.00	6.02	10680	867	
40	90	7/17/2014	6.05	6.05	6.00	6.03	5.95	5.95	6.00	5.97	11230	931	

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Varmer _____

Date: _____ 8/27/2014 _____

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 2 _____

Project No. _____ 140241

Mix Date _____ Friday, April 18, 2014

Mix Time: _____ 10:00 AM

7 DAY CYLINDER DATA

Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	5.99	28.18	12.3	129250
6	5.96	27.9	12.13	126050
7	5.98	28.09	12.27	
8	5.96	27.85	12.22	
9	5.95	27.76	12.27	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) _____ 4.95

Longitudinal gage to yoke supports (0.01 in.) _____ 5.40

Longitudinal Gage length (0.01 in.) _____ 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) _____ 3.91

Transverse gage to mid yoke supports (0.01 in.) _____ 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) _____ 51060

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) _____ 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
7	9060	0.00085	0.00005	0.000004	323	51060	0.00590	0.00050	0.00035	0.000037	1818	4939240.6	4.95E+06	0.11
7	8360	0.00085	0.00005	0.000004	298	51060	0.00585	0.00070	0.00035	0.000052	1818	5071640.3	5.05E+06	0.16
7	7860	0.00085	0.00000	0.000000	280	51060	0.00595	0.00065	0.00036	0.000049	1818	5030687.1	5.05E+06	0.16
Average	8427	0.00085	0.00003	0.000002	300	51060	0.00590	0.00062	0.00035	0.000046	1818	5013856	5.00E+06	0.14
8	9470	0.00085	0.00005	0.000004	340	51060	0.00585	0.00065	0.00035	0.000049	1833	4982370.6	5.00E+06	0.15
8	8330	0.00085	0.00000	0.000000	299	51060	0.00605	0.00055	0.00036	0.000041	1833	4922572.2	4.90E+06	0.13
8	8820	0.00085	0.00005	0.000004	317	51060	0.00600	0.00065	0.00036	0.000049	1833	4913242.5	4.90E+06	0.15
Average	8873	0.00085	0.00003	0.000002	319	51060	0.00597	0.00062	0.00036	0.000046	1833	4939395.1	4.95E+06	0.14
9	8250	0.00085	0.00005	0.000004	297	51060	0.00610	0.00065	0.00036	0.000049	1839	4900777.9	4.90E+06	0.14
9	8400	0.00085	0.00000	0.000000	303	51060	0.00600	0.00055	0.00036	0.000041	1839	4978183.2	5.00E+06	0.13
9	7570	0.00085	0.00000	0.000000	273	51060	0.00620	0.00060	0.00037	0.000045	1839	4885800.8	4.90E+06	0.14
Average	8073	0.00085	0.00002	0.000001	291	51060	0.00610	0.00060	0.00036	0.000045	1839	4921587.3	4.90E+06	0.14
Overall Average	8458	0.00085	0.00003	0.000002	303	51060	0.00599	0.00061	0.00036	0.000046	1830	4958279.5	4.95E+06	0.14

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Vamer _____

Date: _____ 8/27/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 2

Project No. 140241

Mix Date Friday, April 18, 2014

Mix Time: 10:00 AM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	5.97	27.99	12.27	131830
12	5.97	27.95	12.20	135620
13	5.97	27.99	12.25	
14	5.97	27.95	12.24	
15	5.98	28.04	12.17	

Compressometer Calibration
 Pivot rod to yoke supports (0.01 in.) 4.95
 Longitudinal gage to yoke supports (0.01 in.) 5.40
 Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration
 Hinge to mid yoke supports (0.01 in.) 3.91
 Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:
 Machine applied load (lbs.), **P**
 Longitudinal gage reading, **G_{long}**
 Longitudinal Strain, **ε_{long}**
 Transverse gage reading, **G_{tran}**
 Transverse Strain, **ε_{tran}**
 Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 53490

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	9810	0.00085	0.00015	0.000011	350	53490	0.00630	0.00075	0.00038	0.000056	1911	4777746.3	4.80E+06	0.14
13	10430	0.00085	0.00015	0.000011	373	53490	0.00600	0.00075	0.00036	0.000056	1911	4983570.6	5.00E+06	0.15
13	10040	0.00085	0.00015	0.000011	359	53490	0.00595	0.00075	0.00036	0.000056	1911	5077877	5.10E+06	0.15
Average	10093	0.00085	0.00015	0.000011	361	53490	0.00608	0.00075	0.00036	0.000056	1911	4946398	4.95E+06	0.14
14	8660	0.00085	0.00005	0.000004	310	53490	0.00640	0.00075	0.00038	0.000056	1914	4822290	4.80E+06	0.16
14	9150	0.00085	0.00010	0.000007	327	53490	0.00625	0.00080	0.00037	0.000060	1914	4901736.2	4.90E+06	0.16
14	8990	0.00085	0.00010	0.000007	322	53490	0.00635	0.00080	0.00038	0.000060	1914	4830201.1	4.85E+06	0.16
Average	8933	0.00085	0.00008	0.000006	320	53490	0.00633	0.00078	0.00038	0.000059	1914	4851409.1	4.85E+06	0.16
15	9360	0.00085	0.00025	0.000019	334	53490	0.00610	0.00085	0.00036	0.000063	1908	5001441.3	5.00E+06	0.14
15	9560	0.00085	0.00015	0.000011	341	53490	0.00610	0.00075	0.00036	0.000056	1908	4978774.5	5.00E+06	0.14
15	9730	0.00085	0.00015	0.000011	347	53490	0.00610	0.00075	0.00036	0.000056	1908	4959507.6	4.95E+06	0.14
Average	9550	0.00085	0.00018	0.000014	341	53490	0.00610	0.00078	0.00036	0.000058	1908	4979907.8	5.00E+06	0.14
Overall Average	9526	0.00085	0.00014	0.000010	340	53490	0.00617	0.00077	0.00037	0.000058	1911	4925905	4.95E+06	0.15

Reported By: Scott Bivings

Date:

Reviewed By: Robert Vamer

Date: 8/27/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 2 _____

Project No. 140241

Mix Date Friday, April 18, 2014

Mix Time: 10:00 AM

28 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	5.97	27.95	12.30	160910
18	5.96	27.85	12.20	155650
19	5.98	28.09	12.17	
20	5.97	27.99	12.21	
21	5.99	28.13	12.24	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 63312

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	8570	0.00085	0.00005	0.000004	305	63312	0.00745	0.00085	0.00045	0.000063	2254	4928942.4	4.95E+06	0.15
19	8760	0.00085	0.00005	0.000004	312	63312	0.00705	0.00085	0.00042	0.000063	2254	5228032.1	5.25E+06	0.16
19	8020	0.00085	0.00005	0.000004	286	63312	0.00730	0.00090	0.00044	0.000067	2254	5093998.1	5.10E+06	0.16
Average	8450	0.00085	0.00005	0.000004	301	63312	0.00727	0.00087	0.00043	0.000065	2254	5083657.5	5.10E+06	0.16
20	7700	0.00085	0.00005	0.000004	275	63312	0.00695	0.00085	0.00042	0.000064	2262	5436146.5	5.45E+06	0.16
20	7060	0.00085	0.00010	0.000007	252	63312	0.00695	0.00090	0.00042	0.000067	2262	5498707.3	5.50E+06	0.16
20	8860	0.00085	0.00010	0.000007	317	63312	0.00675	0.00080	0.00040	0.000060	2262	5502771.2	5.50E+06	0.15
Average	7873	0.00085	0.00008	0.000006	281	63312	0.00688	0.00085	0.00041	0.000064	2262	5479208.3	5.50E+06	0.16
21	7290	0.00085	0.00000	0.000000	259	63312	0.00730	0.00080	0.00044	0.000060	2251	5153913.2	5.15E+06	0.15
21	7630	0.00085	0.00005	0.000004	271	63312	0.00735	0.00085	0.00044	0.000063	2251	5083311.5	5.10E+06	0.15
21	7690	0.00085	0.00005	0.000004	273	63312	0.00735	0.00090	0.00044	0.000067	2251	5077834	5.10E+06	0.16
Average	7537	0.00085	0.00003	0.000002	268	63312	0.00733	0.00085	0.00044	0.000063	2251	5105019.5	5.10E+06	0.16
Overall Average	7953	0.00085	0.00006	0.000004	283	63312	0.00716	0.00086	0.00043	0.000064	2256	5222628.5	5.20E+06	0.16

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/27/2014

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

PHONE: (601) 856-2332
FAX: (601) 856-3552

Mix ID Mix 2

Project No. 140241

Mix Date Friday, April 18, 2014

Mix Time: 10:00 AM

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	5.97	27.95	12.37	196110
24	5.96	27.85	12.38	192730
25	5.96	27.85	12.34	
26	5.98	28.09	12.38	
27	5.95	27.76	12.37	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 77768

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	10450	0.00085	0.00005	0.000004	375	77768	0.00830	0.00090	0.00050	0.000067	2792	5417272.4	5.40E+06	0.14
25	9070	0.00085	0.00005	0.000004	326	77768	0.00845	0.00090	0.00051	0.000067	2792	5419408.7	5.40E+06	0.14
25	9170	0.00085	0.00005	0.000004	329	77768	0.00835	0.00085	0.00050	0.000064	2792	5483542.6	5.50E+06	0.13
Average	9563	0.00085	0.00005	0.000004	343	77768	0.00837	0.00088	0.00050	0.000066	2792	5440074.5	5.45E+06	0.14
26	10140	0.00085	0.00010	0.000007	361	77768	0.00745	0.00100	0.00045	0.000075	2769	6089191.5	6.10E+06	0.17
26	9010	0.00085	0.00005	0.000004	321	77768	0.00765	0.00095	0.00046	0.000071	2769	6009214.2	6.00E+06	0.16
26	9330	0.00085	0.00000	0.000000	332	77768	0.00755	0.00090	0.00045	0.000067	2769	6070338.3	6.05E+06	0.17
Average	9493	0.00085	0.00005	0.000004	338	77768	0.00755	0.00095	0.00045	0.000071	2769	6056248	6.05E+06	0.17
27	9210	0.00085	0.00005	0.000004	332	77768	0.00825	0.00100	0.00049	0.000075	2801	5572274.9	5.55E+06	0.16
27	9340	0.00085	0.00020	0.000015	336	77768	0.00815	0.00115	0.00049	0.000086	2801	5637754.5	5.65E+06	0.16
27	9050	0.00085	0.00015	0.000011	326	77768	0.00825	0.00110	0.00049	0.000083	2801	5585279.4	5.60E+06	0.16
Average	9200	0.00085	0.00013	0.000010	331	77768	0.00822	0.00108	0.00049	0.000081	2801	5598436.3	5.60E+06	0.16
Overall Average	9419	0.00085	0.00008	0.000006	338	77768	0.00804	0.00097	0.00048	0.000073	2787	5698252.9	5.70E+06	0.16

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/27/2014

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241

Mix Number Mix 2 Set No: 2
Mix Date Friday, April 18, 2014
Mix Time 10:00 AM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
5	10.0000	0.8100	0.8090	11.58150	1.6190	9.9625
6	10.0000	0.8120	0.8130	11.62300	1.6250	9.9980
7	10.0000	0.8175	0.8135	11.62950	1.6310	9.9985
8	10.0000	0.8150	0.8135	11.59520	1.6285	9.9667

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
		Specimen 5	Reference Bar 5	Δ Length 5	Specimen 6	Reference Bar 6	Δ Length 6	Specimen 7	Reference Bar 7	Δ Length 7	Specimen 8	Reference Bar 8	Δ Length 8	Average
10		(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
Specimen Age	Test date	0.0604	0.0983	-0.0379	0.0986	0.0983	-0.0003	0.0959	0.0983	-0.0024	0.0602	0.0983	-0.0381	-0.0195
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
		Specimen 5	Reference Bar 5	Δ Length 5	Specimen 6	Reference Bar 6	Δ Length 6	Specimen 7	Reference Bar 7	Δ Length 7	Specimen 8	Reference Bar 8	Δ Length 8	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
7	Friday, April 25, 2014	0.0606	0.0982	0.0030	0.0989	0.0982	0.0040	0.0962	0.0982	0.0040	0.0606	0.0982	0.0050	0.0040
11	Tuesday, April 29, 2014	0.0598	0.0982	-0.0050	0.0980	0.0982	-0.0050	0.0953	0.0982	-0.0050	0.0597	0.0982	-0.0040	-0.0047
14	Friday, May 02, 2014	0.0595	0.0982	-0.0080	0.0979	0.0982	-0.0060	0.0951	0.0982	-0.0070	0.0594	0.0982	-0.0070	-0.0070
21	Friday, May 09, 2014	0.0589	0.0980	-0.0120	0.0973	0.0980	-0.0100	0.0943	0.0980	-0.0130	0.0589	0.0980	-0.0100	-0.0113
35	Friday, May 23, 2014	0.0582	0.0980	-0.0190	0.0965	0.0980	-0.0180	0.0937	0.0980	-0.0190	0.0581	0.0980	-0.0180	-0.0185
63	Friday, June 20, 2014	0.0572	0.0978	-0.0270	0.0956	0.0978	-0.0250	0.0926	0.0978	-0.0280	0.0571	0.0978	-0.0260	-0.0265
119	Friday, August 15, 2014	0.0565	0.0975	-0.0310	0.0946	0.0975	-0.0320	0.0918	0.0975	-0.0330	0.0563	0.0975	-0.0310	-0.0318
231	Friday, December 05, 2014	0.0560	0.0975	-0.0360	0.0942	0.0975	-0.0360	0.0912	0.0975	-0.0390	0.0558	0.0975	-0.0360	-0.0368
455	Friday, July 17, 2015	0.0555	0.0971	-0.0370	0.0937	0.0971	-0.0370	0.0906	0.0970	-0.0400	0.0552	0.0970	-0.0370	-0.0378
42	Calculated 35 Day Shrinkage			-0.0212			-0.0198			-0.0222			-0.0199	-0.0208
Note: Lowest Reading Value Recorded (Minimum)														
Reported by: <u>Scott Bivings</u>					Reviewed by: <u>Robert Varner 10/7/2015</u>									

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 2 Set No: 2
Mix Date Friday, April 18, 2014
Mix Time 10:00 AM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
5	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
6	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
7	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
8	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

	Reference Bar Length (in.)	INITIAL READINGS												
	10	Specimen 5	Reference Bar 5	Δ Length 5	Specimen 6	Reference Bar 6	Δ Length 6	Specimen 7	Reference Bar 7	Δ Length 7	Specimen 8	Reference Bar 8	Δ Length 8	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
819	Friday, July 15, 2016	0.0551	0.0970	-0.0400	0.0934	0.0970	-0.0390	0.0903	0.0970	-0.0430	0.0549	0.0970	-0.0400	-0.0405
Reintroduce to Waterbath		LENGTH CHANGE CALCULATIONS												
		Specimen 5	Reference Bar 5	Δ Length 5	Specimen 6	Reference Bar 6	Δ Length 6	Specimen 7	Reference Bar 7	Δ Length 7	Specimen 8	Reference Bar 8	Δ Length 8	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
820	Saturday, July 16, 2016	0.0567	0.0970	-0.0240	0.0950	0.0970	-0.0230	0.0919	0.0970	-0.0270	0.0567	0.0970	-0.0220	-0.0240
822	Monday, July 18, 2016	0.0569	0.0969	-0.0210	0.0951	0.0969	-0.0210	0.0920	0.0969	-0.0250	0.0567	0.0969	-0.0210	-0.0220
826	Friday, July 22, 2016	0.0572	0.0969	-0.0180	0.0954	0.0968	-0.0170	0.0922	0.0969	-0.0230	0.0569	0.0969	-0.0190	-0.0193
833	Friday, July 29, 2016	0.0573	0.0970	-0.0180	0.0956	0.0970	-0.0170	0.0924	0.0970	-0.0220	0.0572	0.0970	-0.0170	-0.0185
847	Friday, August 12, 2016	0.0575	0.0971	-0.0170	0.0958	0.0971	-0.0160	0.0927	0.0971	-0.0200	0.0573	0.0971	-0.0170	-0.0175
854	Friday, August 19, 2016	0.0575	0.0971	-0.0170	0.0958	0.0971	-0.0160	0.0927	0.0971	-0.0200	0.0573	0.0971	-0.0170	-0.0175
875	Friday, September 09, 2016	0.0575	0.0971	-0.0170	0.0958	0.0971	-0.0160	0.0928	0.0971	-0.0190	0.0572	0.0971	-0.0180	-0.0175
986	Thursday, December 29, 2016	0.0574	0.0967	-0.0140	0.0959	0.0967	-0.0110	0.0925	0.0967	-0.0180	0.0571	0.0967	-0.0150	-0.0145

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:			
Customer:	MDOT		Project:	SP-9999-09(110)/106812-101000				Lab #:	BCD		Beams Only		
MIX NUMBER	Mix 3.1						Set #:	3					
Date:	5/2/2014		Mix Code:	Mix 1	f'c:	3,500 psi	Size(c.f.):	6.75	Factor:	0.25			
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorption	Agg. FM				
Cement 1:	2.09	411.00	102.75	102.75	102.75	Type I-II Cement	3.15			Roller Meter Air 5			
Cement 2:	0.00	0.00	0.00	0.00			0.00			Coarseness and Workability (volume)			
Fly Ash:	0.84	137.00	34.25	34.25	34.25	Class C Fly Ash	2.60			Cumulative % retained on 3/8" 56.26			
Slag:	0.00	0.00	0.00	0.00			0.00			Cumulative % retained on No 8 65.11			
Sand 1:	6.99	1149.35	287.34	298.57	298.57	Sand	2.636	0.52%		Cumulative % passing No 8 34.60			
Coarse Aggregate 1:	12.49	1929.00	482.25	487.01	487.01	CA_ID1 - 57 Gravel High Absorption	2.475	3.37%		Coarseness Factor 86.40			
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%		Workability Factor 34.60			
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%		Adjusted Workability Factor 34.17			
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%					
Air:	4.50%	1.22	0.00	0.00	0.00								
Water:	3.37	210.40	52.60	36.61	36.61		1.00						
"+-Air:	0.50%												
Total:	27.00	3836.75	959.19	959.19									
UW w/o Air:		148.80	148.80	148.80									
ADMIX INFORMATION							Aggregate Moistures						
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)					
Air	0.50	2.7	81.0	20.3	20.3	Air	Sand:	3.93%	11.23				
Water Reducer	5.00	27.4	810.3	202.6	202.6	Water Reducer	CA 1	1.02%	4.76				
							CA 2	0.00%	0.00				
							CA 3	0.00%	0.00				
							CA 4	0.00%	0.00				
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.					
Batch Time	1:00 PM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4						
Sample Time	1:30 PM		35.87	64.13	0	0	0						
Slump, in.	2.75	2 in.	0.0	0.0	0.0	0.0	0.0	0.0					
Mix Temp.	77.0	1.5 in.	0.0	0.0	0.0	0.0	0.0	0.0					
Air Temp.	73.9	1.0 in.	0.0	1.5	0.0	0.0	0.0	1.0					
ACF Air %	4.7	3/4 in.	0.0	14.5	0.0	0.0	0.0	9.3					
Unit Weight (pcf)	143.20	1/2 in.	0.0	44.6	0.0	0.0	0.0	28.6					
Design Unit Wt.	142.10	3/8 in.	0.0	27.1	0.0	0.0	0.0	17.4					
Yield	6.70	No. 4	0.4	10.4	0.0	0.0	0.0	6.8					
Relative Yield	0.99	No. 8	4.5	0.7	0.0	0.0	0.0	2.1					
Design w/c	0.384	No. 16	8.4	0.3	0.0	0.0	0.0	3.2					
Actual w/c	0.384	No. 30	17.0	0.1	0.0	0.0	0.0	6.2					
Fine/Coarse	0.60	No. 50	57.8	0.1	0.0	0.0	0.0	20.8					
Bag Factor	5.83	No. 100	11.3	0.1	0.0	0.0	0.0	4.2					
Theoretical Air (%)	3.76	Pan	0.2	0.4	0.0	0.0	0.0	0.3					

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
 Fax: (601) 856-3552

Mix ID: _____ Mix 3

BDC Project NO. 140241

Made Date: Friday, May 02, 2014

COMPRESSION TESTS RESULTS

Specimen Age	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	5/9/2014	5.96	5.96	12.05	12.10	12.10	28.22	144.65	27.90	143770	5153	3	5540
6	7	5/9/2014	5.94	5.96	12.05	12.05	12.10	28.30	145.75	27.81	150350	5406	5	
7	7	5/9/2014	5.95	5.94	12.00	12.00	12.10	28.27	146.24	27.76	165450	5960	3	
8	7	5/9/2014	5.94	5.97	12.10	12.05	12.15	28.35	145.36	27.85	154980	5565	3	
9	7	5/9/2014	5.97	5.96	12.00	12.00	12.00	27.92	143.86	27.95	156660	5605	4	
11	14	5/16/2014	5.99	6.00	12.00	11.95	12.00	28.07	143.39	28.23	175810	6228	3	6420
12	14	5/16/2014	5.99	5.98	12.10	12.10	12.10	28.38	144.06	28.13	179110	6367	3	
13	14	5/16/2014	5.95	5.99	12.00	12.00	12.00	28.27	145.42	27.99	183420	6553	3	
14	14	5/16/2014	6.01	6.01	11.95	11.95	11.95	28.09	143.18	28.37	184440	6501	3	
15	14	5/16/2014	5.97	5.97	11.95	11.95	12.05	28.14	144.96	27.99	180590	6452	3	
17	28	5/30/2014	5.98	5.99	11.95	11.95	11.95	28.10	144.43	28.13	202330	7193	4	7130
18	28	5/30/2014	5.95	5.98	12.05	12.00	12.00	28.20	145.11	27.95	202380	7241	4	
19	28	5/30/2014	5.96	5.97	12.05	12.05	12.00	28.50	146.45	27.95	206170	7376	3	
20	28	5/30/2014	5.96	5.99	12.00	12.05	12.00	28.10	144.11	28.04	202260	7213	4	
21	28	5/30/2014	5.97	5.96	12.00	11.95	12.00	28.20	145.51	27.95	185710	6644	3	
23	90	7/31/2014	5.95	5.95	12.00	12.00	12.00	28.19	145.99	27.81	213010	7659	3	7910
24	90	7/31/2014	5.98	5.99	11.95	11.95	12.00	28.17	144.59	28.13	223460	7944	3	
25	90	7/31/2014	5.98	5.96	12.00	12.00	12.00	28.21	145.11	27.99	236200	8439	3	
26	90	7/31/2014	5.96	5.96	12.00	12.00	12.00	27.96	144.31	27.90	219480	7867	3	
27	90	7/31/2014	6.02	5.95	11.95	12.05	12.05	28.10	143.63	28.13	214970	7642	3	

Reported By: _____ Scott Bivings _____ Date: _____

Reviewed By: _____ Robert Varner _____ Date: 8/27/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 3

Project No. 140241

Mix Date Friday, May 02, 2014

Mix Time: 1:00 PM

7 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	5.96	27.9	12.40	143770
6	5.95	27.81	12.26	150350
7	5.95	27.76	12.24	
8	5.96	27.85	12.33	
9	5.97	27.95	12.34	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95
 Longitudinal gage to yoke supports (0.01 in.) 5.40
 Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91
 Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**
 Longitudinal gage reading, **G_{long}**
 Longitudinal Strain, **ε_{long}**
 Transverse gage reading, **G_{tran}**
 Transverse Strain, **ε_{tran}**
 Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 58824

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
7	8660	0.00085	0.00010	0.000008	312	58824	0.00635	0.00080	0.00038	0.000060	2119	5482261.1	5.50E+06	0.16
7	8280	0.00085	0.00010	0.000008	298	58824	0.00685	0.00080	0.00041	0.000060	2119	5064518	5.05E+06	0.15
7	8350	0.00085	0.00010	0.000008	301	58824	0.00695	0.00075	0.00042	0.000056	2119	4974779	4.95E+06	0.13
Average	8430	0.00085	0.00010	0.000008	304	58824	0.00672	0.00078	0.00040	0.000059	2119	5173852.7	5.15E+06	0.15
8	9800	0.00085	0.00000	0.000000	352	58824	0.00660	0.00075	0.00039	0.000056	2112	5108720.1	5.10E+06	0.16
8	7980	0.00085	0.00005	0.000004	287	58824	0.00670	0.00080	0.00040	0.000060	2112	5208019.7	5.20E+06	0.16
8	8050	0.00085	0.00000	0.000000	289	58824	0.00665	0.00065	0.00040	0.000049	2112	5245579.3	5.25E+06	0.14
Average	8610	0.00085	0.00002	0.000001	309	58824	0.00665	0.00073	0.00040	0.000055	2112	5187439.7	5.20E+06	0.15
9	8160	0.00085	0.00020	0.000015	292	58824	0.00675	0.00095	0.00040	0.000071	2105	5127293.6	5.15E+06	0.16
9	8510	0.00085	0.00005	0.000004	304	58824	0.00690	0.00085	0.00041	0.000064	2105	4965912	4.95E+06	0.16
9	8150	0.00085	0.00010	0.000007	292	58824	0.00695	0.00090	0.00042	0.000067	2105	4960539.5	4.95E+06	0.16
Average	8273	0.00085	0.00012	0.000009	296	58824	0.00687	0.00090	0.00041	0.000067	2105	5017915	5.00E+06	0.16
Overall Average	8438	0.00085	0.00008	0.000006	303	58824	0.00674	0.00081	0.00040	0.000060	2112	5126402.5	5.15E+06	0.15

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/27/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 3

Project No. 140241

Mix Date Friday, May 02, 2014

Mix Time: 1:00 PM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	6.00	28.23	12.21	175810
12	5.99	28.13	12.26	179110
13	5.97	27.99	12.21	
14	6.01	28.37	12.17	
15	5.97	27.99	12.20	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 70984

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	9880	0.00085	0.00015	0.000011	353	70984	0.00675	0.00080	0.00040	0.000060	2536	6175004.3	6.20E+06	0.14
13	8810	0.00085	0.00005	0.000004	315	70984	0.00685	0.00070	0.00041	0.000052	2536	6178654.1	6.20E+06	0.14
13	9690	0.00085	0.00010	0.000007	346	70984	0.00665	0.00075	0.00040	0.000056	2536	6300751.3	6.30E+06	0.14
Average	9460	0.00085	0.00010	0.000007	338	70984	0.00675	0.00075	0.00040	0.000056	2536	6218136.6	6.20E+06	0.14
14	8700	0.00085	0.00005	0.000004	307	70984	0.00740	0.00090	0.00044	0.000067	2502	5594970.3	5.60E+06	0.16
14	9860	0.00085	0.00005	0.000004	348	70984	0.00720	0.00090	0.00043	0.000067	2502	5663334.5	5.65E+06	0.17
14	8980	0.00085	0.00000	0.000000	317	70984	0.00695	0.00105	0.00042	0.000078	2502	5979789.6	6.00E+06	0.21
Average	9180	0.00085	0.00003	0.000002	324	70984	0.00718	0.00095	0.00043	0.000071	2502	5746031.5	5.75E+06	0.18
15	10210	0.00085	0.00000	0.000000	365	70984	0.00750	0.00075	0.00045	0.000056	2536	5450405	5.45E+06	0.14
15	9500	0.00085	0.00005	0.000004	339	70984	0.00745	0.00075	0.00045	0.000056	2536	5555767.2	5.55E+06	0.13
15	9560	0.00085	0.00000	0.000000	342	70984	0.00745	0.00075	0.00045	0.000056	2536	5550345.5	5.55E+06	0.14
Average	9757	0.00085	0.00002	0.000001	349	70984	0.00747	0.00075	0.00045	0.000056	2536	5518839.2	5.50E+06	0.14
Overall Average	9466	0.00085	0.00005	0.000004	337	70984	0.00713	0.00082	0.00043	0.000061	2525	5827669.1	5.85E+06	0.15

Reported By: Scott Bivings

Date:

Reviewed By: Robert Varner

Date: 8/27/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 3

Project No. 140241

Mix Date Friday, May 02, 2014

Mix Time: 1:00 PM

28 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	5.99	28.13	12.16	202330
18	5.97	27.95	12.18	202380
19	5.97	27.95	12.19	
20	5.98	28.04	12.18	
21	5.97	27.95	12.24	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u> </u> 4.95
Longitudinal gage to yoke supports (0.01 in.)	<u> </u> 5.40
Longitudinal Gage length (0.01 in.)	<u> </u> 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u> </u> 3.91
Transverse gage to mid yoke supports (0.01 in.)	<u> </u> 4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 80942

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	10040	0.00085	0.00010	0.000007	359	80942	0.00765	0.00085	0.00046	0.000064	2896	6227630.8	6.25E+06	0.14
19	9660	0.00085	0.00000	0.000000	346	80942	0.00740	0.00080	0.00044	0.000060	2896	6499481.2	6.50E+06	0.15
19	10560	0.00085	0.00000	0.000000	378	80942	0.00735	0.00080	0.00044	0.000060	2896	6466680.7	6.45E+06	0.15
Average	10087	0.00085	0.00003	0.000002	361	80942	0.00747	0.00082	0.00045	0.000061	2896	6397930.9	6.40E+06	0.15
20	9480	0.00085	0.00000	0.000000	338	80942	0.00735	0.00070	0.00044	0.000052	2887	6544836.3	6.55E+06	0.13
20	10030	0.00085	0.00000	0.000000	358	80942	0.00715	0.00070	0.00043	0.000052	2887	6700192.8	6.70E+06	0.14
20	11390	0.00085	0.00000	0.000000	406	80942	0.00705	0.00070	0.00042	0.000052	2887	6677454.2	6.70E+06	0.14
Average	10300	0.00085	0.00000	0.000000	367	80942	0.00718	0.00070	0.00043	0.000052	2887	6640827.7	6.65E+06	0.14
21	10440	0.00085	0.00000	0.000000	374	80942	0.00800	0.00075	0.00048	0.000056	2896	5889944.9	5.90E+06	0.13
21	10710	0.00085	0.00000	0.000000	383	80942	0.00790	0.00080	0.00047	0.000060	2896	5950453	5.95E+06	0.14
21	9690	0.00085	0.00000	0.000000	347	80942	0.00800	0.00090	0.00048	0.000067	2896	5952602.1	5.95E+06	0.16
Average	10280	0.00085	0.00000	0.000000	368	80942	0.00797	0.00082	0.00048	0.000061	2896	5931000	5.95E+06	0.14
Overall Average	10222	0.00085	0.00001	0.000001	365	80942	0.00754	0.00078	0.00045	0.000058	2893	6323252.9	6.30E+06	0.14

Reported By: Scott Bivings

Date:

Reviewed By: Robert Vamer

Date: 8/24/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 3

Project No. 140241

Mix Date Friday, May 02, 2014

Mix Time: 1:00 PM

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	5.95	27.81	12.20	213010
24	5.99	28.13	12.22	223460
25	5.97	27.99	12.19	
26	5.96	27.90	12.21	
27	5.98	28.13	12.25	

Compressometer Calibration
 Pivot rod to yoke supports (0.01 in.) 4.95
 Longitudinal gage to yoke supports (0.01 in.) 5.40
 Longitudinal Gage length (0.01 in.) 8.00
Extensometer Calibration
 Hinge to mid yoke supports (0.01 in.) 3.91
 Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:
 Machine applied load (lbs.), **P**
 Longitudinal gage reading, **G_{long}**
 Longitudinal Strain, **ε_{long}**
 Transverse gage reading, **G_{tran}**
 Transverse Strain, **ε_{tran}**
 Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 87294

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	9630	0.00085	0.00000	0.000000	344	87294	0.00870	0.00080	0.00052	0.000060	3119	5902263.2	5.90E+06	0.13
25	8610	0.00085	0.00005	0.000004	308	87294	0.00875	0.00095	0.00052	0.000071	3119	5941999.1	5.95E+06	0.14
25	8010	0.00085	0.00005	0.000004	286	87294	0.00880	0.00090	0.00053	0.000067	3119	5949717.9	5.95E+06	0.13
Average	8750	0.00085	0.00003	0.000002	313	87294	0.00875	0.00088	0.00052	0.000066	3119	5931326.7	5.95E+06	0.13
26	9910	0.00085	0.00000	0.000000	355	87294	0.00965	0.00100	0.00058	0.000075	3129	5264013.3	5.25E+06	0.14
26	9560	0.00085	0.00010	0.000007	343	87294	0.00965	0.00115	0.00058	0.000086	3129	5287821.9	5.30E+06	0.15
26	9480	0.00085	0.00005	0.000004	340	87294	0.00970	0.00105	0.00058	0.000079	3129	5263404.5	5.25E+06	0.14
Average	9650	0.00085	0.00005	0.000004	346	87294	0.00967	0.00107	0.00058	0.000080	3129	5271746.6	5.25E+06	0.14
27	11570	0.00085	0.00010	0.000007	411	87294	0.00850	0.00080	0.00051	0.000060	3103	5875624.9	5.90E+06	0.11
27	10670	0.00085	0.00010	0.000007	379	87294	0.00860	0.00085	0.00051	0.000063	3103	5868877.4	5.85E+06	0.12
27	9270	0.00085	0.00000	0.000000	330	87294	0.00875	0.00070	0.00052	0.000052	3103	5862833	5.85E+06	0.11
Average	10503	0.00085	0.00007	0.000005	373	87294	0.00862	0.00078	0.00052	0.000058	3103	5869111.8	5.85E+06	0.12
Overall Average	9634	0.00085	0.00005	0.000004	344	87294	0.00901	0.00091	0.00054	0.000068	3117	5690728.4	5.70E+06	0.13

Reported By: Scott Bivings

Date:

Reviewed By: Robert Varner

Date: 8/27/2014

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241

Mix Number Mix 3 Set No: 3
Mix Date Friday, May 02, 2014
Mix Time 1:00 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
9	10.0000	0.8135	0.8115	11.59550	1.6250	9.9705
10	10.0000	0.8130	0.8140	11.61550	1.6270	9.9885
11	10.0000	0.8125	0.8135	11.61050	1.6260	9.9845
12	10.0000	0.8120	0.8130	11.61050	1.6250	9.9855

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
10		Specimen 9	Reference Bar 9	Δ Length 9	Specimen 10	Reference Bar 10	Δ Length 10	Specimen 11	Reference Bar 11	Δ Length 11	Specimen 12	Reference Bar 12	Δ Length 12	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Saturday, May 03, 2014	0.0630	0.0983	-0.0353	0.0821	0.0983	-0.0162	0.0767	0.0982	-0.0215	0.0837	0.0982	-0.0145	-0.0219
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
		Specimen 9	Reference Bar 9	Δ Length 9	Specimen 10	Reference Bar 10	Δ Length 10	Specimen 11	Reference Bar 11	Δ Length 11	Specimen 12	Reference Bar 12	Δ Length 12	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
7	Friday, May 09, 2014	0.0631	0.0982	0.0020	0.0824	0.0981	0.0050	0.0771	0.0981	0.0050	0.0839	0.0980	0.0040	0.0040
11	Tuesday, May 13, 2014	0.0621	0.0980	-0.0060	0.0814	0.0980	-0.0040	0.0760	0.0980	-0.0050	0.0828	0.0980	-0.0070	-0.0055
14	Friday, May 16, 2014	0.0616	0.0980	-0.0110	0.0808	0.0980	-0.0100	0.0756	0.0980	-0.0090	0.0824	0.0980	-0.0110	-0.0103
21	Friday, May 23, 2014	0.0615	0.0979	-0.0110	0.0807	0.0979	-0.0100	0.0753	0.0979	-0.0110	0.0822	0.0979	-0.0120	-0.0110
35	Friday, June 06, 2014	0.0608	0.0979	-0.0180	0.0799	0.0979	-0.0180	0.0747	0.0979	-0.0170	0.0815	0.0979	-0.0190	-0.0180
63	Friday, July 04, 2014	0.0599	0.0976	-0.0240	0.0791	0.0976	-0.0230	0.0739	0.0977	-0.0230	0.0808	0.0977	-0.0240	-0.0235
119	Friday, August 29, 2014	0.0592	0.0975	-0.0300	0.0783	0.0975	-0.0300	0.0731	0.0975	-0.0290	0.0799	0.0975	-0.0310	-0.0300
231	Friday, December 19, 2014	0.0588	0.0975	-0.0340	0.0779	0.0975	-0.0340	0.0726	0.0975	-0.0340	0.0794	0.0975	-0.0360	-0.0345
455	Friday, July 31, 2015	0.0582	0.0971	-0.0360	0.0774	0.0971	-0.0350	0.0720	0.0971	-0.0360	0.0789	0.0971	-0.0370	-0.0360
42	Calculated 35 Day Shrinkage			-0.0197			-0.0192			-0.0191			-0.0202	-0.0196
Note: Lowest Reading Value Recorded (Minimum)														
Reported by: <u>Scott Bivings</u>					Reviewed by: <u>Robert Varner 10/9/2015</u>									

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 3 Set No: 3
Mix Date Friday, May 02, 2014
Mix Time 1:00 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
9	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
10	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
11	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
12	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

Reference Bar Length (in.)		INITIAL READINGS													
10		Specimen 9	Reference Bar 9	Δ Length 9	Specimen 10	Reference Bar 10	Δ Length 10	Specimen 11	Reference Bar 11	Δ Length 11	Specimen 12	Reference Bar 12	Δ Length 12	Average	
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches	
819	Friday, July 29, 2016	0.0581	0.0971	-0.0370	0.0771	0.0971	-0.0380	0.0718	0.0971	-0.0380	0.0787	0.0971	-0.0390	-0.0380	
Reintroduce to Waterbath		LENGTH CHANGE CALCULATIONS													
		Specimen 9	Reference Bar 9	Δ Length 9	Specimen 10	Reference Bar 10	Δ Length 10	Specimen 11	Reference Bar 11	Δ Length 11	Specimen 12	Reference Bar 12	Δ Length 12	Average	
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)	
824	Wednesday, August 03, 2016	0.0600	0.0971	-0.0180	0.0792	0.0971	-0.0170	0.0738	0.0971	-0.0180	0.0807	0.0971	-0.0190	-0.0180	
825	Thursday, August 04, 2016	0.0600	0.0970	-0.0170	0.0792	0.0970	-0.0160	0.0739	0.0970	-0.0160	0.0807	0.0971	-0.0190	-0.0170	
826	Friday, August 05, 2016	0.0602	0.0971	-0.0160	0.0794	0.0971	-0.0150	0.0740	0.0971	-0.0160	0.0808	0.0971	-0.0180	-0.0163	
833	Friday, August 12, 2016	0.0603	0.0971	-0.0150	0.0794	0.0971	-0.0150	0.0741	0.0971	-0.0150	0.0809	0.0971	-0.0170	-0.0155	
847	Friday, August 26, 2016	0.0603	0.0971	-0.0150	0.0795	0.0971	-0.0140	0.0741	0.0971	-0.0150	0.0808	0.0971	-0.0180	-0.0155	
854	Friday, September 02, 2016	0.0603	0.0971	-0.0150	0.0796	0.0971	-0.0130	0.0742	0.0971	-0.0140	0.0810	0.0971	-0.0160	-0.0145	
875	Friday, September 23, 2016	0.0602	0.0971	-0.0160	0.0795	0.0971	-0.0140	0.0741	0.0971	-0.0150	0.0811	0.0971	-0.0150	-0.0150	
972	Thursday, December 29, 2016	0.0603	0.0967	-0.0110	0.0797	0.0967	-0.0080	0.0742	0.0967	-0.0100	0.0811	0.0967	-0.0110	-0.0100	

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:	
Customer: MDOT		Project: SP-9999-09(110)/106812-101000				Lab #: BCD		1st bucket full = 43.65 with 3.5% air			
MIX NUMBER		Mix 4.1		Set #: 4		added 3 ml air: 2nd bucket 43.45 with 4.0% air.					
Date: 5/5/2014		Mix Code: Mix 1		f'c: 3,500 psi		Size(c.f.): 6.25		Factor: 0.23			
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorp- tion	Agg. FM		
Cement 1:	1.39	274.00	63.43	63.43	63.43	Type I-II Cement	3.15		Roller Meter Air 4.5		
Cement 2:	0.00	0.00	0.00	0.00			0.00		Coarseness and Workability (volume)		
Fly Ash:	0.00	0.00	0.00	0.00			2.42		Cumulative % retained on 3/8" 57.08		
Slag:	1.52	274.00	63.43	63.43	63.43	Slag Cement	2.89		Cumulative % retained on No 8 65.99		
Sand 1:	6.71	1103.45	255.43	265.41	265.43	Sand	2.636	0.52%	Cumulative % passing No 8 33.73		
Coarse Aggregate 1:	12.49	1929.00	446.53	450.93	450.93	CA_ID1 - 57 Gravel High Absorption	2.475	3.37%	Coarseness Factor 86.49		
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%	Workability Factor 33.73		
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%	Adjusted Workability Factor 33.30		
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%			
Air:	4.50%	1.22	0.00	0.00	0.00						
Water:	3.67	229.19	53.05	38.66	38.66		1.00				
"+-Air:	0.50%										
Total:	27.00	3809.64	881.86	881.86							
UW w/o Air:		147.75	147.75	147.75							
ADMIX INFORMATION							Aggregate Moistures				
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)			
Air	0.57	3.1	92.2	21.3	21.3	Air	Sand: 3.93%	9.99			
Water Reducer	5.00	27.4	810.3	187.6	187.6	Water Reducer	CA 1 1.02%	4.41			
							CA 2 0.00%	0.00			
							CA 3 0.00%	0.00			
							CA 4 0.00%	0.00			
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.			
Batch Time	12:59 PM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4				
Sample Time	1:07 PM		34.94	65.06	0	0	0				
Slump, in.	2.50	2 in.	0.0	0.0	0.0	0.0	0.0				
Mix Temp.	79.1	1.5 in.	0.0	0.0	0.0	0.0	0.0				
Air Temp.	83.0	1.0 in.	0.0	1.5	0.0	0.0	0.0				
ACF Air %	4.5	3/4 in.	0.0	14.5	0.0	0.0	0.0				
Unit Weight (pcf)	143.80	1/2 in.	0.0	44.6	0.0	0.0	0.0				
Design Unit Wt.	141.10	3/8 in.	0.0	27.1	0.0	0.0	0.0				
Yield	6.13	No. 4	0.4	10.4	0.0	0.0	0.0				
Relative Yield	0.98	No. 8	4.5	0.7	0.0	0.0	0.0				
Design w/c	0.418	No. 16	8.4	0.3	0.0	0.0	0.0				
Actual w/c	0.418	No. 30	17.0	0.1	0.0	0.0	0.0				
Fine/Coarse	0.57	No. 50	57.8	0.1	0.0	0.0	0.0				
Bag Factor	5.83	No. 100	11.3	0.1	0.0	0.0	0.0				
Theoretical Air (%)	2.67	Pan	0.2	0.4	0.0	0.0	0.0				
							Combined Gradation by Volume				

Draft Report

**BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength**

278 COMMERCE PARK DRIVE
RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
Fax: (601) 856-3552

Mix ID: _____ Mix 4

BDC Project NO. 140241

Made Date: _____ Monday, May 05, 2014

COMPRESSION TESTS RESULTS

Specimen No.	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	5/12/2014	5.94	5.98	12.00	12.05	12.10	28.41	146.03	27.90	124710	4470	3	4410
6	7	5/12/2014	6.01	5.98	12.05	12.05	12.05	28.41	144.33	28.23	111840	3962	3	
7	7	5/12/2014	5.96	5.98	12.00	12.00	12.00	28.37	145.94	27.99	123970	4429	3	
8	7	5/12/2014	5.94	5.95	12.05	12.00	12.00	28.26	146.39	27.76	131090	4722	3	
9	7	5/12/2014	5.91	5.99	11.95	11.95	12.00	28.19	146.40	27.81	124650	4482	3	
11	14	5/19/2014	5.97	6.02	12.00	12.00	12.00	28.39	144.83	28.23	173070	6131	3	6340
12	14	5/19/2014	5.99	6.00	12.00	12.00	12.00	28.34	144.57	28.23	180060	6378	4	
13	14	5/19/2014	5.99	5.99	12.00	12.00	12.05	28.51	145.48	28.18	176640	6268	3	
14	14	5/19/2014	5.96	5.97	12.05	11.95	12.00	28.27	145.67	27.95	185830	6649	1	
15	14	5/19/2014	5.98	6.02	12.05	12.05	12.00	28.41	144.29	28.28	178100	6298	3	
17	28	6/2/2014	5.94	6.00	12.00	12.00	12.00	28.37	145.94	27.99	201510	7199	4	7020
18	28	6/2/2014	5.93	5.93	11.95	12.05	12.05	28.40	147.86	27.62	190180	6886	4	
19	28	6/2/2014	5.93	5.99	11.95	12.00	12.05	28.37	146.41	27.90	174600	6258	3	
20	28	6/2/2014	5.92	5.91	12.00	12.00	12.00	28.32	148.40	27.48	208260	7579	4	
21	28	6/2/2014	5.92	5.96	12.00	12.00	12.00	28.41	147.62	27.71	198970	7180	3	
23	90	8/3/2014	5.99	5.99	12.00	12.05	12.00	28.39	144.87	28.18	227230	8064	3	7850
24	90	8/3/2014	5.99	5.95	12.10	12.05	12.00	28.35	145.23	27.99	211700	7563	3	
25	90	8/3/2014	5.96	5.97	12.05	12.00	12.05	28.31	145.47	27.95	213300	7631	3	
26	90	8/3/2014	5.98	5.99	11.95	12.00	12.00	28.29	145.00	28.13	226380	8048	3	
27	90	8/3/2014	5.98	5.99	12.10	12.15	12.10	28.65	145.23	28.13	222870	7923	3	

Reported By: _____ Scott Bivings _____ Date: _____

Reviewed By: _____ Robert Varner _____ Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
 AASHTO T97 Flexural Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID: _____ Mix 4
 Made Date: _____ Monday, May 05, 2014

BDC Project NO. 140241

Specimen No.	Specimen Age	Test Date	Depth 1 (0.05 in)	Depth 2 (0.05 in)	Depth 3 (0.05 in)	Avg Depth (in.)	Width 1 (0.05 in)	Width 2 (0.05 in)	Width 3 (0.05 in)	Avg Width (in.)	Max Load	Flex Strength (psi)	Avg (psi)
29	7	5/12/2014	6.05	6.05	6.05	6.05	5.95	5.95	5.95	5.95	8600	711	675
30	7	5/12/2014	6.05	6.05	6.05	6.05	6.10	6.00	6.05	6.05	7840	637	
31	7	5/12/2014	6.05	6.10	6.10	6.08	6.05	6.00	6.00	6.02	8450	683	
32	14	5/19/2014	6.05	6.05	6.00	6.03	6.10	6.05	6.00	6.05	9630	788	795
33	14	5/19/2014	6.05	6.10	6.05	6.07	6.05	6.05	6.10	6.05	10120	817	
34	14	5/19/2014	6.10	6.10	6.10	6.10	6.10	6.10	6.10	6.10	9790	776	
35	28	6/2/2014	6.15	6.10	6.10	6.12	5.90	5.90	5.95	5.92	10210	829	845
36	28	6/2/2014	6.15	6.10	6.05	6.10	6.10	6.10	6.05	6.08	9990	795	
37	28	6/2/2014	6.10	6.10	6.05	6.08	6.10	6.00	6.00	6.03	11190	904	
38	90	8/3/2014	6.05	6.05	6.05	6.05	6.00	5.95	5.95	5.95	10360	856	845
39	90	8/3/2014	6.05	6.10	6.05	6.07	6.00	6.00	6.05	6.00	10630	866	
40	90	8/3/2014	6.05	6.05	6.05	6.05	5.95	5.90	6.00	5.95	9910	819	

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Varner _____

Date: _____ 8/28/2014 _____

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 4

Project No. 140241

Mix Date _____ Monday, May 05, 2014

Mix Time: _____ 12:59 PM

7 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	5.96	27.9	12.36	124710
6	6.00	28.23	12.28	111840
7	5.97	27.99	12.26	
8	5.95	27.76	12.27	
9	5.95	27.81	12.19	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) _____ 47310

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) _____ 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
7	8990	0.00085	0.00015	0.000011	321	47310	0.00530	0.00055	0.00032	0.000041	1690	5130491	5.15E+06	0.11
7	8230	0.00085	0.00015	0.000011	294	47310	0.00535	0.00065	0.00032	0.000049	1690	5174283.6	5.15E+06	0.14
7	8340	0.00085	0.00015	0.000011	298	47310	0.00525	0.00070	0.00031	0.000052	1690	5276623.4	5.30E+06	0.16
Average	8520	0.00085	0.00015	0.000011	304	47310	0.00530	0.00063	0.00032	0.000047	1690	5193799.3	5.20E+06	0.14
8	9210	0.00085	0.00015	0.000011	332	47310	0.00505	0.00070	0.00030	0.000053	1704	5448457.9	5.45E+06	0.16
8	9030	0.00085	0.00005	0.000004	325	47310	0.00495	0.00060	0.00030	0.000045	1704	5607273.1	5.60E+06	0.17
8	9710	0.00085	0.00020	0.000015	350	47310	0.00520	0.00075	0.00031	0.000056	1704	5192123	5.20E+06	0.16
Average	9317	0.00085	0.00013	0.000010	336	47310	0.00507	0.00068	0.00030	0.000051	1704	5415951.3	5.40E+06	0.16
9	8590	0.00085	0.00015	0.000011	309	47310	0.00550	0.00075	0.00033	0.000056	1701	4993842.2	5.00E+06	0.16
9	8560	0.00085	0.00015	0.000011	308	47310	0.00545	0.00075	0.00033	0.000056	1701	5051873.8	5.05E+06	0.16
9	8710	0.00085	0.00018	0.000014	313	47310	0.00545	0.00070	0.00033	0.000053	1701	5032318.2	5.05E+06	0.14
Average	8620	0.00085	0.00016	0.000012	310	47310	0.00547	0.00073	0.00033	0.000055	1701	5026011.4	5.05E+06	0.16
Overall Average	8819	0.00085	0.00015	0.000011	317	47310	0.00528	0.00068	0.00032	0.000051	1699	5211920.7	5.20E+06	0.15

Reported By: _____ Scott Bivings

Date: _____

Reviewed By: _____ Robert Vamer

Date: _____ 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 4

Project No. 140241

Mix Date _____ Monday, May 05, 2014

Mix Time: _____ 12:59 PM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	5.99	28.23	12.19	173070
12	6.00	28.23	12.17	180060
13	5.99	28.18	12.27	
14	5.97	27.95	12.20	
15	6.00	28.28	12.26	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00
Extensometer Calibration	
Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) _____ 70626

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) _____ 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	11680	0.00085	0.00015	0.000011	414	70626	0.00725	0.00100	0.00043	0.000075	2506	5455494.9	5.45E+06	0.17
13	8970	0.00085	0.00015	0.000011	318	70626	0.00760	0.00100	0.00045	0.000075	2506	5411021.3	5.40E+06	0.16
13	9790	0.00085	0.00005	0.000004	347	70626	0.00750	0.00100	0.00045	0.000075	2506	5419179.2	5.40E+06	0.18
Average	10147	0.00085	0.00012	0.000009	360	70626	0.00745	0.00100	0.00045	0.000075	2506	5428565.1	5.45E+06	0.17
14	8570	0.00085	0.00000	0.000000	307	70626	0.00740	0.00085	0.00044	0.000064	2527	5658256	5.65E+06	0.16
14	9240	0.00085	0.00005	0.000004	331	70626	0.00730	0.00085	0.00044	0.000064	2527	5683760.2	5.70E+06	0.15
14	9580	0.00085	0.00010	0.000007	343	70626	0.00730	0.00095	0.00044	0.000071	2527	5652279.4	5.65E+06	0.16
Average	9130	0.00085	0.00005	0.000004	327	70626	0.00733	0.00088	0.00044	0.000066	2527	5664765.2	5.65E+06	0.16
15	9520	0.00085	0.00015	0.000011	337	70626	0.00770	0.00110	0.00046	0.000082	2497	5265932.9	5.25E+06	0.17
15	8110	0.00085	0.00005	0.000004	287	70626	0.00770	0.00100	0.00046	0.000074	2497	5387442.5	5.40E+06	0.17
15	8540	0.00085	0.00015	0.000011	302	70626	0.00765	0.00115	0.00046	0.000086	2497	5389648.7	5.40E+06	0.18
Average	8723	0.00085	0.00012	0.000009	308	70626	0.00768	0.00108	0.00046	0.000081	2497	5347674.7	5.35E+06	0.18
Overall Average	9333	0.00085	0.00009	0.000007	332	70626	0.00749	0.00099	0.00045	0.000074	2510	5480335	5.50E+06	0.17

Reported By: _____ Scott Bivings

Date: _____

Reviewed By: _____ Robert Varner

Date: _____ 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 4 _____

Project No. _____ 140241 _____

Mix Date _____ Monday, May 05, 2014 _____

Mix Time: _____ 12:59 PM _____

90 DAY CYLINDER DATA

Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	5.99	28.18	12.26	227230
24	5.97	27.99	12.28	211700
25	5.97	27.95	12.24	
26	5.99	28.13	12.24	
27	5.99	28.13	12.35	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) _____ 4.95
 Longitudinal gage to yoke supports (0.01 in.) _____ 5.40
 Longitudinal Gage length (0.01 in.) _____ 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) _____ 3.91
 Transverse gage to mid yoke supports (0.01 in.) _____ 4.85

Variable Definitions:

Machine applied load (lbs.), **P**
 Longitudinal gage reading, **G_{long}**
 Longitudinal Strain, ϵ_{long}
 Transverse gage reading, **G_{tran}**
 Transverse Strain, ϵ_{tran}
 Compressive Stress, σ

40% of Ultimate Load (lbs.) _____ 87786 _____

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) _____ 0.00084 _____

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ϵ_{tran}	σ	P	G _{long}	G _{tran}	ϵ_{long}	ϵ_{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	9320	0.00085	0.00005	0.000004	333	87786	0.00825	0.00105	0.00049	0.000079	3141	6334226.1	6.35E+06	0.17
25	9630	0.00085	0.00005	0.000004	345	87786	0.00825	0.00115	0.00049	0.000086	3141	6309201.1	6.30E+06	0.19
25	10300	0.00085	0.00010	0.000007	369	87786	0.00815	0.00105	0.00049	0.000079	3141	6340641.6	6.35E+06	0.16
Average	9750	0.00085	0.00007	0.000005	349	87786	0.00822	0.00108	0.00049	0.000081	3141	6328022.9	6.35E+06	0.17
26	10680	0.00085	0.00010	0.000007	380	87786	0.00850	0.00110	0.00051	0.000082	3121	5982857.9	6.00E+06	0.16
26	10220	0.00085	0.00010	0.000007	363	87786	0.00845	0.00120	0.00051	0.000089	3121	6058075.4	6.05E+06	0.18
26	10130	0.00085	0.00010	0.000007	360	87786	0.00855	0.00120	0.00051	0.000089	3121	5986476.2	6.00E+06	0.18
Average	10343	0.00085	0.00010	0.000007	368	87786	0.00850	0.00117	0.00051	0.000087	3121	6009136.5	6.00E+06	0.17
27	11290	0.00085	0.00010	0.000007	401	87786	0.00790	0.00105	0.00047	0.000078	3121	6439702.4	6.45E+06	0.17
27	10530	0.00085	0.00010	0.000007	374	87786	0.00805	0.00105	0.00048	0.000078	3121	6368444.6	6.35E+06	0.16
27	10680	0.00085	0.00010	0.000007	380	87786	0.00805	0.00100	0.00048	0.000075	3121	6356079.7	6.35E+06	0.16
Average	10833	0.00085	0.00010	0.000007	385	87786	0.00800	0.00103	0.00048	0.000077	3121	6388075.6	6.40E+06	0.16
Overall Average	10309	0.00085	0.00009	0.000007	367	87786	0.00824	0.00109	0.00049	0.000082	3127	6241745	6.25E+06	0.17

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Vamer _____

Date: _____ 8/28/2014 _____

Draft Report

**BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS**

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241
Mix Number Mix 4
Mix Date Monday, May 05, 2014
Mix Time 12:59 PM

Set No: 4

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
13	10.0000	0.8140	0.8165	11.59450	1.6305	9.9640
14	10.0000	0.8145	0.8155	11.62150	1.6300	9.9915
15	10.0000	0.8135	0.8130	11.61300	1.6265	9.9865
16	10.0000	0.8135	0.8125	11.62950	1.6260	10.0035

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
10		Specimen 13	Reference Bar 13	Δ Length 13	Specimen 14	Reference Bar 14	Δ Length 14	Specimen 15	Reference Bar 15	Δ Length 15	Specimen 16	Reference Bar 16	Δ Length 16	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Tuesday, May 06, 2014	0.0561	0.0982	-0.0421	0.0884	0.0982	-0.0098	0.0811	0.0982	-0.0171	0.1039	0.0982	0.0057	-0.0158
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
		Specimen 13	Reference Bar 13	Δ Length 13	Specimen 14	Reference Bar 14	Δ Length 14	Specimen 15	Reference Bar 15	Δ Length 15	Specimen 16	Reference Bar 16	Δ Length 16	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001%)
7	Monday, May 12, 2014	0.0565	0.0980	0.0060	0.0887	0.0980	0.0050	0.0815	0.0980	0.0060	0.1046	0.0980	0.0090	0.0065
11	Friday, May 16, 2014	0.0559	0.0980	0.0000	0.0881	0.0980	-0.0010	0.0809	0.0981	-0.0010	0.1039	0.0981	0.0010	-0.0003
14	Monday, May 19, 2014	0.0556	0.0980	-0.0030	0.0879	0.0980	-0.0030	0.0807	0.0980	-0.0020	0.1038	0.0980	0.0010	-0.0018
21	Monday, May 26, 2014	0.0554	0.0979	-0.0040	0.0877	0.0979	-0.0040	0.0806	0.0979	-0.0020	0.1036	0.0979	0.0000	-0.0025
35	Monday, June 09, 2014	0.0551	0.0979	-0.0070	0.0874	0.0979	-0.0070	0.0803	0.0979	-0.0050	0.1031	0.0979	-0.0050	-0.0060
63	Monday, July 07, 2014	0.0544	0.0975	-0.0100	0.0867	0.0975	-0.0100	0.0797	0.0975	-0.0070	0.1024	0.0975	-0.0080	-0.0088
119	Monday, September 01, 2014	0.0536	0.0975	-0.0180	0.0860	0.0975	-0.0170	0.0790	0.0975	-0.0140	0.1018	0.0975	-0.0140	-0.0158
231	Monday, December 22, 2014	0.0527	0.0975	-0.0270	0.0853	0.0975	-0.0240	0.0783	0.0975	-0.0210	0.1011	0.0975	-0.0210	-0.0233
455	Monday, August 03, 2015	0.0519	0.0971	-0.0310	0.0844	0.0971	-0.0290	0.0774	0.0971	-0.0260	0.1002	0.0971	-0.0260	-0.0280
42	Calculated 35 Day Shrinkage			-0.0090			-0.0089			-0.0064			-0.0060	-0.0076
Note: Lowest Reading Value Recorded (Minimum)														
Reported by: <u>Scott Bivings</u>					Reviewed by: <u>Robert Varner 11/30/2015</u>									

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 4
Mix Date Monday, May 05, 2014
Mix Time 12:59 PM

Set No: 4

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
13	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
14	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
15	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
16	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

Reference Bar Length (in.)		INITIAL READINGS													
		Specimen 13	Reference Bar 13	Δ Length 13	Specimen 14	Reference Bar 14	Δ Length 14	Specimen 15	Reference Bar 15	Δ Length 15	Specimen 16	Reference Bar 16	Δ Length 16	Average	
10		(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches	
Specimen Age	Test date	0.0513	0.0970	-0.0360	0.0839	0.0970	-0.0330	0.0767	0.0970	-0.0320	0.0998	0.0970	-0.0290	-0.0325	
821	Wednesday, August 03, 2016														
Reintroduce to Waterbath		LENGTH CHANGE CALCULATIONS													
		Specimen 13	Reference Bar 13	Δ Length 13	Specimen 14	Reference Bar 14	Δ Length 14	Specimen 15	Reference Bar 15	Δ Length 15	Specimen 16	Reference Bar 16	Δ Length 16	Average	
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)	
822	Thursday, August 04, 2016	0.0532	0.0970	-0.0170	0.0856	0.0970	-0.0160	0.0786	0.0970	-0.0130	0.1015	0.0970	-0.0120	-0.0145	
823	Friday, August 05, 2016	0.0535	0.0971	-0.0150	0.0858	0.0971	-0.0150	0.0789	0.0971	-0.0110	0.1017	0.0971	-0.0110	-0.0130	
828	Wednesday, August 10, 2016	0.0537	0.0971	-0.0130	0.0861	0.0971	-0.0120	0.0791	0.0971	-0.0090	0.1019	0.0971	-0.0090	-0.0108	
835	Wednesday, August 17, 2016	0.0539	0.0970	-0.0100	0.0862	0.0970	-0.0100	0.0792	0.0970	-0.0070	0.1020	0.0970	-0.0070	-0.0085	
849	Wednesday, August 31, 2016	0.0542	0.0971	-0.0080	0.0864	0.0971	-0.0090	0.0793	0.0971	-0.0070	0.1022	0.0971	-0.0060	-0.0075	
856	Wednesday, September 07, 2016	0.0542	0.0971	-0.0080	0.0864	0.0971	-0.0090	0.0794	0.0971	-0.0060	0.1024	0.0971	-0.0040	-0.0068	
877	Wednesday, September 28, 2016	0.0541	0.0971	-0.0090	0.0864	0.0971	-0.0090	0.0794	0.0971	-0.0060	0.1030	0.0971	0.0020	-0.0055	
969	Thursday, December 29, 2016	0.0543	0.0967	-0.0030	0.0867	0.0967	-0.0020	0.0797	0.0967	0.0010	0.1027	0.0967	0.0030	-0.0003	

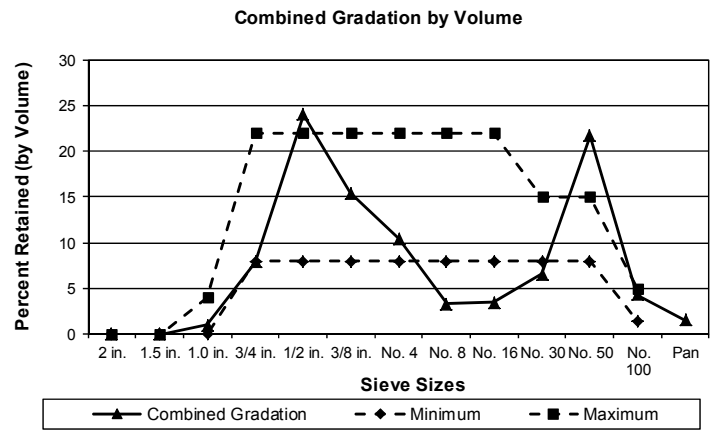
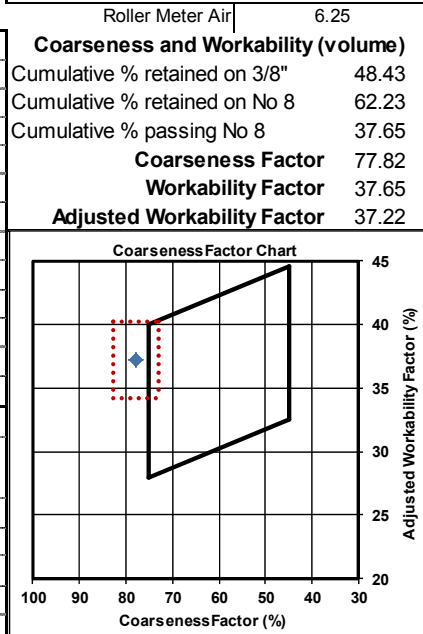
Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:	
Customer: MDOT		Project: SP-9999-09(110)/106812-101000				Lab #: BCD					
MIX NUMBER Mix 5.1		Mix Code:		Mix 1	f'c:	3,500 psi		Size(c.f.):	6.50	Set #: 5	Factor: 0.24
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source		SSD Specific Gravity	Agg. absorption	Agg. FM	
Material	Vol. (c.f.)										
Cement 1:	2.79	548.00	131.93	131.93	131.93	Type II Cement		3.15			
Cement 2:	0.00	0.00	0.00	0.00				0.00			
Fly Ash:	0.00	0.00	0.00	0.00				2.42			
Slag:	0.00	0.00	0.00	0.00				0.00			
Sand 1:	7.17	1180.13	284.11	293.01	293.01	Sand		2.636	0.52%	2.36	
Coarse Aggregate 1:	12.12	1993.00	479.80	479.99	479.99	CA_ID2 - 57 Crushed Limestone MO		2.636	1.49%	6.70	
Coarse Aggregate 2:	0.00	0.00	0.00	0.00				1.000	1.00%		
Coarse Aggregate 3:	0.00	0.00	0.00	0.00				1.000	1.00%		
Coarse Aggregate 4:	0.00	0.00	0.00	0.00				1.000	1.00%		
Air:	4.50%	1.22	0.00	0.00	0.00						
Water:	3.71	231.25	55.67	46.58	46.58			1.00			
"±-Air:	0.50%										
Total:	27.00	3952.38	951.50	951.50							
UW w/o Air:		153.28	153.28	153.28							
ADMIX INFORMATION							Aggregate Moistures				
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)			
Air	0.50	2.7	81.0	19.5	19.5	Air	Sand:	3.15%	8.90		
Water Reducer	5.00	27.4	810.3	195.1	195.1	Water Reducer	CA 1	0.04%	0.19		
							CA 2	0.00%	0.00		
							CA 3	0.00%	0.00		
							CA 4	0.00%	0.00		
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.			
Batch Time	1:12 PM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4				
Sample Time	1:20 PM		37.19	62.81	0	0	0				
Slump, in.	2.50	2 in.	0.0	0.0	0.0	0.0	0.0	0.0			
Mix Temp.	80.1	1.5 in.	0.0	0.0	0.0	0.0	0.0	0.0			
Air Temp.	83.5	1.0 in.	0.0	1.6	0.0	0.0	0.0	1.0			
ACF Air %	5.3	3/4 in.	0.0	12.6	0.0	0.0	0.0	7.9			
Unit Weight (pcf)	145.40	1/2 in.	0.0	38.3	0.0	0.0	0.0	24.1			
Design Unit Wt.	146.38	3/8 in.	0.0	24.6	0.0	0.0	0.0	15.5			
Yield	6.54	No. 4	0.4	16.5	0.0	0.0	0.0	10.5			
Relative Yield	1.01	No. 8	4.5	2.6	0.0	0.0	0.0	3.3			
Design w/c	0.422	No. 16	8.4	0.6	0.0	0.0	0.0	3.5			
Actual w/c	0.422	No. 30	17.0	0.4	0.0	0.0	0.0	6.6			
Fine/Coarse	0.59	No. 50	57.8	0.3	0.0	0.0	0.0	21.7			
Bag Factor	5.83	No. 100	11.3	0.2	0.0	0.0	0.0	4.3			
Theoretical Air (%)	5.14	Pan	0.2	2.4	0.0	0.0	0.0	1.6			



Draft Report

**BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength**

278 COMMERCE PARK DRIVE
RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
Fax: (601) 856-3552

Mix ID: _____ Mix 5

BDC Project NO. 140241

Made Date: Wednesday, May 07, 2014

COMPRESSION TESTS RESULTS

Specimen Age	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	5/14/2014	5.98	6.01	12.05	12.00	12.05	29.26	148.85	28.23	157780	5589	3	5450
6	7	5/14/2014	5.94	5.96	11.95	11.95	12.00	28.80	149.56	27.81	149860	5389	1	
7	7	5/14/2014	6.01	6.00	12.10	12.10	12.10	29.46	148.55	28.32	150840	5326	3	
8	7	5/14/2014	5.99	6.00	12.10	12.10	12.05	29.41	148.99	28.23	154260	5464	1	
9	7	5/14/2014	6.00	6.03	12.10	12.05	12.05	29.52	148.76	28.42	156450	5505	1	
11	14	5/21/2014	6.00	5.99	12.05	12.05	12.05	29.58	150.27	28.23	160970	5702	3	5940
12	14	5/21/2014	6.00	5.99	12.05	12.05	12.00	29.47	149.92	28.23	172500	6111	3	
13	14	5/21/2014	6.01	6.02	12.05	12.05	12.05	29.45	148.62	28.42	166610	5862	3	
14	14	5/21/2014	5.95	5.96	11.95	11.95	12.00	28.84	149.52	27.85	172080	6179	4	
15	14	5/21/2014	5.96	5.95	12.00	12.00	12.00	28.66	148.17	27.85	163150	5858	3	
17	28	6/4/2014	6.00	6.04	12.10	12.10	12.10	29.52	148.11	28.46	181070	6362	3	6370
18	28	6/4/2014	6.03	6.03	12.05	12.00	12.05	29.36	147.63	28.56	170380	5966	3	
19	28	6/4/2014	6.02	6.01	12.05	12.05	12.05	29.47	148.72	28.42	188340	6627	3	
20	28	6/4/2014	6.00	5.99	12.10	12.05	12.05	29.32	148.74	28.23	185200	6560	4	
21	28	6/4/2014	6.00	6.00	12.05	12.05	12.00	29.50	149.82	28.28	178490	6312	3	
23	90	8/5/2014	6.01	6.00	12.05	12.05	12.05	29.57	149.72	28.32	194050	6852	3	7030
24	90	8/5/2014	6.03	5.99	12.05	12.05	12.05	29.62	149.72	28.37	201240	7093	3	
25	90	8/5/2014	5.92	5.92	12.00	12.10	12.10	29.05	151.13	27.53	203040	7375	3	
26	90	8/5/2014	6.02	6.02	12.00	12.05	12.10	29.40	148.12	28.46	195730	6877	3	
27	90	8/5/2014	6.03	6.02	12.05	12.05	12.05	29.59	148.83	28.51	198650	6968	3	

Reported By: Scott Bivings Date: _____

Reviewed By: Robert Varner Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
 CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
 AASHTO T97 Flexural Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID: _____ Mix 5

BDC Project NO. 140241

Made Date: _____ Wednesday, May 07, 2014

Specimen No.	Specimen Age	Test Date	Depth 1 (0.05 in)	Depth 2 (0.05 in)	Depth 3 (0.05 in)	Avg Depth (in.)	Width 1 (0.05 in)	Width 2 (0.05 in)	Width 3 (0.05 in)	Avg Width (in.)	Max Load	Flex Strength (psi)	Avg (psi)
29	7	5/14/2014	6.00	6.05	6.05	6.03	5.95	5.95	5.95	5.95	8210	683	685
30	7	5/14/2014	6.05	6.10	6.05	6.07	6.10	6.10	6.10	6.10	8850	709	
31	7	5/14/2014	6.10	6.05	6.05	6.07	5.90	6.00	6.00	5.97	8050	659	
32	14	5/21/2014	6.10	6.10	6.10	6.10	6.10	6.10	6.10	6.10	9470	751	730
33	14	5/21/2014	6.10	6.05	6.05	6.07	5.95	5.95	5.95	5.95	8390	689	
34	14	5/21/2014	6.05	6.00	6.00	6.02	6.00	5.95	6.00	5.98	9040	751	
35	28	6/4/2014	6.10	6.10	6.10	6.10	6.05	6.10	6.10	6.08	9230	734	735
36	28	6/4/2014	6.10	6.10	6.05	6.08	5.95	5.95	6.00	5.97	9240	754	
37	28	6/4/2014	6.05	6.05	6.05	6.05	5.95	5.95	6.00	5.97	8740	720	
38	90	8/5/2014	6.05	6.05	6.05	6.05	6.10	6.05	6.10	6.08	8830	714	725
39	90	8/5/2014	6.00	6.00	6.05	6.02	6.05	6.05	6.05	6.05	8940	734	
40	90	8/5/2014	6.05	6.10	6.05	6.07	6.00	5.95	5.95	5.97	8920	730	

Reported By: _____ Scott Bivings

Date: _____

Reviewed By: _____ Robert Varner

Date: _____ 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 5 _____

Project No. 140241

Mix Date Wednesday, May 07, 2014

Mix Time: 1:12 PM

7 DAY CYLINDER DATA

Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	6.00	28.23	12.29	157780
6	5.95	27.81	12.13	149860
7	6.01	28.32	12.27	
8	6.00	28.23	12.24	
9	6.02	28.42	12.33	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 61528

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
7	7830	0.00085	0.00005	0.000004	276	61528	0.00775	0.00105	0.00046	0.000078	2173	4587578.1	4.60E+06	0.18
7	8070	0.00085	0.00010	0.000007	285	61528	0.00730	0.00115	0.00044	0.000085	2173	4885035	4.90E+06	0.20
7	7960	0.00085	0.00010	0.000007	281	61528	0.00798	0.00120	0.00048	0.000089	2173	4429125.5	4.45E+06	0.19
Average	7953	0.00085	0.00008	0.000006	281	61528	0.00768	0.00113	0.00046	0.000084	2173	4633912.8	4.65E+06	0.19
8	7600	0.00085	0.00015	0.000011	269	61528	0.00720	0.00120	0.00043	0.000089	2180	5021381.5	5.00E+06	0.21
8	7790	0.00085	0.00015	0.000011	276	61528	0.00710	0.00125	0.00042	0.000093	2180	5083574.8	5.10E+06	0.22
8	7490	0.00085	0.00015	0.000011	265	61528	0.00710	0.00120	0.00042	0.000089	2180	5111954.6	5.10E+06	0.21
Average	7627	0.00085	0.00015	0.000011	270	61528	0.00713	0.00122	0.00043	0.000091	2180	5072303.7	5.05E+06	0.21
9	9440	0.00085	0.00015	0.000011	332	61528	0.00680	0.00120	0.00041	0.000089	2165	5140763.1	5.15E+06	0.22
9	9120	0.00085	0.00015	0.000011	321	61528	0.00685	0.00115	0.00041	0.000085	2165	5129340	5.15E+06	0.21
9	8700	0.00085	0.00015	0.000011	306	61528	0.00680	0.00130	0.00041	0.000096	2165	5213796.5	5.20E+06	0.24
Average	9087	0.00085	0.00015	0.000011	320	61528	0.00682	0.00122	0.00041	0.000090	2165	5161299.9	5.15E+06	0.22
Overall Average	8222	0.00085	0.00013	0.000009	290	61528	0.00721	0.00119	0.00043	0.000088	2172	4955838.8	4.95E+06	0.21

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 5

Project No. 140241

Mix Date Wednesday, May 07, 2014

Mix Time: 1:12 PM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	6.00	28.23	12.25	160970
12	6.00	28.23	12.28	172500
13	6.02	28.42	12.25	
14	5.96	27.85	12.17	
15	5.96	27.85	12.21	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 66694

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	8440	0.00085	0.00005	0.000004	297	66694	0.00745	0.00110	0.00045	0.000082	2347	5184256.8	5.20E+06	0.20
13	7990	0.00085	0.00005	0.000004	281	66694	0.00725	0.00110	0.00043	0.000082	2347	5387216.5	5.40E+06	0.20
13	8270	0.00085	0.00005	0.000004	291	66694	0.00740	0.00115	0.00044	0.000085	2347	5238993.3	5.25E+06	0.21
Average	8233	0.00085	0.00005	0.000004	290	66694	0.00737	0.00112	0.00044	0.000083	2347	5270155.5	5.25E+06	0.20
14	8890	0.00085	0.00010	0.000007	319	66694	0.00720	0.00120	0.00043	0.000090	2395	5455725.1	5.45E+06	0.22
14	9270	0.00085	0.00015	0.000011	333	66694	0.00690	0.00120	0.00041	0.000090	2395	5688008.4	5.70E+06	0.22
14	8460	0.00085	0.00005	0.000004	304	66694	0.00700	0.00120	0.00042	0.000090	2395	5674656.2	5.65E+06	0.23
Average	8873	0.00085	0.00010	0.000007	319	66694	0.00703	0.00120	0.00042	0.000090	2395	5606129.9	5.60E+06	0.22
15	9590	0.00085	0.00020	0.000015	344	66694	0.00660	0.00115	0.00039	0.000086	2395	5950725.2	5.95E+06	0.21
15	9280	0.00085	0.00010	0.000007	333	66694	0.00695	0.00110	0.00042	0.000082	2395	5640507	5.65E+06	0.20
15	10150	0.00085	0.00015	0.000011	364	66694	0.00650	0.00110	0.00039	0.000082	2395	5996407	6.00E+06	0.21
Average	9673	0.00085	0.00015	0.000011	347	66694	0.00668	0.00112	0.00040	0.000084	2395	5862546.4	5.85E+06	0.21
Overall Average	8927	0.00085	0.00010	0.000007	319	66694	0.00703	0.00114	0.00042	0.000085	2379	5579610.6	5.60E+06	0.21

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 5

Project No. 140241

Mix Date Wednesday, May 07, 2014

Mix Time: 1:12 PM

28 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	6.02	28.46	12.21	181070
18	6.03	28.56	12.18	170380
19	6.02	28.42	12.19	
20	6.00	28.23	12.22	
21	6.00	28.28	12.24	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 70290

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	10450	0.00085	0.00005	0.000004	368	70290	0.00700	0.00115	0.00042	0.000085	2473	5714202.7	5.70E+06	0.22
19	9700	0.00085	0.00005	0.000004	341	70290	0.00710	0.00110	0.00042	0.000082	2473	5693449.6	5.70E+06	0.21
19	10070	0.00085	0.00000	0.000000	354	70290	0.00695	0.00105	0.00042	0.000078	2473	5797519.4	5.80E+06	0.21
Average	10073	0.00085	0.00003	0.000002	354	70290	0.00702	0.00110	0.00042	0.000082	2473	5735057.2	5.75E+06	0.21
20	8730	0.00085	0.00000	0.000000	309	70290	0.00780	0.00090	0.00047	0.000067	2490	5238136.2	5.25E+06	0.16
20	9140	0.00085	0.00000	0.000000	324	70290	0.00765	0.00100	0.00046	0.000074	2490	5317797.2	5.30E+06	0.18
20	9300	0.00085	0.00000	0.000000	329	70290	0.00755	0.00095	0.00045	0.000071	2490	5382884.7	5.40E+06	0.18
Average	9057	0.00085	0.00000	0.000000	321	70290	0.00767	0.00095	0.00046	0.000071	2490	5312939.4	5.30E+06	0.17
21	10030	0.00085	0.00000	0.000000	355	70290	0.00770	0.00100	0.00046	0.000074	2486	5193027.2	5.20E+06	0.18
21	10990	0.00085	0.00010	0.000007	389	70290	0.00730	0.00115	0.00044	0.000086	2486	5426546.3	5.45E+06	0.20
21	10200	0.00085	0.00000	0.000000	361	70290	0.00715	0.00100	0.00043	0.000074	2486	5629481.2	5.65E+06	0.20
Average	10407	0.00085	0.00003	0.000002	368	70290	0.00738	0.00105	0.00044	0.000078	2486	5416351.5	5.40E+06	0.19
Overall Average	9846	0.00085	0.00002	0.000002	348	70290	0.00736	0.00103	0.00044	0.000077	2483	5488116	5.50E+06	0.19

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varnier

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 5 _____

Project No. 140241

Mix Date Wednesday, May 07, 2014

Mix Time: 1:12 PM

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	6.01	28.32	12.38	194050
24	6.01	28.37	12.32	201240
25	5.92	27.53	12.35	
26	6.02	28.46	12.26	
27	6.03	28.51	12.29	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 79058

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	10100	0.00085	0.00005	0.000004	367	79058	0.00835	0.00125	0.00050	0.000094	2872	5576393.5	5.60E+06	0.20
25	9830	0.00085	0.00010	0.000008	357	79058	0.00845	0.00130	0.00051	0.000098	2872	5524698.5	5.50E+06	0.20
25	9470	0.00085	0.00015	0.000011	344	79058	0.00845	0.00135	0.00051	0.000102	2872	5553428.1	5.55E+06	0.20
Average	9800	0.00085	0.00010	0.000008	356	79058	0.00842	0.00130	0.00050	0.000098	2872	5551506.7	5.55E+06	0.20
26	10080	0.00085	0.00015	0.000011	354	79058	0.00765	0.00140	0.00046	0.000104	2778	5950067.4	5.95E+06	0.23
26	10570	0.00085	0.00015	0.000011	371	79058	0.00760	0.00140	0.00045	0.000104	2778	5951473.1	5.95E+06	0.23
26	10080	0.00085	0.00010	0.000007	354	79058	0.00770	0.00130	0.00046	0.000096	2778	5906722.6	5.90E+06	0.22
Average	10243	0.00085	0.00013	0.000010	360	79058	0.00765	0.00137	0.00046	0.000101	2778	5936087.7	5.95E+06	0.22
27	10000	0.00085	0.00010	0.000007	351	79058	0.00750	0.00130	0.00045	0.000096	2773	6080378.7	6.10E+06	0.22
27	10040	0.00085	0.00010	0.000007	352	79058	0.00765	0.00130	0.00046	0.000096	2773	5943076.7	5.95E+06	0.22
27	9500	0.00085	0.00010	0.000007	333	79058	0.00770	0.00130	0.00046	0.000096	2773	5945943	5.95E+06	0.22
Average	9847	0.00085	0.00010	0.000007	345	79058	0.00762	0.00130	0.00046	0.000096	2773	5989799.5	6.00E+06	0.22
Overall Average	9963	0.00085	0.00011	0.000008	354	79058	0.00789	0.00132	0.00047	0.000099	2808	5825798	5.85E+06	0.21

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/28/2014

Draft Report

**BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS**

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241
Mix Number Mix 5 Set No: 5
Mix Date Wednesday, May 07, 2014
Mix Time 1:12 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
17	10.0000	0.8075	0.8100	11.61400	1.6175	9.9965
18	10.0000	0.8125	0.8130	11.61750	1.6255	9.9920
19	10.0000	0.8120	0.8115	11.62150	1.6235	9.9980
20	10.0000	0.8140	0.8115	11.60650	1.6255	9.9810

SHRINKAGE TESTING - AASHTO T 160

Specimen Age	Reference Bar Length (in.)	Test date	INITIAL READINGS													
			Specimen 17	Reference Bar 17	Δ Length 17	Specimen 18	Reference Bar 18	Δ Length 18	Specimen 19	Reference Bar 19	Δ Length 19	Specimen 20	Reference Bar 20	Δ Length 20	Average	
1	10	Thursday, May 08, 2014	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches	
			0.0991	0.0981	0.0010	0.1036	0.0981	0.0055	0.1019	0.0981	0.0038	0.0846	0.0981	-0.0135	-0.0008	
			LENGTH CHANGE CALCULATIONS													
Specimen Age	Reference Bar Length (in.)	Test date	Moisture Cure for 7 Days	Specimen 17	Reference Bar 17	Δ Length 17	Specimen 18	Reference Bar 18	Δ Length 18	Specimen 19	Reference Bar 19	Δ Length 19	Specimen 20	Reference Bar 20	Δ Length 20	Average
				(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)
7	10	Wednesday, May 14, 2014		0.0993	0.0980	0.0030	0.1037	0.0980	0.0020	0.1022	0.0980	0.0040	0.0847	0.0980	0.0020	0.0028
12	10	Monday, May 19, 2014		0.0983	0.0980	-0.0070	0.1026	0.0979	-0.0080	0.1010	0.0979	-0.0070	0.0836	0.0979	-0.0080	-0.0075
14	10	Wednesday, May 21, 2014		0.0981	0.0980	-0.0090	0.1024	0.0980	-0.0110	0.1009	0.0980	-0.0090	0.0834	0.0980	-0.0110	-0.0100
21	10	Wednesday, May 28, 2014		0.0976	0.0979	-0.0130	0.1020	0.0979	-0.0140	0.1004	0.0979	-0.0130	0.0829	0.0979	-0.0150	-0.0137
35	10	Wednesday, June 11, 2014		0.0969	0.0979	-0.0200	0.1012	0.0979	-0.0220	0.0996	0.0979	-0.0210	0.0822	0.0979	-0.0220	-0.0212
63	10	Wednesday, July 09, 2014		0.0961	0.0976	-0.0250	0.1003	0.0976	-0.0280	0.0988	0.0975	-0.0250	0.0814	0.0975	-0.0260	-0.0260
119	10	Wednesday, September 03, 2014		0.0954	0.0975	-0.0310	0.0996	0.0975	-0.0340	0.0980	0.0975	-0.0330	0.0807	0.0975	-0.0330	-0.0328
231	10	Wednesday, December 24, 2014		0.0950	0.0975	-0.0350	0.0991	0.0975	-0.0390	0.0976	0.0975	-0.0370	0.0803	0.0975	-0.0370	-0.0370
455	10	Wednesday, August 05, 2015		0.0944	0.0971	-0.0370	0.0985	0.0971	-0.0410	0.0970	0.0971	-0.0390	0.0797	0.0971	-0.0390	-0.0390
42	10	Calculated 35 Day Shrinkage				-0.0211			-0.0233			-0.0217			-0.0231	-0.0223
Note: Lowest Reading Value Recorded (Minimum)																
Reported by: <u>Scott Bivings</u> Reviewed by: <u>Robert Varner 10/9/2015</u>																

Draft Report

BURNS COOLEY DENNIS, INC.

GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO.		Set No.		Measurements Required Before Making Specimens						
140241		5		Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
Mix Number	Mix 5			17	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
Mix Date	Wednesday, May 07, 2014			18	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
Mix Time	1:12 PM			19	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
				20	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

Reference Bar Length (in.)		INITIAL READINGS													
10		Specimen 17	Reference Bar 17	Δ Length 17	Specimen 18	Reference Bar 18	Δ Length 18	Specimen 19	Reference Bar 19	Δ Length 19	Specimen 20	Reference Bar 20	Δ Length 20	Average	
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches	
819	Wednesday, August 03, 2016	0.0944	0.0971	-0.0370	0.0982	0.0971	-0.0440	0.0967	0.0971	-0.0420	0.0794	0.0971	-0.0420	-0.0413	
Reintroduce to Waterbath		LENGTH CHANGE CALCULATIONS													
		Specimen 17	Reference Bar 17	Δ Length 17	Specimen 18	Reference Bar 18	Δ Length 18	Specimen 19	Reference Bar 19	Δ Length 19	Specimen 20	Reference Bar 20	Δ Length 20	Average	
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)	
820	Thursday, August 04, 2016	0.0960	0.0970	-0.0200	0.1001	0.0970	-0.0240	0.0986	0.0970	-0.0220	0.0812	0.0970	-0.0230	-0.0223	
822	Saturday, August 06, 2016	0.0961	0.0970	-0.0190	0.1004	0.0970	-0.0210	0.0988	0.0970	-0.0200	0.0815	0.0970	-0.0200	-0.0200	
826	Wednesday, August 10, 2016	0.0963	0.0970	-0.0170	0.1006	0.0970	-0.0190	0.0989	0.0970	-0.0190	0.0816	0.0970	-0.0190	-0.0185	
833	Wednesday, August 17, 2016	0.0964	0.0971	-0.0170	0.1007	0.0971	-0.0190	0.0991	0.0971	-0.0180	0.0819	0.0971	-0.0170	-0.0178	
847	Wednesday, August 31, 2016	0.0966	0.0971	-0.0150	0.1008	0.0971	-0.0180	0.0992	0.0971	-0.0170	0.0818	0.0971	-0.0180	-0.0170	
854	Wednesday, September 07, 2016	0.0966	0.0971	-0.0150	0.1008	0.0971	-0.0180	0.0992	0.0971	-0.0170	0.0819	0.0971	-0.0170	-0.0168	
875	Wednesday, September 28, 2016	0.0966	0.0971	-0.0150	0.1008	0.0971	-0.0180	0.0992	0.0971	-0.0170	0.0820	0.0971	-0.0160	-0.0165	
967	Thursday, December 29, 2016	0.0967	0.0967	-0.0100	0.1010	0.0967	-0.0120	0.0994	0.0967	-0.0110	0.0821	0.0967	-0.0110	-0.0110	
Note: Lowest Reading Value Recorded (Minimum)															
			Reported by:	Scott Bivings					Reviewed by:	Robert Varner 12/29/2016					

Draft Report

BCD 140241										Notes:		
Customer:	MDOT		Project:	SP-9999-09(110)/106812-101000				Lab #:	BCD		Started with 27 gallon of water. Increase to 28 gallons.	
MIX NUMBER	Mix 6.1						Set #:	6				
Date:	5/9/2014		Mix Code:	Mix 1	f'c:	3,500 psi		Size(c.f.):	6.25		Factor:	0.23
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source		SSD Specific Gravity	Agg. absorption	Agg. FM	Specimens made from combination of 6.1 and 6.2.	
Material	Vol. (c.f.)											
Cement 1:	2.09	411.00	95.14	95.14	95.14	Type I-II Cement		3.15			Roller Meter Air 5.25 Coarseness and Workability (volume) Cumulative % retained on 3/8" 48.96 Cumulative % retained on No 8 62.86 Cumulative % passing No 8 37.02 Coarseness Factor 77.89 Workability Factor 37.02 Adjusted Workability Factor 36.59	
Cement 2:	0.00	0.00	0.00	0.00				0.00				
Fly Ash:	1.01	137.00	31.71	31.71	31.71	Class F Fly Ash		2.18				
Slag:	0.00	0.00	0.00	0.00				0.00				
Sand 1:	6.96	1145.59	265.18	273.68	273.68	Sand		2.636	0.52%	2.36	Coarseness Factor Chart Adjusted Workability Factor (%) Coarseness Factor (%)	
Coarse Aggregate 1:	12.12	1993.00	461.34	461.52	461.52	CA_ID2 - 57 Crushed Limestone MO		2.636	1.49%	6.70		
Coarse Aggregate 2:	0.00	0.00	0.00	0.00				1.000	1.00%		Aggregate Moistures Free H ₂ O Content Batch free H ₂ O (lbs.) Sand: 3.22% 8.49 CA 1: 0.04% 0.18 CA 2: 0.00% 0.00 CA 3: 0.00% 0.00 CA 4: 0.00% 0.00	
Coarse Aggregate 3:	0.00	0.00	0.00	0.00				1.000	1.00%			
Coarse Aggregate 4:	0.00	0.00	0.00	0.00				1.000	1.00%		PLASTIC TEST RESULTS Aggregate - Individual Percent Retained, by weight Batch Time: 9:55 AM Sample Time: 10:05 AM Slump, in.: 2.25 Mix Temp.: 73.6 Air Temp.: 63.6 ACF Air %: 6.0 Unit Weight (pcf): 143.40 Design Unit Wt.: 144.47 Yield: 6.33 Relative Yield: 1.01 Design w/c: 0.426 Actual w/c: 0.426 Fine/Coarse: 0.57 Bag Factor: 5.83 Theoretical Air (%): 5.18	
Air:	4.50%	1.22	0.00	0.00	0.00							
Water:	3.74	233.34	54.01	45.34	45.34			1.00			Combined Gradation by Volume Percent Retained (by Volume) Sieve Sizes Combined Gradation (solid line with triangles) Minimum (dashed line with diamonds) Maximum (dashed line with squares)	
"+-Air:	0.50%											
Total:	27.13	3919.93	907.39	907.39							ADMIX INFORMATION Type oz /cwt oz /cy ml /cy batch ml actual ml Brand / Name Air: 1.25 6.9 202.6 46.9 46.9 Air Water Reducer: 5.00 27.4 810.3 187.6 187.6 Water Reducer	
UW w/o Air:		151.24	152.02	152.02								

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
 Fax: (601) 856-3552

Mix ID: _____ Mix 6

BDC Project NO. 140241

Made Date: Friday, May 09, 2014

COMPRESSION TESTS RESULTS

Specimen Age	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	5/16/2014	5.99	6.01	12.10	12.10	12.05	29.57	149.56	28.28	116200	4109	3	4370
6	7	5/16/2014	6.03	6.02	12.10	12.10	12.15	29.51	147.61	28.51	118130	4143	3	
7	7	5/16/2014	6.02	6.02	12.10	12.10	12.10	29.52	148.11	28.46	129860	4563	1	
8	7	5/16/2014	6.01	6.01	12.05	12.10	12.10	29.53	148.86	28.37	128740	4538	3	
9	7	5/16/2014	5.94	6.00	12.05	12.00	12.05	28.89	148.20	27.99	125470	4483	3	
11	14	5/23/2014	6.04	6.02	12.10	12.10	12.10	29.69	148.47	28.56	141350	4949	3	4960
12	14	5/23/2014	6.03	6.02	12.05	12.05	12.05	29.46	148.17	28.51	134990	4735	3	
13	14	5/23/2014	5.94	5.94	12.05	12.00	12.00	28.97	150.32	27.71	145230	5241	3	
14	14	5/23/2014	6.03	6.03	12.10	12.05	12.05	29.60	148.43	28.56	140700	4926	4	
15	14	5/23/2014	6.01	6.02	12.10	12.05	12.05	29.67	149.52	28.42	139990	4926	3	
17	28	6/6/2014	6.00	5.99	12.10	12.05	12.10	28.98	146.82	28.23	169230	5995	3	5970
18	28	6/6/2014	6.04	6.03	12.10	12.10	12.15	29.72	148.17	28.61	174400	6096	3	
19	28	6/6/2014	6.02	6.04	12.10	12.15	12.15	29.68	148.01	28.56	163490	5724	3	
20	28	6/6/2014	6.02	6.03	12.05	12.10	12.05	29.58	148.57	28.51	167590	5878	3	
21	28	6/6/2014	6.04	6.01	12.05	12.10	12.10	29.52	148.07	28.51	175190	6145	3	
23	90	8/7/2014	6.01	6.01	12.05	12.05	12.10	29.72	150.02	28.37	219920	7752	3	7410
24	90	8/7/2014	6.00	6.01	12.05	12.05	12.05	29.68	150.28	28.32	206310	7285	3	
25	90	8/7/2014	5.99	6.02	12.05	12.05	12.05	29.66	150.17	28.32	197970	6990	3	
26	90	8/7/2014	6.01	6.02	12.10	12.10	12.10	29.63	148.91	28.42	216590	7621	3	
27	90	8/7/2014	6.00	5.98	12.05	12.05	12.05	29.56	150.42	28.18	209180	7423	3	

Reported By: _____ Scott Bivings _____ Date: _____

Reviewed By: _____ Robert Vamer _____ Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
 CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
 AASHTO T97 Flexural Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID: Mix 6
 Made Date: Friday, May 09, 2014

BDC Project NO. 140241

Specimen No.	Specimen Age	Test Date	Depth 1 (0.05 in)	Depth 2 (0.05 in)	Depth 3 (0.05 in)	Avg Depth (in.)	Width 1 (0.05 in)	Width 2 (0.05 in)	Width 3 (0.05 in)	Avg Width (in.)	Max Load	Flex Strength (psi)	Avg (psi)
29	7	5/16/2014	6.05	6.05	6.05	6.05	6.00	6.05	6.05	6.03	7670	626	595
30	7	5/16/2014	6.05	6.05	6.10	6.07	6.05	6.00	6.00	6.02	7690	624	
31	7	5/16/2014	6.05	6.05	6.05	6.05	6.00	6.00	6.05	6.02	6550	535	
32	14	5/23/2014	6.05	6.05	6.05	6.05	5.95	5.95	6.00	5.95	8260	683	680
33	14	5/23/2014	6.00	6.05	6.00	6.02	6.00	5.95	5.90	5.95	8090	675	
34	14	5/23/2014	6.05	6.05	6.10	6.07	5.95	5.90	5.95	5.95	8320	683	
35	28	6/6/2014	6.05	6.05	6.00	6.03	6.00	6.05	6.00	6.02	8600	707	720
36	28	6/6/2014	6.10	6.10	6.10	6.10	5.95	6.00	6.00	5.98	9420	762	
37	28	6/6/2014	6.10	6.10	6.10	6.10	6.00	5.95	6.05	6.00	8620	695	
38	90	8/7/2014	6.00	5.95	5.95	5.97	5.95	5.95	6.00	5.97	9590	811	805
39	90	8/7/2014	6.05	6.05	6.05	6.05	6.00	6.00	6.05	6.02	9910	810	
40	90	8/7/2014	6.05	6.05	6.05	6.05	6.00	6.00	6.00	6.00	9760	800	

Reported By: Scott Bivings

Date:

Reviewed By: Robert Varner

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 6

Project No. 140241

Mix Date _____ Friday, May 09, 2014

Mix Time: _____ 9:55 AM

7 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	6.00	28.28	12.27	116200
6	6.03	28.51	12.26	118130
7	6.02	28.46	12.26	
8	6.01	28.37	12.22	
9	5.97	27.99	12.17	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 46866

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data						40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ		P	G _{long}	G _{tran}	ε _{long}	ε _{tran}		σ	MOE (psi)	MOE (50,000 psi)
7	7440	0.00085	0.00010	0.000007	261	46866	0.00485	0.00085	0.00029	0.000063	1647	5773443.7	5.75E+06	0.23	
7	8680	0.00085	0.00010	0.000007	305	46866	0.00485	0.00080	0.00029	0.000059	1647	5591861.3	5.60E+06	0.22	
7	9280	0.00085	0.00005	0.000004	326	46866	0.00460	0.00080	0.00028	0.000059	1647	5869602.6	5.85E+06	0.25	
Average	8467	0.00085	0.00008	0.000006	297	46866	0.00477	0.00082	0.00028	0.000061	1647	5744969.2	5.75E+06	0.23	
8	8640	0.00085	0.00005	0.000004	305	46866	0.00515	0.00085	0.00031	0.000063	1652	5224937.8	5.20E+06	0.23	
8	9040	0.00085	0.00010	0.000007	319	46866	0.00485	0.00095	0.00029	0.000071	1652	5556716	5.55E+06	0.26	
8	8490	0.00085	0.00010	0.000007	299	46866	0.00485	0.00085	0.00029	0.000063	1652	5637512.1	5.65E+06	0.23	
Average	8723	0.00085	0.00008	0.000006	307	46866	0.00495	0.00088	0.00030	0.000066	1652	5473055.3	5.45E+06	0.24	
9	7160	0.00085	0.00000	0.000000	256	46866	0.00585	0.00080	0.00035	0.000060	1674	4732880.6	4.75E+06	0.20	
9	6760	0.00085	0.00010	0.000007	242	46866	0.00580	0.00095	0.00035	0.000071	1674	4828715.6	4.85E+06	0.21	
9	7190	0.00085	0.00005	0.000004	257	46866	0.00575	0.00090	0.00034	0.000067	1674	4825553.2	4.85E+06	0.22	
Average	7037	0.00085	0.00005	0.000004	251	46866	0.00580	0.00088	0.00035	0.000066	1674	4795716.5	4.80E+06	0.21	
Overall Average	8076	0.00085	0.00007	0.000005	285	46866	0.00517	0.00086	0.00031	0.000064	1658	5337913.6	5.35E+06	0.23	

Reported By: _____ Scott Bivings

Date: _____

Reviewed By: _____ Robert Vamer

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 6

Project No. 140241

Mix Date Friday, May 09, 2014

Mix Time: 9:55 AM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	6.03	28.56	12.24	141350
12	6.03	28.51	12.19	134990
13	5.94	27.71	12.16	
14	6.03	28.56	12.22	
15	6.02	28.42	12.30	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), P
- Longitudinal gage reading, G_{long}
- Longitudinal Strain, ε_{long}
- Transverse gage reading, G_{tran}
- Transverse Strain, ε_{tran}
- Compressive Stress, σ

40% of Ultimate Load (lbs.) 55268

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	9240	0.00085	0.00005	0.000004	333	55268	0.00620	0.00090	0.00037	0.000068	1995	5180258	5.20E+06	0.20
13	7000	0.00085	0.00005	0.000004	253	55268	0.00635	0.00080	0.00038	0.000060	1995	5284571.7	5.30E+06	0.17
13	8700	0.00085	0.00010	0.000008	314	55268	0.00615	0.00095	0.00037	0.000071	1995	5290349.5	5.30E+06	0.20
Average	8313	0.00085	0.00007	0.000005	300	55268	0.00623	0.00088	0.00037	0.000066	1995	5251726.4	5.25E+06	0.19
14	9400	0.00085	0.00010	0.000007	329	55268	0.00615	0.00085	0.00037	0.000063	1935	5055742.1	5.05E+06	0.17
14	8610	0.00085	0.00005	0.000004	301	55268	0.00560	0.00085	0.00033	0.000063	1935	5736598.5	5.75E+06	0.21
14	8990	0.00085	0.00015	0.000011	315	55268	0.00555	0.00090	0.00033	0.000067	1935	5750233	5.75E+06	0.20
Average	9000	0.00085	0.00010	0.000007	315	55268	0.00577	0.00087	0.00034	0.000064	1935	5514191.2	5.50E+06	0.19
15	8510	0.00085	0.00010	0.000007	299	55268	0.00665	0.00095	0.00040	0.000070	1945	4733791.5	4.75E+06	0.18
15	8620	0.00085	0.00005	0.000004	303	55268	0.00665	0.00095	0.00040	0.000070	1945	4722655.1	4.70E+06	0.19
15	7710	0.00085	0.00005	0.000004	271	55268	0.00670	0.00095	0.00040	0.000070	1945	4773727.4	4.75E+06	0.19
Average	8280	0.00085	0.00007	0.000005	291	55268	0.00667	0.00095	0.00040	0.000070	1945	4743391.3	4.75E+06	0.19
Overall Average	8531	0.00085	0.00008	0.000006	302	55268	0.00622	0.00090	0.00037	0.000067	1958	5169769.6	5.15E+06	0.19

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 6

Project No. 140241

Mix Date Friday, May 09, 2014

Mix Time: 9:55 AM

28 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	6.00	28.23	12.22	169230
18	6.04	28.61	12.29	174400
19	6.03	28.56	12.29	
20	6.03	28.51	12.24	
21	6.03	28.51	12.28	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>
Extensometer Calibration	
Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 68726

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	9830	0.00085	0.00000	0.000000	344	68726	0.00780	0.00105	0.00047	0.000078	2406	4953551.1	4.95E+06	0.19
19	8610	0.00085	0.00010	0.000007	301	68726	0.00770	0.00110	0.00046	0.000081	2406	5129827.3	5.15E+06	0.18
19	8370	0.00085	0.00015	0.000011	293	68726	0.00775	0.00120	0.00046	0.000089	2406	5113059.6	5.10E+06	0.19
Average	8937	0.00085	0.00008	0.000006	313	68726	0.00775	0.00112	0.00046	0.000083	2406	5065479.3	5.05E+06	0.19
20	9470	0.00085	0.00000	0.000000	332	68726	0.00665	0.00110	0.00040	0.000081	2411	5980154.3	6.00E+06	0.23
20	9580	0.00085	0.00015	0.000011	336	68726	0.00690	0.00120	0.00041	0.000089	2411	5722952.6	5.70E+06	0.21
20	9300	0.00085	0.00005	0.000004	326	68726	0.00745	0.00110	0.00045	0.000081	2411	5271862.9	5.25E+06	0.20
Average	9450	0.00085	0.00007	0.000005	331	68726	0.00700	0.00113	0.00042	0.000084	2411	5658323.3	5.65E+06	0.22
21	10640	0.00085	0.00005	0.000004	373	68726	0.00730	0.00105	0.00044	0.000078	2411	5272571.5	5.25E+06	0.19
21	9480	0.00085	0.00000	0.000000	333	68726	0.00710	0.00095	0.00042	0.000070	2411	5549583.9	5.55E+06	0.19
21	9730	0.00085	0.00005	0.000004	341	68726	0.00695	0.00105	0.00042	0.000078	2411	5661752.5	5.65E+06	0.20
Average	9950	0.00085	0.00003	0.000002	349	68726	0.00712	0.00102	0.00043	0.000075	2411	5494636	5.50E+06	0.19
Overall Average	9446	0.00085	0.00006	0.000005	331	68726	0.00729	0.00109	0.00044	0.000081	2409	5406146.2	5.40E+06	0.20

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/28/2014

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 6

Project No. 140241

Mix Date Friday, May 09, 2014

Mix Time: 9:55 AM

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	6.01	28.37	12.38	219920
24	6.01	28.32	12.28	206310
25	6.01	28.32	12.29	
26	6.02	28.42	12.29	
27	5.99	28.18	12.25	

Compressometer Calibration	
Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>
Extensometer Calibration	
Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:
 Machine applied load (lbs.), **P**
 Longitudinal gage reading, **G_{long}**
 Longitudinal Strain, **ε_{long}**
 Transverse gage reading, **G_{tran}**
 Transverse Strain, **ε_{tran}**
 Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 85246

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	10150	0.00085	0.00015	0.000011	358	85246	0.00715	0.00130	0.00043	0.000097	3010	7025368.8	7.05E+06	0.23
25	10800	0.00085	0.00015	0.000011	381	85246	0.00705	0.00125	0.00042	0.000093	3010	7076645.2	7.10E+06	0.22
25	10040	0.00085	0.00015	0.000011	355	85246	0.00725	0.00130	0.00043	0.000097	3010	6925961.1	6.95E+06	0.22
Average	10330	0.00085	0.00015	0.000011	365	85246	0.00715	0.00128	0.00043	0.000095	3010	7009325	7.00E+06	0.22
26	10710	0.00085	0.00010	0.000007	377	85246	0.00785	0.00130	0.00047	0.000096	3000	6254950.9	6.25E+06	0.21
26	10800	0.00085	0.00005	0.000004	380	85246	0.00770	0.00120	0.00046	0.000089	3000	6383930.7	6.40E+06	0.21
26	11200	0.00085	0.00015	0.000011	394	85246	0.00770	0.00130	0.00046	0.000096	3000	6349629.7	6.35E+06	0.21
Average	10903	0.00085	0.00010	0.000007	384	85246	0.00775	0.00127	0.00046	0.000094	3000	6329503.8	6.35E+06	0.21
27	9650	0.00085	0.00015	0.000011	342	85246	0.00860	0.00130	0.00051	0.000097	3025	5779866.1	5.80E+06	0.18
27	9960	0.00085	0.00015	0.000011	353	85246	0.00820	0.00130	0.00049	0.000097	3025	6068844.9	6.05E+06	0.19
27	9210	0.00085	0.00010	0.000007	327	85246	0.00825	0.00130	0.00049	0.000097	3025	6087964.8	6.10E+06	0.20
Average	9607	0.00085	0.00013	0.000010	341	85246	0.00835	0.00130	0.00050	0.000097	3025	5978891.9	6.00E+06	0.19
Overall Average	10280	0.00085	0.00013	0.000009	363	85246	0.00775	0.00128	0.00046	0.000095	3012	6439240.2	6.45E+06	0.21

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/28/2014

Draft Report

**BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS**

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241

Mix Number Mix 6 Set No: 6
Mix Date Friday, May 09, 2014
Mix Time 9:55 AM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
21	10.0000	0.8120	0.8135	11.58300	1.6255	9.9575
22	10.0000	0.8120	0.8105	11.56150	1.6225	9.9390
23	10.0000	0.8135	0.8125	11.61600	1.6260	9.9900
24	10.0000	0.8135	0.8130	11.58800	1.6265	9.9615

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
		Specimen 21	Reference Bar 21	Δ Length 21	Specimen 22	Reference Bar 22	Δ Length 22	Specimen 23	Reference Bar 23	Δ Length 23	Specimen 24	Reference Bar 24	Δ Length 24	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Saturday, May 10, 2014	0.0536	0.0981	-0.0445	0.0412	0.0981	-0.0569	0.0871	0.0981	-0.0110	0.0590	0.0981	-0.0391	-0.0379
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
		Specimen 21	Reference Bar 21	Δ Length 21	Specimen 22	Reference Bar 22	Δ Length 22	Specimen 23	Reference Bar 23	Δ Length 23	Specimen 24	Reference Bar 24	Δ Length 24	Average
7	Friday, May 16, 2014	0.0537	0.0981	0.0010	0.0417	0.0981	0.0050	0.0872	0.0981	0.0010	0.0591	0.0981	0.0010	0.0020
11	Tuesday, May 20, 2014	0.0527	0.0980	-0.0080	0.0407	0.0980	-0.0040	0.0863	0.0980	-0.0070	0.0582	0.0980	-0.0070	-0.0065
14	Friday, May 23, 2014	0.0524	0.0979	-0.0100	0.0404	0.0979	-0.0060	0.0859	0.0979	-0.0100	0.0578	0.0979	-0.0100	-0.0090
21	Friday, May 30, 2014	0.0518	0.0979	-0.0160	0.0397	0.0979	-0.0130	0.0852	0.0979	-0.0170	0.0571	0.0979	-0.0170	-0.0157
35	Friday, June 13, 2014	0.0511	0.0979	-0.0230	0.0390	0.0979	-0.0200	0.0845	0.0979	-0.0240	0.0564	0.0979	-0.0240	-0.0227
63	Friday, July 11, 2014	0.0503	0.0975	-0.0270	0.0382	0.0975	-0.0240	0.0836	0.0975	-0.0290	0.0556	0.0975	-0.0280	-0.0270
119	Friday, September 05, 2014	0.0496	0.0975	-0.0340	0.0375	0.0975	-0.0310	0.0830	0.0975	-0.0350	0.0549	0.0975	-0.0350	-0.0338
231	Friday, December 26, 2014	0.0492	0.0975	-0.0380	0.0371	0.0975	-0.0350	0.0825	0.0975	-0.0400	0.0544	0.0975	-0.0400	-0.0383
455	Friday, August 07, 2015	0.0487	0.0971	-0.0390	0.0366	0.0971	-0.0360	0.0820	0.0971	-0.0410	0.0540	0.0971	-0.0400	-0.0390
42	Calculated 35 Day Shrinkage			-0.0241			-0.0211			-0.0251			-0.0251	-0.0238
Note: Lowest Reading Value Recorded (Minimum)														
Reported by: <u>Scott Bivings</u>					Reviewed by: <u>Robert Varmer 10/9/2015</u>									

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 6 Set No: 6
Mix Date Friday, May 09, 2014
Mix Time 9:55 AM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
21	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
22	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
23	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
24	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

	Reference Bar Length (in.)	INITIAL READINGS												
		Specimen 21	Reference Bar 21	Δ Length 21	Specimen 22	Reference Bar 22	Δ Length 22	Specimen 23	Reference Bar 23	Δ Length 23	Specimen 24	Reference Bar 24	Δ Length 24	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
819	Friday, August 05, 2016	0.0487	0.0971	-0.0390	0.0365	0.0971	-0.0370	0.0818	0.0971	-0.0430	0.0539	0.0971	-0.0410	-0.0400
Reintroduce to Waterbath		LENGTH CHANGE CALCULATIONS												
		Specimen 21	Reference Bar 21	Δ Length 21	Specimen 22	Reference Bar 22	Δ Length 22	Specimen 23	Reference Bar 23	Δ Length 23	Specimen 24	Reference Bar 24	Δ Length 24	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
820	Saturday, August 06, 2016	0.0498	0.0970	-0.0270	0.0377	0.0970	-0.0240	0.0831	0.0970	-0.0290	0.0552	0.0970	-0.0270	-0.0268
822	Monday, August 08, 2016	0.0503	0.0970	-0.0220	0.0382	0.0970	-0.0190	0.0835	0.0970	-0.0250	0.0556	0.0970	-0.0230	-0.0223
826	Friday, August 12, 2016	0.0504	0.0971	-0.0220	0.0384	0.0971	-0.0180	0.0838	0.0971	-0.0230	0.0559	0.0971	-0.0210	-0.0210
833	Friday, August 19, 2016	0.0503	0.0971	-0.0230	0.0383	0.0971	-0.0190	0.0838	0.0971	-0.0230	0.0558	0.0971	-0.0220	-0.0218
847	Friday, September 02, 2016	0.0504	0.0971	-0.0220	0.0384	0.0971	-0.0180	0.0838	0.0971	-0.0230	0.0559	0.0971	-0.0210	-0.0210
854	Friday, September 09, 2016	0.0503	0.0971	-0.0230	0.0384	0.0971	-0.0180	0.0839	0.0971	-0.0220	0.0559	0.0971	-0.0210	-0.0210
876	Saturday, October 01, 2016	0.0506	0.0971	-0.0200	0.0387	0.0971	-0.0150	0.0841	0.0971	-0.0200	0.0562	0.0971	-0.0180	-0.0183
965	Thursday, December 29, 2016	0.0504	0.0967	-0.0180	0.0387	0.0967	-0.0110	0.0840	0.0967	-0.0170	0.0560	0.0967	-0.0160	-0.0155

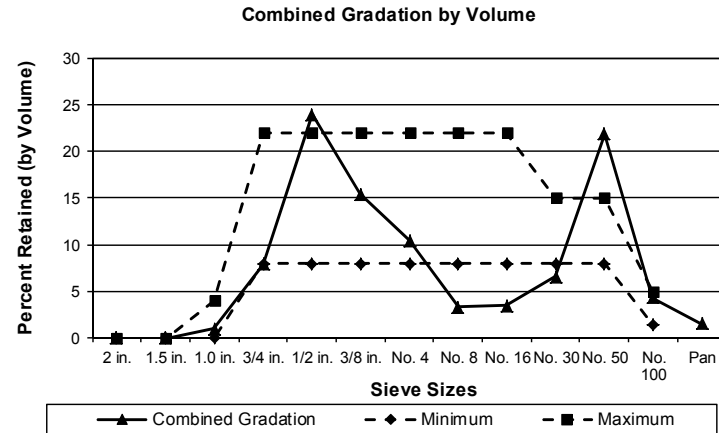
Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:		
Customer: MDOT		Project: SP-9999-09(110)/106812-101000				Lab #: BCD					Specimens made from composit 7.1 & 7.2.	
MIX NUMBER Mix 7.1						Set #: 7						
Date: 5/13/2014		Mix Code: Mix 7		fc: 3,500 psi		Size(c.f.): 6.25		Factor: 0.23				
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorp- tion	Agg. FM			
Cement 1:	2.09	411.00	95.14	95.14	95.14	Type II Cement	3.15					
Cement 2:	0.00	0.00	0.00	0.00			0.00					
Fly Ash:	0.84	137.00	31.71	31.71	31.71	Class C Fly Ash	2.60					
Slag:	0.00	0.00	0.00	0.00			0.00					
Sand 1:	7.26	1194.31	276.46	286.88	286.88	Sand	2.636	0.52%	2.36			
Coarse Aggregate 1:	12.12	1993.00	461.34	461.52	461.52	CA_ID2 - 57 Crushed Limestone MO	2.636	1.49%	6.70			
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%				
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%				
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%				
Air:	4.50%	1.22	0.00	0.00								
Water:	3.61	225.00	52.08	41.48	41.48		1.00					
"+-Air:	0.50%											
Total:	27.13	3960.31	916.74	916.74								
UW w/o Air:		152.80	153.59	153.59								
ADMIX INFORMATION							Aggregate Moistures			<p>Roller Meter Air 5</p> <p>Coarseness and Workability (volume)</p> <p>Cumulative % retained on 3/8" 48.21</p> <p>Cumulative % retained on No 8 61.97</p> <p>Cumulative % passing No 8 37.90</p> <p>Coarseness Factor 77.80</p> <p>Workability Factor 37.90</p> <p>Adjusted Workability Factor 37.47</p>		
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)				
Air	0.55	3.0	89.1	20.6	20.6	Air	Sand:	3.79% 10.42				
Water Reducer	5.00	27.4	810.3	187.6	187.6	Water Reducer	CA 1	0.04% 0.18				
							CA 2	0.00% 0.00				
							CA 3	0.00% 0.00				
							CA 4	0.00% 0.00				
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.				
Batch Time	3:50 PM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4					
Sample Time	4:00 PM		37.47	62.53	0	0	0					
Slump, in.	2.00	2 in.	0.0	0.0	0.0	0.0	0.0					
Mix Temp.	81.0	1.5 in.	0.0	0.0	0.0	0.0	0.0					
Air Temp.	77.5	1.0 in.	0.0	1.6	0.0	0.0	1.0					
ACF Air %	4.9	3/4 in.	0.0	12.6	0.0	0.0	7.9					
Unit Weight (pcf)	145.80	1/2 in.	0.0	38.3	0.0	0.0	23.9					
Design Unit Wt.	145.96	3/8 in.	0.0	24.6	0.0	0.0	15.4					
Yield	6.29	No. 4	0.4	16.5	0.0	0.0	10.5					
Relative Yield	1.01	No. 8	4.5	2.6	0.0	0.0	3.3					
Design w/c	0.411	No. 16	8.4	0.6	0.0	0.0	3.5					
Actual w/c	0.411	No. 30	17.0	0.4	0.0	0.0	6.6					
Fine/Coarse	0.60	No. 50	57.8	0.3	0.0	0.0	21.8					
Bag Factor	5.83	No. 100	11.3	0.2	0.0	0.0	4.4					
Theoretical Air (%)	4.58	Pan	0.2	2.4	0.0	0.0	1.6					



**BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength**

278 COMMERCE PARK DRIVE
RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
Fax: (601) 856-3552

Mix ID: Mix 7

BDC Project NO. 140241

Made Date: Tuesday, May 13, 2014

COMPRESSION TESTS RESULTS

Specimen Age	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	5/20/2014	5.95	6.01	12.00	11.95	12.00	29.19	149.86	28.09	168840	6011	3	6140
6	7	5/20/2014	6.04	6.05	12.10	12.10	12.10	29.98	149.17	28.7	179840	6266	3	
7	7	5/20/2014	6.04	6.03	12.10	12.10	12.05	29.59	147.93	28.61	164480	5749	3	
8	7	5/20/2014	6.00	6.00	12.05	12.05	11.95	29.07	147.84	28.28	171260	6056	4	
9	7	5/20/2014	6.02	6.04	12.05	12.05	12.05	29.74	149.33	28.56	188430	6598	3	
11	14	5/27/2014	6.02	6.02	12.10	12.10	12.10	30.05	150.77	28.46	216540	7609	4	7400
12	14	5/27/2014	5.93	5.96	12.00	12.00	12.05	29.30	151.78	27.76	204860	7380	3	
13	14	5/27/2014	6.00	5.99	12.05	12.20	12.15	29.80	150.35	28.23	208580	7389	3	
14	14	5/27/2014	6.03	6.03	12.10	12.15	12.05	29.70	148.52	28.56	204360	7155	3	
15	14	5/27/2014	5.98	6.04	12.05	12.05	12.10	29.75	150.17	28.37	212340	7485	3	
17	28	6/10/2014	6.02	6.01	12.10	12.05	12.05	29.70	149.67	28.42	226040	7954	4	7970
18	28	6/10/2014	6.02	6.04	12.05	12.05	12.05	29.80	149.64	28.56	220470	7720	3	
19	28	6/10/2014	6.02	6.06	12.05	12.00	12.05	29.70	148.85	28.65	233390	8146	3	
20	28	6/10/2014	6.02	6.00	12.05	12.05	12.10	29.70	149.92	28.37	228730	8062	4	
21	28	6/10/2014	6.03	6.05	12.00	12.05	12.05	29.75	149.12	28.65	228750	7984	3	
23	90	8/11/2014	6.01	6.05	12.05	12.05	12.05	29.75	149.38	28.56	256110	8967	4	9300
24	90	8/11/2014	6.02	6.01	12.05	12.05	12.05	29.88	150.79	28.42	281660	9911	4	
25	90	8/11/2014	6.02	6.01	12.10	12.10	12.10	29.87	150.11	28.42	257670	9067	3	
26	90	8/11/2014	6.02	6.05	12.10	12.10	12.10	29.83	148.92	28.61	261960	9156	4	
27	90	8/11/2014	6.02	6.00	12.05	12.10	12.10	29.90	150.72	28.37	265940	9374	3	

Reported By: Scott Bivings Date: _____

Reviewed By: Robert Vamer Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
 CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
 AASHTO T97 Flexural Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID: _____ Mix 7 _____

BDC Project NO. 140241

Made Date: _____ Tuesday, May 13, 2014 _____

Specimen No.	Specimen Age	Test Date	Depth 1 (0.05 in)	Depth 2 (0.05 in)	Depth 3 (0.05 in)	Avg Depth (in.)	Width 1 (0.05 in)	Width 2 (0.05 in)	Width 3 (0.05 in)	Avg Width (in.)	Max Load	Flex Strength (psi)	Avg (psi)
29	7	5/20/2014	6.05	6.05	6.10	6.07	6.00	5.95	6.00	5.98	9260	756	740
30	7	5/20/2014	6.10	6.15	6.10	6.12	6.05	6.10	6.10	6.08	8640	683	
31	7	5/20/2014	6.10	6.10	6.05	6.08	6.05	6.05	6.05	6.05	9640	776	
32	14	5/27/2014	6.00	6.05	6.00	6.02	6.00	6.00	6.05	6.02	9540	787	800
33	14	5/27/2014	6.05	6.10	6.10	6.08	6.00	6.00	6.00	6.00	9840	799	
34	14	5/27/2014	6.05	6.10	6.05	6.07	5.95	5.95	5.95	5.95	9960	818	
35	28	6/10/2014	6.10	6.10	6.05	6.08	6.00	6.00	6.00	6.00	9690	786	815
36	28	6/10/2014	6.05	6.05	6.05	6.05	6.00	6.00	6.00	6.00	10500	861	
37	28	6/10/2014	6.15	6.15	6.10	6.13	5.95	5.95	6.00	5.97	9980	801	
38	90	8/11/2014	6.10	6.10	6.05	6.08	6.00	6.00	6.00	6.00	9840	799	840
39	90	8/11/2014	6.05	6.05	6.05	6.05	5.95	5.95	5.95	5.95	10040	830	
40	90	8/11/2014	6.05	6.05	6.00	6.03	5.95	6.00	5.95	5.97	10810	896	

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Varner _____

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 7

Project No. 140241

Mix Date Tuesday, May 13, 2014

Mix Time: 3:50 PM

7 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	5.98	28.09	12.16	168840
6	6.05	28.70	12.26	179840
7	6.04	28.61	12.26	
8	6.00	28.28	12.24	
9	6.03	28.56	12.20	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 69736

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
7	8140	0.00085	0.00000	0.000000	285	69736	0.00850	0.00110	0.00051	0.000081	2437	4699210.5	4.70E+06	0.18
7	8780	0.00085	0.00015	0.000011	307	69736	0.00825	0.00125	0.00049	0.000092	2437	4807203	4.80E+06	0.18
7	8510	0.00085	0.00010	0.000007	297	69736	0.00840	0.00120	0.00050	0.000089	2437	4732738.7	4.75E+06	0.18
Average	8477	0.00085	0.00008	0.000006	296	69736	0.00838	0.00118	0.00050	0.000087	2437	4746384.1	4.75E+06	0.18
8	9410	0.00085	0.00010	0.000007	333	69736	0.00795	0.00115	0.00048	0.000086	2466	5016012.4	5.00E+06	0.18
8	9020	0.00085	0.00010	0.000007	319	69736	0.00790	0.00115	0.00047	0.000086	2466	5084175.7	5.10E+06	0.18
8	9360	0.00085	0.00015	0.000011	331	69736	0.00790	0.00120	0.00047	0.000089	2466	5055705.1	5.05E+06	0.18
Average	9263	0.00085	0.00012	0.000009	328	69736	0.00792	0.00117	0.00047	0.000087	2466	5051964.4	5.05E+06	0.18
9	16140	0.00085	0.00020	0.000015	565	69736	0.00680	0.00115	0.00041	0.000085	2442	5263664	5.25E+06	0.20
9	15400	0.00085	0.00020	0.000015	539	69736	0.00665	0.00115	0.00040	0.000085	2442	5474024.5	5.45E+06	0.20
9	16610	0.00085	0.00020	0.000015	582	69736	0.00655	0.00115	0.00039	0.000085	2442	5445797.1	5.45E+06	0.21
Average	16050	0.00085	0.00020	0.000015	562	69736	0.00667	0.00115	0.00040	0.000085	2442	5394495.2	5.40E+06	0.20
Overall Average	11263	0.00085	0.00013	0.000010	395	69736	0.00766	0.00117	0.00046	0.000086	2448	5064281.2	5.05E+06	0.19

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 7

Project No. 140241

Mix Date Tuesday, May 13, 2014

Mix Time: 3:50 PM

14 DAY CYLINDER DATA

Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	6.02	28.46	12.26	216540
12	5.95	27.76	12.19	204860
13	6.00	28.23	12.3	
14	6.03	28.56	12.27	
15	6.01	28.37	12.20	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 84280

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	9610	0.00085	0.00010	0.000007	340	84280	0.00865	0.00140	0.00052	0.000104	2985	5662487	5.65E+06	0.21
13	8600	0.00085	0.00005	0.000004	305	84280	0.00860	0.00120	0.00051	0.000089	2985	5776040.1	5.80E+06	0.18
13	8590	0.00085	0.00000	0.000000	304	84280	0.00865	0.00120	0.00052	0.000089	2985	5739837.1	5.75E+06	0.19
Average	8933	0.00085	0.00005	0.000004	316	84280	0.00863	0.00127	0.00052	0.000094	2985	5726121.4	5.75E+06	0.19
14	9290	0.00085	0.00010	0.000007	325	84280	0.00900	0.00140	0.00054	0.000104	2951	5380054	5.40E+06	0.20
14	9420	0.00085	0.00005	0.000004	330	84280	0.00885	0.00140	0.00053	0.000104	2951	5471257.1	5.45E+06	0.21
14	7850	0.00085	0.00010	0.000007	275	84280	0.00900	0.00140	0.00054	0.000104	2951	5483364.8	5.50E+06	0.20
Average	8853	0.00085	0.00008	0.000006	310	84280	0.00895	0.00140	0.00054	0.000104	2951	5444892	5.45E+06	0.20
15	9040	0.00085	0.00000	0.000000	319	84280	0.00870	0.00120	0.00052	0.000089	2971	5641455.5	5.65E+06	0.19
15	8610	0.00085	0.00005	0.000004	303	84280	0.00855	0.00130	0.00051	0.000097	2971	5784027.8	5.80E+06	0.20
15	9890	0.00085	0.00005	0.000004	349	84280	0.00850	0.00130	0.00051	0.000097	2971	5723286.3	5.70E+06	0.20
Average	9180	0.00085	0.00003	0.000002	324	84280	0.00858	0.00127	0.00051	0.000094	2971	5716256.5	5.70E+06	0.20
Overall Average	8989	0.00085	0.00006	0.000004	317	84280	0.00872	0.00131	0.00052	0.000097	2969	5629090	5.65E+06	0.20

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 7

Project No. 140241

Mix Date Tuesday, May 13, 2014

Mix Time: 3:50 PM

28 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	6.02	28.42	12.26	226040
18	6.03	28.56	12.24	220470
19	6.04	28.65	12.24	
20	6.01	28.37	12.20	
21	6.04	28.65	12.18	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u> </u> 4.95
Longitudinal gage to yoke supports (0.01 in.)	<u> </u> 5.40
Longitudinal Gage length (0.01 in.)	<u> </u> 8.00

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u> </u> 3.91
Transverse gage to mid yoke supports (0.01 in.)	<u> </u> 4.85

40% of Ultimate Load (lbs.) 89302

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	10000	0.00085	0.00005	0.000004	349	89302	0.00930	0.00135	0.00056	0.000100	3117	5470508	5.45E+06	0.19
19	10220	0.00085	0.00010	0.000007	357	89302	0.00905	0.00140	0.00054	0.000103	3117	5621376.6	5.60E+06	0.20
19	10010	0.00085	0.00000	0.000000	349	89302	0.00920	0.00135	0.00055	0.000100	3117	5535218.2	5.55E+06	0.20
Average	10077	0.00085	0.00005	0.000004	352	89302	0.00918	0.00137	0.00055	0.000101	3117	5542367.6	5.55E+06	0.20
20	11530	0.00085	0.00005	0.000004	406	89302	0.00780	0.00140	0.00047	0.000104	3148	6584957.6	6.60E+06	0.24
20	9170	0.00085	0.00005	0.000004	323	89302	0.00795	0.00140	0.00048	0.000104	3148	6641713.3	6.65E+06	0.24
20	10010	0.00085	0.00010	0.000007	353	89302	0.00785	0.00150	0.00047	0.000111	3148	6665794.6	6.65E+06	0.25
Average	10237	0.00085	0.00007	0.000005	361	89302	0.00787	0.00143	0.00047	0.000106	3148	6630821.8	6.65E+06	0.24
21	11710	0.00085	0.00000	0.000000	409	89302	0.00725	0.00130	0.00043	0.000096	3117	7063389	7.05E+06	0.25
21	10030	0.00085	0.00005	0.000004	350	89302	0.00755	0.00130	0.00045	0.000096	3117	6893860.8	6.90E+06	0.23
21	10430	0.00085	0.00010	0.000007	364	89302	0.00760	0.00140	0.00045	0.000103	3117	6808369.5	6.80E+06	0.24
Average	10723	0.00085	0.00005	0.000004	374	89302	0.00747	0.00133	0.00045	0.000099	3117	6921873.1	6.90E+06	0.24
Overall Average	10346	0.00085	0.00006	0.000004	362	89302	0.00817	0.00138	0.00049	0.000102	3127	6365020.8	6.35E+06	0.23

Reported By: Scott Bivings

Date:

Reviewed By: Robert Varner

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 7 _____

Project No. _____ 140241 _____

Mix Date _____ Tuesday, May 13, 2014 _____

Mix Time: _____ 3:50 PM _____

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	6.03	28.56	12.23	256110
24	6.02	28.42	12.25	281660
25	6.02	28.42	12.27	
26	6.04	28.61	12.30	
27	6.01	28.37	12.27	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) _____ 4.95 _____

Longitudinal gage to yoke supports (0.01 in.) _____ 5.40 _____

Longitudinal Gage length (0.01 in.) _____ 8.00 _____

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) _____ 3.91 _____

Transverse gage to mid yoke supports (0.01 in.) _____ 4.85 _____

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) _____ 107554 _____

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) _____ 0.00084 _____

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	10330	0.00085	0.00005	0.000004	363	107554	0.01020	0.00170	0.00061	0.000126	3784	6111249.4	6.10E+06	0.22
25	10330	0.00085	0.00010	0.000007	363	107554	0.01020	0.00170	0.00061	0.000126	3784	6111249.4	6.10E+06	0.21
25	10280	0.00085	0.00015	0.000011	362	107554	0.01030	0.00180	0.00062	0.000133	3784	6049783	6.05E+06	0.22
Average	10313	0.00085	0.00010	0.000007	363	107554	0.01023	0.00173	0.00061	0.000129	3784	6090760.6	6.10E+06	0.22
26	10750	0.00085	0.00015	0.000011	376	107554	0.01040	0.00175	0.00062	0.000129	3759	5918035	5.90E+06	0.21
26	10870	0.00085	0.00015	0.000011	380	107554	0.01035	0.00170	0.00062	0.000126	3759	5941763.2	5.95E+06	0.20
26	10440	0.00085	0.00010	0.000007	365	107554	0.01035	0.00170	0.00062	0.000126	3759	5968189.1	5.95E+06	0.21
Average	10687	0.00085	0.00013	0.000010	374	107554	0.01037	0.00172	0.00062	0.000127	3759	5942662.4	5.95E+06	0.21
27	11200	0.00085	0.00005	0.000004	395	107554	0.00980	0.00155	0.00059	0.000115	3791	6337986.7	6.35E+06	0.21
27	10730	0.00085	0.00005	0.000004	378	107554	0.00965	0.00160	0.00058	0.000119	3791	6477295.3	6.50E+06	0.22
27	11080	0.00085	0.00005	0.000004	391	107554	0.00985	0.00185	0.00059	0.000137	3791	6310678.5	6.30E+06	0.25
Average	11003	0.00085	0.00005	0.000004	388	107554	0.00977	0.00167	0.00058	0.000124	3791	6375320.1	6.40E+06	0.22
Overall Average	10668	0.00085	0.00009	0.000007	375	107554	0.01012	0.00171	0.00061	0.000126	3778	6136247.7	6.15E+06	0.22

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Varner _____

Date: _____ 8/28/2014 _____

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241

Mix Number Mix 7 Set No: 7
Mix Date Tuesday, May 13, 2014
Mix Time 3:50 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
25	10.0000	0.8120	0.8140	11.64700	1.6260	10.0210
26	10.0000	0.8115	0.8135	11.57750	1.6250	9.9525
27	10.0000	0.8120	0.8125	11.59750	1.6245	9.9730
28	10.0000	0.8125	0.8110	11.60400	1.6235	9.9805

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
10		Specimen 25	Reference Bar 25	Δ Length 25	Specimen 26	Reference Bar 26	Δ Length 26	Specimen 27	Reference Bar 27	Δ Length 27	Specimen 28	Reference Bar 28	Δ Length 28	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Wednesday, May 14, 2014	0.1099	0.0980	0.0119	0.0456	0.0980	-0.0524	0.0683	0.0980	-0.0297	0.0739	0.0981	-0.0242	-0.0236
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
		Specimen 25	Reference Bar 25	Δ Length 25	Specimen 26	Reference Bar 26	Δ Length 26	Specimen 27	Reference Bar 27	Δ Length 27	Specimen 28	Reference Bar 28	Δ Length 28	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
7	Tuesday, May 20, 2014	0.1108	0.0980	0.0090	0.0459	0.0980	0.0030	0.0686	0.0980	0.0030	0.0740	0.0980	0.0020	0.0043
10	Friday, May 23, 2014	0.1098	0.0979	0.0000	0.0448	0.0979	-0.0070	0.0675	0.0979	-0.0070	0.0730	0.0979	-0.0070	-0.0052
14	Tuesday, May 27, 2014	0.1090	0.0979	-0.0080	0.0441	0.0979	-0.0140	0.0667	0.0979	-0.0150	0.0723	0.0979	-0.0140	-0.0127
21	Tuesday, June 03, 2014	0.1082	0.0979	-0.0160	0.0434	0.0979	-0.0210	0.0660	0.0979	-0.0220	0.0716	0.0979	-0.0210	-0.0200
35	Tuesday, June 17, 2014	0.1073	0.0978	-0.0240	0.0424	0.0978	-0.0300	0.0650	0.0978	-0.0310	0.0707	0.0978	-0.0290	-0.0285
63	Tuesday, July 15, 2014	0.1066	0.0976	-0.0290	0.0418	0.0976	-0.0340	0.0643	0.0976	-0.0360	0.0700	0.0976	-0.0340	-0.0333
119	Tuesday, September 09, 2014	0.1060	0.0975	-0.0340	0.0412	0.0975	-0.0390	0.0637	0.0975	-0.0410	0.0694	0.0975	-0.0390	-0.0383
231	Tuesday, December 30, 2014	0.1055	0.0975	-0.0390	0.0408	0.0974	-0.0420	0.0632	0.0974	-0.0450	0.0690	0.0974	-0.0420	-0.0420
455	Tuesday, August 11, 2015	0.1051	0.0971	-0.0390	0.0405	0.0971	-0.0420	0.0628	0.0971	-0.0460	0.0686	0.0971	-0.0430	-0.0425
42	Calculated 35 Day Shrinkage			-0.0246			-0.0301			-0.0312			-0.0296	-0.0289
Note: Lowest Reading Value Recorded (Minimum)														
Reported by: <u>Scott Bivings</u>					Reviewed by: <u>Robert Varner</u>									

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 7 Set No: 7
Mix Date Tuesday, May 13, 2014
Mix Time 3:50 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
25	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
26	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
27	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
28	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

	Reference Bar Length (in.)	INITIAL READINGS												
	10	Specimen 25	Reference Bar 25	Δ Length 25	Specimen 26	Reference Bar 26	Δ Length 26	Specimen 27	Reference Bar 27	Δ Length 27	Specimen 28	Reference Bar 28	Δ Length 28	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
819	Tuesday, August 09, 2016	0.1049	0.0971	-0.0410	0.0403	0.0971	-0.0440	0.0626	0.0971	-0.0480	0.0685	0.0971	-0.0440	-0.0443
	Reintroduce to Waterbath	LENGTH CHANGE CALCULATIONS												
		Specimen 25	Reference Bar 25	Δ Length 25	Specimen 26	Reference Bar 26	Δ Length 26	Specimen 27	Reference Bar 27	Δ Length 27	Specimen 28	Reference Bar 28	Δ Length 28	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
820	Wednesday, August 10, 2016	0.1062	0.0970	-0.0270	0.0417	0.0970	-0.0290	0.0641	0.0970	-0.0320	0.0699	0.0970	-0.0290	-0.0292
822	Friday, August 12, 2016	0.1066	0.0971	-0.0240	0.0422	0.0971	-0.0250	0.0647	0.0971	-0.0270	0.0704	0.0971	-0.0250	-0.0253
826	Tuesday, August 16, 2016	0.1070	0.0971	-0.0200	0.0424	0.0971	-0.0230	0.0649	0.0971	-0.0250	0.0706	0.0971	-0.0230	-0.0228
833	Tuesday, August 23, 2016	0.1070	0.0971	-0.0200	0.0423	0.0971	-0.0240	0.0648	0.0971	-0.0260	0.0706	0.0971	-0.0230	-0.0233
847	Tuesday, September 06, 2016	0.1071	0.0971	-0.0190	0.0425	0.0971	-0.0220	0.0649	0.0971	-0.0250	0.0707	0.0971	-0.0220	-0.0220
854	Tuesday, September 13, 2016	0.1071	0.0971	-0.0190	0.0426	0.0971	-0.0210	0.0650	0.0971	-0.0240	0.0707	0.0971	-0.0220	-0.0215
875	Tuesday, October 04, 2016	0.1074	0.0972	-0.0170	0.0428	0.0972	-0.0200	0.0653	0.0972	-0.0220	0.0711	0.0972	-0.0190	-0.0195
961	Thursday, December 29, 2016	0.1073	0.0967	-0.0130	0.0428	0.0967	-0.0150	0.0653	0.0967	-0.0170	0.0709	0.0967	-0.0160	-0.0152

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:			
Customer:	MDOT		Project:	SP-9999-09(110)/106812-101000				Lab #:	BCD		Specimens made from composite 8.1 & 8.2.		
MIX NUMBER	Mix 8.1						Set #:	8					
Date:	5/15/2014		Mix Code:	Mix 8	f'c:	3,500 psi		Size(c.f.):	6.25		Factor:	0.23	
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorption	Agg. FM				
Cement 1:	1.39	274.00	63.43	63.43	63.43	Type I-II Cement	3.15			Roller Meter Air 5			
Cement 2:	0.00	0.00	0.00	0.00			0.00			Coarseness and Workability (volume)			
Fly Ash:	0.00	0.00	0.00	0.00			2.60			Cumulative % retained on 3/8" 48.74			
Slag:	1.52	274.00	63.43	63.43	63.43	Slag Cement	2.89			Cumulative % retained on No 8 62.60			
Sand 1:	7.05	1159.50	268.40	278.52	278.52	Sand	2.636	0.52%	2.36	Cumulative % passing No 8 37.28			
Coarse Aggregate 1:	12.12	1993.00	461.34	461.52	461.52	CA_ID2 - 57 Crushed Limestone MO	2.636	1.49%	6.70	Coarseness Factor 77.86			
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%		Workability Factor 37.28			
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%		Adjusted Workability Factor 36.85			
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%					
Air:	4.50%	1.22	0.00	0.00	0.00								
Water:	3.81	237.50	54.98	44.68	44.68		1.00						
"+-Air:	0.50%												
Total:	27.10	3938.00	911.57	911.57									
UW w/o Air:		152.13	152.72	152.72									
ADMIX INFORMATION							Aggregate Moistures						
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)					
Air	0.78	4.3	126.2	29.2	29.1	Air	Sand:	3.79%	10.12				
Water Reducer	5.00	27.4	810.3	187.6	187.6	Water Reducer	CA 1	0.04%	0.18				
							CA 2	0.00%	0.00				
							CA 3	0.00%	0.00				
							CA 4	0.00%	0.00				
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.					
Batch Time	2:51 PM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4						
Sample Time	3:00 PM		36.78	63.22	0	0	0						
Slump, in.	1.50	2 in.	0.0	0.0	0.0	0.0	0.0	0.0					
Mix Temp.	71.9	1.5 in.	0.0	0.0	0.0	0.0	0.0	0.0					
Air Temp.	63.1	1.0 in.	0.0	1.6	0.0	0.0	0.0	1.0					
ACF Air %	4.6	3/4 in.	0.0	12.6	0.0	0.0	0.0	8.0					
Unit Weight (pcf)	146.00	1/2 in.	0.0	38.3	0.0	0.0	0.0	24.2					
Design Unit Wt.	145.31	3/8 in.	0.0	24.6	0.0	0.0	0.0	15.6					
Yield	6.24	No. 4	0.4	16.5	0.0	0.0	0.0	10.6					
Relative Yield	1.00	No. 8	4.5	2.6	0.0	0.0	0.0	3.3					
Design w/c	0.433	No. 16	8.4	0.6	0.0	0.0	0.0	3.5					
Actual w/c	0.433	No. 30	17.0	0.4	0.0	0.0	0.0	6.5					
Fine/Coarse	0.58	No. 50	57.8	0.3	0.0	0.0	0.0	21.4					
Bag Factor	5.83	No. 100	11.3	0.2	0.0	0.0	0.0	4.3					
Theoretical Air (%)	4.03	Pan	0.2	2.4	0.0	0.0	0.0	1.6					

Draft Report

**BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength**

278 COMMERCE PARK DRIVE
RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
Fax: (601) 856-3552

Mix ID: _____ Mix 8

BDC Project NO. 140241

Made Date: _____ Thursday, May 15, 2014

COMPRESSION TESTS RESULTS

Specimen Age	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	5/22/2014	5.93	5.99	12.05	12.05	12.00	29.04	149.47	27.90	159300	5710	3	5680
6	7	5/22/2014	5.92	5.94	12.05	12.05	12.00	29.15	151.56	27.62	161000	5829	3	
7	7	5/22/2014	5.92	5.99	12.00	12.00	12.00	29.19	150.91	27.85	162880	5848	3	
8	7	5/22/2014	5.92	5.93	12.00	12.05	12.05	28.95	150.77	27.57	155950	5657	4	
9	7	5/22/2014	5.93	5.97	11.90	11.95	12.00	28.73	149.41	27.81	148940	5356	3	
11	14	5/29/2014	5.98	5.96	12.10	12.10	12.05	29.09	148.61	27.99	206820	7389	4	7530
12	14	5/29/2014	5.97	5.97	12.05	12.10	12.10	29.13	148.81	27.99	207200	7403	3	
13	14	5/29/2014	5.98	6.01	12.00	11.95	12.00	29.01	148.19	28.23	204810	7255	4	
14	14	5/29/2014	5.93	5.90	12.00	12.05	12.00	28.92	151.34	27.48	212170	7721	3	
15	14	5/29/2014	5.98	5.96	12.05	12.00	12.00	29.24	150.20	27.99	220360	7873	3	
17	28	6/12/2014	5.98	6.01	12.10	12.10	12.05	29.15	147.68	28.23	227780	8069	4	8040
18	28	6/12/2014	5.99	5.96	12.05	12.05	12.05	29.14	149.03	28.04	223110	7957	4	
19	28	6/12/2014	5.98	5.95	12.05	12.05	12.05	29.03	148.96	27.95	219500	7853	3	
20	28	6/12/2014	5.98	6.00	12.05	12.05	12.05	29.01	147.62	28.18	236570	8395	3	
21	28	6/12/2014	5.93	5.97	11.95	11.95	12.05	28.84	149.56	27.81	220550	7931	3	
23	90	8/13/2014	5.98	6.01	12.05	12.05	12.05	29.14	148.03	28.23	227710	8066	1	8310
24	90	8/13/2014	5.96	5.99	12.05	12.00	12.05	29.11	149.08	28.04	251540	8971	3	
25	90	8/13/2014	6.00	5.98	12.05	12.05	12.10	28.97	147.21	28.18	231590	8218	3	
26	90	8/13/2014	5.98	5.98	12.05	12.00	12.00	29.15	149.24	28.09	244880	8718	3	
27	90	8/13/2014	5.99	6.01	12.00	12.00	12.00	29.09	148.15	28.28	214680	7591	3	

Reported By: _____ Scott Bivings _____ Date: _____

Reviewed By: _____ Robert Varner _____ Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
 CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
 AASHTO T97 Flexural Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID: _____ Mix 8

BDC Project NO. 140241

Made Date: _____ Thursday, May 15, 2014

Specimen No.	Specimen Age	Test Date	Depth 1 (0.05 in)	Depth 2 (0.05 in)	Depth 3 (0.05 in)	Avg Depth (in.)	Width 1 (0.05 in)	Width 2 (0.05 in)	Width 3 (0.05 in)	Avg Width (in.)	Max Load	Flex Strength (psi)	Avg (psi)
29	7	5/22/2014	6.05	6.05	6.05	6.05	6.05	6.00	6.00	6.02	8800	719	720
30	7	5/22/2014	6.05	6.05	6.00	6.03	6.15	6.05	6.05	6.08	9240	752	
31	7	5/22/2014	6.05	6.05	6.05	6.05	6.05	6.00	6.00	6.02	8420	688	
32	14	5/29/2014	6.10	6.10	6.10	6.10	6.15	6.10	6.15	6.13	10540	832	830
33	14	5/29/2014	6.05	6.05	6.05	6.05	6.05	6.00	6.05	6.03	10260	837	
34	14	5/29/2014	6.05	6.05	6.05	6.05	5.95	5.95	6.05	5.98	9910	815	
35	28	6/12/2014	6.10	6.10	6.10	6.10	6.15	6.10	6.10	6.12	11580	915	915
36	28	6/12/2014	6.10	6.10	6.05	6.08	6.15	6.10	6.10	6.12	10720	853	
37	28	6/12/2014	6.05	6.10	6.10	6.08	6.00	6.00	5.95	5.98	11920	971	
38	90	8/13/2014	6.00	6.10	6.05	6.05	6.00	5.95	6.00	5.98	11770	968	950
39	90	8/13/2014	6.05	6.05	6.05	6.05	6.05	5.95	5.95	5.98	11070	910	
40	90	8/13/2014	6.00	6.05	6.05	6.03	5.95	6.00	6.00	5.98	11740	972	

Reported By: _____ Scott Bivings

Date: _____

Reviewed By: _____ Robert Varner

Date: 8/28/2014

Draft Report

**BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio**

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

PHONE: (601) 856-2332
FAX: (601) 856-3552

Mix ID Mix 8

Project No. 140241

Mix Date Thursday, May 15, 2014

Mix Time: 2:51 PM

7 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in.²)	Length Cap (0.01 in.)	Ultimate Load
5	5.96	27.9	12.29	159300
6	5.93	27.62	12.33	161000
7	5.96	27.85	12.26	
8	5.93	27.57	12.28	
9	5.95	27.81	12.22	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 64060

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
7	8600	0.00085	0.00005	0.000004	309	64060	0.00720	0.00105	0.00043	0.000079	2300	5234490.9	5.25E+06	0.20
7	8370	0.00085	0.00010	0.000007	301	64060	0.00715	0.00115	0.00043	0.000086	2300	5297824.8	5.30E+06	0.21
7	8630	0.00085	0.00005	0.000004	310	64060	0.00685	0.00100	0.00041	0.000075	2300	5536147.5	5.55E+06	0.20
Average	8533	0.00085	0.00007	0.000005	306	64060	0.00707	0.00107	0.00042	0.000080	2300	5356154.4	5.35E+06	0.20
8	8640	0.00085	0.00000	0.000000	313	64060	0.00710	0.00105	0.00042	0.000079	2324	5368195.9	5.35E+06	0.21
8	7740	0.00085	0.00010	0.000008	281	64060	0.00705	0.00115	0.00042	0.000087	2324	5499271.8	5.50E+06	0.21
8	7550	0.00085	0.00000	0.000000	274	64060	0.00715	0.00105	0.00043	0.000079	2324	5430428.7	5.45E+06	0.21
Average	7977	0.00085	0.00003	0.000003	289	64060	0.00710	0.00108	0.00042	0.000082	2324	5432632.1	5.45E+06	0.21
9	9270	0.00085	0.00010	0.000008	333	64060	0.00710	0.00115	0.00042	0.000086	2303	5261370.8	5.25E+06	0.21
9	8310	0.00085	0.00000	0.000000	299	64060	0.00715	0.00115	0.00043	0.000086	2303	5311160.9	5.30E+06	0.23
9	8390	0.00085	0.00010	0.000008	302	64060	0.00715	0.00125	0.00043	0.000094	2303	5303539.5	5.30E+06	0.23
Average	8657	0.00085	0.00007	0.000005	311	64060	0.00713	0.00118	0.00043	0.000089	2303	5292023.7	5.30E+06	0.22
Overall Average	8389	0.00085	0.00006	0.000004	302	64060	0.00710	0.00111	0.00042	0.000083	2309	5360270.1	5.35E+06	0.21

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/28/2014

Draft Report

**BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio**

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

PHONE: (601) 856-2332
FAX: (601) 856-3552

Mix ID Mix 8

Project No. 140241

Mix Date Thursday, May 15, 2014

Mix Time: 2:51 PM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in.²)	Length Cap (0.01 in.)	Ultimate Load
11	5.97	27.99	12.30	206820
12	5.97	27.99	12.21	207200
13	6.00	28.23	12.21	
14	5.92	27.48	12.19	
15	5.97	27.99	12.23	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 82804

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	11120	0.00085	0.00005	0.000004	394	82804	0.00915	0.00130	0.00055	0.000097	2933	5109112.5	5.10E+06	0.19
13	10220	0.00085	0.00010	0.000007	362	82804	0.00930	0.00145	0.00056	0.000108	2933	5081572.9	5.10E+06	0.20
13	9650	0.00085	0.00000	0.000000	342	82804	0.00945	0.00135	0.00056	0.000100	2933	5032291.7	5.05E+06	0.20
Average	10330	0.00085	0.00005	0.000004	366	82804	0.00930	0.00137	0.00056	0.000102	2933	5074325.7	5.05E+06	0.19
14	8550	0.00085	0.00005	0.000004	311	82804	0.00865	0.00115	0.00052	0.000087	3013	5784623.1	5.80E+06	0.18
14	10020	0.00085	0.00005	0.000004	365	82804	0.00860	0.00120	0.00051	0.000090	3013	5706622.5	5.70E+06	0.19
14	10040	0.00085	0.00005	0.000004	365	82804	0.00860	0.00130	0.00051	0.000098	3013	5705054.4	5.70E+06	0.20
Average	9537	0.00085	0.00005	0.000004	347	82804	0.00862	0.00122	0.00052	0.000092	3013	5732100	5.75E+06	0.19
15	9960	0.00085	0.00000	0.000000	356	82804	0.00780	0.00130	0.00047	0.000097	2958	6251438.2	6.25E+06	0.23
15	10650	0.00085	0.00005	0.000004	380	82804	0.00760	0.00130	0.00045	0.000097	2958	6375326.1	6.40E+06	0.23
15	10500	0.00085	0.00010	0.000007	375	82804	0.00760	0.00140	0.00045	0.000105	2958	6388579.6	6.40E+06	0.24
Average	10370	0.00085	0.00005	0.000004	370	82804	0.00767	0.00133	0.00046	0.000100	2958	6338448	6.35E+06	0.23
Overall Average	10079	0.00085	0.00005	0.000004	361	82804	0.00853	0.00131	0.00051	0.000098	2968	5714957.9	5.70E+06	0.21

Reported By: Scott Bivings

Date:

Reviewed By: Robert Vamer

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 8

Project No. 140241

Mix Date _____ Thursday, May 15, 2014

Mix Time: _____ 2:51 PM

28 DAY CYLINDER DATA

Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	6.00	28.23	12.3	227780
18	5.98	28.04	12.25	223110
19	5.97	27.95	12.21	
20	5.99	28.18	12.24	
21	5.95	27.81	12.25	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

Machine applied load (lbs.), **P**
 Longitudinal gage reading, **G_{long}**
 Longitudinal Strain, **ε_{long}**
 Transverse gage reading, **G_{tran}**
 Transverse Strain, **ε_{tran}**
 Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 90178

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	8550	0.00085	0.00005	0.000004	306	90178	0.00940	0.00145	0.00056	0.000108	3226	5704587.7	5.70E+06	0.20
19	9520	0.00085	0.00005	0.000004	341	90178	0.00910	0.00140	0.00054	0.000105	3226	5841435.4	5.85E+06	0.20
19	9370	0.00085	0.00005	0.000004	335	90178	0.00910	0.00145	0.00054	0.000108	3226	5852298.7	5.85E+06	0.21
Average	9147	0.00085	0.00005	0.000004	327	90178	0.00920	0.00143	0.00055	0.000107	3226	5799440.6	5.80E+06	0.21
20	9800	0.00085	0.00005	0.000004	348	90178	0.01035	0.00150	0.00062	0.000112	3200	5015044.6	5.00E+06	0.19
20	11170	0.00085	0.00010	0.000007	396	90178	0.01005	0.00150	0.00060	0.000112	3200	5090074.6	5.10E+06	0.19
20	10050	0.00085	0.00000	0.000000	357	90178	0.00995	0.00150	0.00059	0.000112	3200	5218873.3	5.20E+06	0.21
Average	10340	0.00085	0.00005	0.000004	367	90178	0.01012	0.00150	0.00060	0.000112	3200	5107997.5	5.10E+06	0.19
21	10290	0.00085	0.00005	0.000004	370	90178	0.00995	0.00125	0.00059	0.000094	3243	5272468.6	5.25E+06	0.17
21	10190	0.00085	0.00005	0.000004	366	90178	0.00960	0.00130	0.00057	0.000098	3243	5489902.6	5.50E+06	0.18
21	9510	0.00085	0.00005	0.000004	342	90178	0.01000	0.00125	0.00060	0.000094	3243	5294897.9	5.30E+06	0.16
Average	9997	0.00085	0.00005	0.000004	359	90178	0.00985	0.00127	0.00059	0.000095	3243	5352423	5.35E+06	0.17
Overall Average	9828	0.00085	0.00005	0.000004	351	90178	0.00972	0.00140	0.00058	0.000105	3223	5419953.7	5.40E+06	0.19

Reported By: _____ Scott Bivings

Date: _____

Reviewed By: _____ Robert Varner

Date: 8/28/2014

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 8

Project No. 140241

Mix Date Thursday, May 15, 2014

Mix Time: 2:51 PM

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	6.00	28.23	12.22	227710
24	5.98	28.04	12.25	251540
25	5.99	28.18	12.27	
26	5.98	28.09	12.23	
27	6.00	28.28	12.24	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

40% of Ultimate Load (lbs.) 95850

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	10740	0.00085	0.00000	0.000000	381	95850	0.00935	0.00150	0.00056	0.000112	3401	5934028.7	5.95E+06	0.22
25	9810	0.00085	0.00010	0.000007	348	95850	0.00930	0.00160	0.00056	0.000119	3401	6034309.1	6.05E+06	0.22
25	10680	0.00085	0.00000	0.000000	379	95850	0.00930	0.00155	0.00056	0.000115	3401	5973292.8	5.95E+06	0.23
Average	10410	0.00085	0.00003	0.000002	369	95850	0.00932	0.00155	0.00056	0.000115	3401	5980543.5	6.00E+06	0.22
26	11640	0.00085	0.00005	0.000004	414	95850	0.00960	0.00170	0.00057	0.000127	3412	5722064.1	5.70E+06	0.24
26	11090	0.00085	0.00005	0.000004	395	95850	0.00975	0.00160	0.00058	0.000119	3412	5662515.9	5.65E+06	0.22
26	10430	0.00085	0.00015	0.000011	371	95850	0.00980	0.00175	0.00059	0.000131	3412	5674776.2	5.65E+06	0.22
Average	11053	0.00085	0.00008	0.000006	393	95850	0.00972	0.00168	0.00058	0.000126	3412	5686452	5.70E+06	0.23
27	9540	0.00085	0.00000	0.000000	337	95850	0.00950	0.00140	0.00057	0.000104	3389	5892595.6	5.90E+06	0.20
27	10870	0.00085	0.00000	0.000000	384	95850	0.00905	0.00150	0.00054	0.000112	3389	6119655.7	6.10E+06	0.23
27	10490	0.00085	0.00010	0.000007	371	95850	0.00910	0.00155	0.00054	0.000115	3389	6109827.4	6.10E+06	0.22
Average	10300	0.00085	0.00003	0.000002	364	95850	0.00922	0.00148	0.00055	0.000110	3389	6040692.9	6.05E+06	0.22
Overall Average	10588	0.00085	0.00005	0.000004	376	95850	0.00942	0.00157	0.00056	0.000117	3401	5902562.8	5.90E+06	0.22

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/28/2014

Draft Report

**BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS**

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241

Mix Number Mix 8 Set No: 8
Mix Date Thursday, May 15, 2014
Mix Time 2:51 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
29	10.0000	0.8135	0.8145	11.59550	1.6280	9.9675
30	10.0000	0.8115	0.8130	11.58950	1.6245	9.9650
31	10.0000	0.8145	0.8130	11.57500	1.6275	9.9475
32	10.0000	0.8125	0.8135	11.59500	1.6260	9.9690

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
10		Specimen 29	Reference Bar 29	Δ Length 29	Specimen 30	Reference Bar 30	Δ Length 30	Specimen 31	Reference Bar 31	Δ Length 31	Specimen 32	Reference Bar 32	Δ Length 32	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Friday, May 16, 2014	0.0681	0.0980	-0.0299	0.0616	0.0981	-0.0365	0.0482	0.0981	-0.0499	0.0673	0.0981	-0.0308	-0.0368
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
		Specimen 29	Reference Bar 29	Δ Length 29	Specimen 30	Reference Bar 30	Δ Length 30	Specimen 31	Reference Bar 31	Δ Length 31	Specimen 32	Reference Bar 32	Δ Length 32	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001%)
7	Thursday, May 22, 2014	0.0686	0.0980	0.0050	0.0619	0.0980	0.0040	0.0487	0.0980	0.0060	0.0678	0.0980	0.0060	0.0053
11	Monday, May 26, 2014	0.0676	0.0979	-0.0040	0.0610	0.0979	-0.0040	0.0478	0.0979	-0.0020	0.0668	0.0979	-0.0030	-0.0032
14	Thursday, May 29, 2014	0.0674	0.0979	-0.0060	0.0607	0.0979	-0.0070	0.0476	0.0979	-0.0040	0.0665	0.0979	-0.0060	-0.0057
21	Thursday, June 05, 2014	0.0670	0.0979	-0.0100	0.0604	0.0979	-0.0100	0.0471	0.0979	-0.0090	0.0662	0.0979	-0.0090	-0.0095
35	Thursday, June 19, 2014	0.0664	0.0977	-0.0140	0.0598	0.0977	-0.0140	0.0466	0.0977	-0.0120	0.0656	0.0977	-0.0130	-0.0132
63	Thursday, July 17, 2014	0.0658	0.0976	-0.0190	0.0592	0.0976	-0.0190	0.0461	0.0976	-0.0160	0.0650	0.0976	-0.0180	-0.0180
119	Thursday, September 11, 2014	0.0652	0.0975	-0.0240	0.0585	0.0975	-0.0250	0.0455	0.0975	-0.0210	0.0643	0.0975	-0.0240	-0.0235
231	Thursday, January 01, 2015	0.0646	0.0976	-0.0310	0.0579	0.0976	-0.0320	0.0449	0.0976	-0.0280	0.0637	0.0976	-0.0310	-0.0305
455	Thursday, August 13, 2015	0.0637	0.0971	-0.0350	0.0570	0.0971	-0.0360	0.0440	0.0971	-0.0320	0.0628	0.0971	-0.0350	-0.0345
42	Calculated 35 Day Shrinkage			-0.0160			-0.0161			-0.0139			-0.0151	-0.0153
Note: Lowest Reading Value Recorded (Minimum)														
Reported by: <u>Scott Bivings</u>					Reviewed by: <u>Robert Varner 10/9/2015</u>									

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 8
Mix Date Thursday, May 15, 2014
Mix Time 2:51 PM

Set No: 8

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
29	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
30	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
31	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
32	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

Reference Bar Length (in.)		INITIAL READINGS												
10		Specimen 29	Reference Bar 29	Δ Length 29	Specimen 30	Reference Bar 30	Δ Length 30	Specimen 31	Reference Bar 31	Δ Length 31	Specimen 32	Reference Bar 32	Δ Length 32	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
819	Thursday, August 11, 2016	0.0634	0.0970	-0.0370	0.0566	0.0970	-0.0390	0.0437	0.0970	-0.0340	0.0624	0.0970	-0.0380	-0.0370
Reintroduce to Waterbath		LENGTH CHANGE CALCULATIONS												
		Specimen 29	Reference Bar 29	Δ Length 29	Specimen 30	Reference Bar 30	Δ Length 30	Specimen 31	Reference Bar 31	Δ Length 31	Specimen 32	Reference Bar 32	Δ Length 32	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001%)
820	Friday, August 12, 2016	0.0651	0.0971	-0.0210	0.0583	0.0971	-0.0230	0.0453	0.0971	-0.0190	0.0640	0.0971	-0.0230	-0.0215
823	Monday, August 15, 2016	0.0656	0.0971	-0.0160	0.0589	0.0971	-0.0170	0.0460	0.0971	-0.0120	0.0647	0.0971	-0.0160	-0.0153
826	Thursday, August 18, 2016	0.0658	0.0971	-0.0140	0.0590	0.0971	-0.0160	0.0460	0.0971	-0.0120	0.0647	0.0971	-0.0160	-0.0145
833	Thursday, August 25, 2016	0.0659	0.0971	-0.0130	0.0591	0.0971	-0.0150	0.0462	0.0971	-0.0100	0.0648	0.0971	-0.0150	-0.0133
847	Thursday, September 08, 2016	0.0662	0.0971	-0.0100	0.0593	0.0971	-0.0130	0.0465	0.0971	-0.0070	0.0650	0.0971	-0.0130	-0.0108
854	Thursday, September 15, 2016	0.0662	0.0971	-0.0100	0.0593	0.0971	-0.0130	0.0465	0.0971	-0.0070	0.0650	0.0971	-0.0130	-0.0108
875	Thursday, October 06, 2016	0.0661	0.0971	-0.0110	0.0593	0.0971	-0.0130	0.0463	0.0971	-0.0090	0.0649	0.0971	-0.0140	-0.0118
959	Thursday, December 29, 2016	0.0667	0.0968	-0.0020	0.0596	0.0968	-0.0070	0.0469	0.0968	0.0000	0.0655	0.0968	-0.0050	-0.0035

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:		
Customer: MDOT		Project: SP-9999-09(110)/106812-101000				Lab #: BCD						
MIX NUMBER Mix 9.1						Set #: 9						
Date: 5/19/2014		Mix Code: Mix 9		f'c: 3,500 psi		Size(c.f.): 6.25		Factor: 0.23				
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorption	Agg. FM			
Material	Vol. (c.f.)									Roller Meter Air 5.5		
Cement 1:	2.79	548.00	126.85	126.85	126.85	Type II Cement	3.15			Coarseness and Workability (volume)		
Cement 2:	0.00	0.00	0.00	0.00			0.00			Cumulative % retained on 3/8" 50.50		
Fly Ash:	0.00	0.00	0.00	0.00			2.42			Cumulative % retained on No 8 62.13		
Slag:	0.00	0.00	0.00	0.00			0.00			Cumulative % passing No 8 37.74		
Sand 1:	7.47	1228.24	284.31	295.29	295.29	Sand	2.636	0.52%	2.36	Coarseness Factor 81.29		
Coarse Aggregate 1:	11.82	2029.00	469.68	473.33	473.33	CA_ID3 - 57 Crushed Limestone AL	2.750	0.35%	7.00	Workability Factor 37.74		
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%		Adjusted Workability Factor 37.31		
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%				
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%				
Air:	4.50%	1.22	0.00	0.00								
Water:	3.71	231.25	53.53	38.91	38.91		1.00					
"+-Air:	0.50%											
Total:	27.00	4036.49	934.37	934.37								
UW w/o Air:		156.54	156.54	156.54								
ADMIX INFORMATION							Aggregate Moistures					
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)				
Air	0.40	2.2	64.8	15.0	15.0	Air	Sand: 3.88%	10.97				
Water Reducer	5.00	27.4	810.3	187.6	187.6	Water Reducer	CA 1 0.78%	3.65				
							CA 2 0.00%	0.00				
							CA 3 0.00%	0.00				
							CA 4 0.00%	0.00				
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.				
Batch Time	3:36 PM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4					
Sample Time	3:45 PM		38.71	61.29	0	0	0					
Slump, in.	2.25	2 in.	0.0	0.0	0.0	0.0	0.0	0.0				
Mix Temp.	79.4	1.5 in.	0.0	0.0	0.0	0.0	0.0	0.0				
Air Temp.	83.8	1.0 in.	0.0	2.7	0.0	0.0	0.0	1.7				
ACF Air %	5.5	3/4 in.	0.0	24.0	0.0	0.0	0.0	14.7				
Unit Weight (pcf)	149.00	1/2 in.	0.0	37.5	0.0	0.0	0.0	23.0				
Design Unit Wt.	149.50	3/8 in.	0.0	18.2	0.0	0.0	0.0	11.2				
Yield	6.27	No. 4	0.4	15.0	0.0	0.0	0.0	9.3				
Relative Yield	1.00	No. 8	4.5	0.9	0.0	0.0	0.0	2.3				
Design w/c	0.422	No. 16	8.4	0.3	0.0	0.0	0.0	3.4				
Actual w/c	0.422	No. 30	17.0	0.1	0.0	0.0	0.0	6.6				
Fine/Coarse	0.61	No. 50	57.8	0.1	0.0	0.0	0.0	22.4				
Bag Factor	5.83	No. 100	11.3	0.1	0.0	0.0	0.0	4.5				
Theoretical Air (%)	4.82	Pan	0.2	1.1	0.0	0.0	0.0	0.7				

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
 Fax: (601) 856-3552

Mix ID: _____ Mix 9

BDC Project NO. 140241

Made Date: _____ Monday, May 19, 2014

COMPRESSION TESTS RESULTS

Specimen Age	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	5/26/2014	5.94	5.96	12.05	12.05	12.05	29.81	153.74	27.81	162320	5837	3	6140
6	7	5/26/2014	5.89	5.91	11.95	12.05	12.00	29.76	156.74	27.34	176750	6465	4	
7	7	5/26/2014	5.97	5.99	12.00	12.00	12.05	29.75	152.31	28.09	172430	6138	3	
8	7	5/26/2014	5.97	5.98	12.05	12.00	12.05	29.72	152.20	28.04	170390	6077	3	
9	7	5/26/2014	5.95	5.95	12.10	12.10	12.10	29.92	153.67	27.81	171980	6184	3	
11	14	6/2/2014	5.95	5.92	12.00	11.95	12.00	29.69	154.75	27.67	196520	7102	3	7020
12	14	6/2/2014	5.96	5.96	12.05	12.05	12.05	29.68	152.55	27.9	191580	6867	3	
13	14	6/2/2014	5.96	6.02	12.05	12.05	12.00	29.80	151.85	28.18	193730	6875	3	
14	14	6/2/2014	5.95	5.95	12.05	12.05	12.00	29.86	154.21	27.81	199340	7168	4	
15	14	6/2/2014	5.97	5.97	12.00	12.05	12.05	29.73	152.51	27.99	198610	7096	3	
17	28	6/16/2014	5.99	6.00	12.05	12.00	12.00	29.73	151.45	28.23	203400	7205	3	7320
18	28	6/16/2014	5.95	5.95	12.00	12.00	12.00	29.76	154.12	27.81	206970	7442	3	
19	28	6/16/2014	6.03	6.05	12.10	12.10	12.10	29.90	149.02	28.65	209900	7326	3	
20	28	6/16/2014	6.01	6.03	12.00	12.00	12.00	29.65	150.00	28.46	202460	7114	3	
21	28	6/16/2014	5.94	5.95	12.00	12.05	12.05	29.65	153.38	27.76	207960	7491	3	
23	91	8/18/2014	5.94	5.96	11.95	12.00	12.00	29.72	154.13	27.81	223570	8039	3	7950
24	91	8/18/2014	5.98	6.01	12.05	12.05	11.95	29.36	149.57	28.23	217850	7717	3	
25	91	8/18/2014	6.00	5.99	12.00	12.00	11.95	29.64	151.41	28.23	218100	7726	3	
26	91	8/18/2014	5.93	5.93	11.95	12.00	12.00	29.49	153.97	27.62	224210	8118	3	
27	91	8/18/2014	5.98	5.96	12.00	12.05	12.00	29.59	152.00	27.99	228390	8160	3	

Reported By: _____ Scott Bivings _____ Date: _____

Reviewed By: _____ Robert Varner _____ Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
 CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
 AASHTO T97 Flexural Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID: _____ Mix 9

BDC Project NO. 140241

Made Date: _____ Monday, May 19, 2014

Specimen No.	Specimen Age	Test Date	Depth 1 (0.05 in)	Depth 2 (0.05 in)	Depth 3 (0.05 in)	Avg Depth (in.)	Width 1 (0.05 in)	Width 2 (0.05 in)	Width 3 (0.05 in)	Avg Width (in.)	Max Load	Flex Strength (psi)	Avg (psi)
29	7	5/26/2014	6.10	6.10	6.10	6.10	6.10	6.05	6.10	6.08	10680	850	865
30	7	5/26/2014	6.10	6.05	6.05	6.07	6.05	6.00	6.00	6.02	10620	862	
31	7	5/26/2014	6.10	6.10	6.05	6.08	6.05	6.10	6.10	6.08	11090	888	
32	14	6/2/2014	6.00	6.05	6.10	6.05	6.05	6.05	6.05	6.05	11190	910	915
33	14	6/2/2014	6.00	6.05	6.00	6.02	6.05	6.05	6.05	6.05	11300	928	
34	14	6/2/2014	6.00	6.05	6.05	6.03	6.10	6.05	6.05	6.07	11120	907	
35	28	6/16/2014	6.10	6.10	6.10	6.10	6.10	6.05	6.00	6.05	11750	939	930
36	28	6/16/2014	6.10	6.10	6.15	6.12	6.10	6.15	6.20	6.15	11690	914	
37	28	6/16/2014	6.05	6.10	6.10	6.08	6.05	6.05	6.10	6.05	11550	930	
38	91	8/18/2014	6.10	6.10	6.05	6.08	6.15	6.10	6.15	6.13	11270	895	940
39	91	8/18/2014	6.05	6.10	6.10	6.08	6.15	6.10	6.15	6.13	12430	987	
40	91	8/18/2014	6.05	6.10	6.05	6.07	6.10	6.05	6.05	6.07	11600	934	

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Varner _____

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 9

Project No. 140241

Mix Date Monday, May 19, 2014

Mix Time: 3:36 PM

7 DAY CYLINDER DATA

Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	5.95	27.81	12.33	162320
6	5.90	27.34	12.29	176750
7	5.98	28.09	12.24	
8	5.98	28.04	12.25	
9	5.95	27.81	12.33	

Compressometer Calibration	
Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>
Extensometer Calibration	
Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:
 Machine applied load (lbs.), **P**
 Longitudinal gage reading, **G_{long}**
 Longitudinal Strain, **ε_{long}**
 Transverse gage reading, **G_{tran}**
 Transverse Strain, **ε_{tran}**
 Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 67814

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
7	10480	0.00085	0.00010	0.000007	373	67814	0.00565	0.00090	0.00034	0.000067	2414	7092712.6	7.10E+06	0.21
7	10550	0.00085	0.00000	0.000000	376	67814	0.00560	0.00085	0.00033	0.000063	2414	7158408.5	7.15E+06	0.22
7	11040	0.00085	0.00015	0.000011	393	67814	0.00560	0.00100	0.00033	0.000075	2414	7097155	7.10E+06	0.22
Average	10690	0.00085	0.00008	0.000006	381	67814	0.00562	0.00092	0.00034	0.000068	2414	7116092	7.10E+06	0.22
8	10250	0.00085	0.00010	0.000007	366	67814	0.00600	0.00095	0.00036	0.000071	2418	6650318.5	6.65E+06	0.21
8	10680	0.00085	0.00000	0.000000	381	67814	0.00580	0.00090	0.00035	0.000067	2418	6866600.8	6.85E+06	0.23
8	8750	0.00085	0.00010	0.000007	312	67814	0.00615	0.00100	0.00037	0.000075	2418	6630986.7	6.65E+06	0.21
Average	9893	0.00085	0.00007	0.000005	353	67814	0.00598	0.00095	0.00036	0.000071	2418	6715968.6	6.70E+06	0.21
9	10930	0.00085	0.00010	0.000008	393	67814	0.00605	0.00110	0.00036	0.000083	2438	6562563.8	6.55E+06	0.24
9	9500	0.00085	0.00015	0.000011	342	67814	0.00610	0.00115	0.00036	0.000086	2438	6663633.5	6.65E+06	0.24
9	11110	0.00085	0.00015	0.000011	399	67814	0.00585	0.00110	0.00035	0.000083	2438	6802757.9	6.80E+06	0.24
Average	10513	0.00085	0.00013	0.000010	378	67814	0.00600	0.00112	0.00036	0.000084	2438	6676318.4	6.70E+06	0.24
Overall Average	10366	0.00085	0.00009	0.000007	370	67814	0.00587	0.00099	0.00035	0.000074	2424	6836126.4	6.85E+06	0.22

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 9

Project No. 140241

Mix Date _____ Monday, May 19, 2014

Mix Time: _____ 3:36 PM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	5.94	27.67	12.15	196520
12	5.96	27.9	12.24	191580
13	5.99	28.18	12.26	
14	5.95	27.81	12.19	
15	5.97	27.99	12.23	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) _____ 77620

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) _____ 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	11370	0.00085	0.00010	0.000007	403	77620	0.00700	0.00095	0.00042	0.000071	2754	6380181.3	6.40E+06	0.17
13	10520	0.00085	0.00015	0.000011	373	77620	0.00720	0.00080	0.00043	0.000060	2754	6258947.6	6.25E+06	0.13
13	10800	0.00085	0.00000	0.000000	383	77620	0.00675	0.00105	0.00040	0.000078	2754	6707118.9	6.70E+06	0.22
Average	10897	0.00085	0.00008	0.000006	387	77620	0.00698	0.00093	0.00042	0.000070	2754	6448749.3	6.45E+06	0.17
14	11420	0.00085	0.00000	0.000000	411	77620	0.00675	0.00100	0.00040	0.000075	2791	6733293.1	6.75E+06	0.21
14	12150	0.00085	0.00010	0.000008	437	77620	0.00655	0.00115	0.00039	0.000086	2791	6892136.9	6.90E+06	0.23
14	10730	0.00085	0.00015	0.000011	386	77620	0.00660	0.00115	0.00039	0.000086	2791	6980536	7.00E+06	0.22
Average	11433	0.00085	0.00008	0.000006	411	77620	0.00663	0.00110	0.00040	0.000083	2791	6868655.3	6.85E+06	0.22
15	12730	0.00085	0.00000	0.000000	455	77620	0.00655	0.00095	0.00039	0.000071	2773	6787149.5	6.80E+06	0.21
15	10410	0.00085	0.00000	0.000000	372	77620	0.00680	0.00100	0.00041	0.000075	2773	6735114.5	6.75E+06	0.21
15	13460	0.00085	0.00000	0.000000	481	77620	0.00645	0.00095	0.00039	0.000071	2773	6830339.9	6.85E+06	0.21
Average	12200	0.00085	0.00000	0.000000	436	77620	0.00660	0.00097	0.00039	0.000072	2773	6784201.3	6.80E+06	0.21
Overall Average	11510	0.00085	0.00006	0.000004	411	77620	0.00674	0.00100	0.00040	0.000075	2773	6700535.3	6.70E+06	0.20

Reported By: _____ Scott Bivings

Date: _____

Reviewed By: _____ Robert Vamer

Date: _____ 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 9 _____

Project No. 140241

Mix Date Monday, May 19, 2014

Mix Time: 3:36 PM

28 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	6.00	28.23	12.20	203400
18	5.95	27.81	12.23	206970
19	6.04	28.65	12.38	
20	6.02	28.46	12.23	
21	5.95	27.76	12.22	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:
 Machine applied load (lbs.), **P**
 Longitudinal gage reading, **G_{long}**
 Longitudinal Strain, **ε_{long}**
 Transverse gage reading, **G_{tran}**
 Transverse Strain, **ε_{tran}**
 Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 82074

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	12120	0.00085	0.00015	0.000011	423	82074	0.00710	0.00120	0.00042	0.000089	2865	6520584.5	6.50E+06	0.21
19	12910	0.00085	0.00020	0.000015	451	82074	0.00705	0.00125	0.00042	0.000092	2865	6498824.1	6.50E+06	0.21
19	13160	0.00085	0.00015	0.000011	459	82074	0.00710	0.00120	0.00042	0.000089	2865	6423643.5	6.40E+06	0.21
Average	12730	0.00085	0.00017	0.000012	444	82074	0.00708	0.00122	0.00042	0.000090	2865	6481017.4	6.50E+06	0.21
20	13930	0.00085	0.00010	0.000007	489	82074	0.00695	0.00110	0.00042	0.000082	2884	6551160.8	6.55E+06	0.20
20	10830	0.00085	0.00000	0.000000	381	82074	0.00720	0.00100	0.00043	0.000074	2884	6580110.4	6.60E+06	0.19
20	11250	0.00085	0.00000	0.000000	395	82074	0.00725	0.00100	0.00043	0.000074	2884	6490323.7	6.50E+06	0.19
Average	12003	0.00085	0.00003	0.000002	422	82074	0.00713	0.00103	0.00043	0.000077	2884	6540531.7	6.55E+06	0.20
21	11160	0.00085	0.00000	0.000000	402	82074	0.00680	0.00105	0.00041	0.000079	2957	7165170.1	7.15E+06	0.22
21	10640	0.00085	0.00005	0.000004	383	82074	0.00705	0.00115	0.00042	0.000086	2957	6927313	6.95E+06	0.22
21	10870	0.00085	0.00015	0.000011	392	82074	0.00705	0.00125	0.00042	0.000094	2957	6905008.8	6.90E+06	0.22
Average	10890	0.00085	0.00007	0.000005	392	82074	0.00697	0.00115	0.00042	0.000086	2957	6999164	7.00E+06	0.22
Overall Average	11874	0.00085	0.00009	0.000007	419	82074	0.00706	0.00113	0.00042	0.000084	2902	6673571	6.65E+06	0.21

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 9 _____

Project No. 140241

Mix Date Monday, May 19, 2014

Mix Time: 3:36 PM

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	5.95	27.81	12.19	223570
24	6.00	28.23	12.19	217850
25	6.00	28.23	12.20	
26	5.93	27.62	12.17	
27	5.97	27.99		

Compressometer Calibration
 Pivot rod to yoke supports (0.01 in.) 4.95
 Longitudinal gage to yoke supports (0.01 in.) 5.40
 Longitudinal Gage length (0.01 in.) 8.00
Extensometer Calibration
 Hinge to mid yoke supports (0.01 in.) 3.91
 Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:
 Machine applied load (lbs.), **P**
 Longitudinal gage reading, **G_{long}**
 Longitudinal Strain, **ε_{long}**
 Transverse gage reading, **G_{tran}**
 Transverse Strain, **ε_{tran}**
 Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 88284

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	12480	0.00085	0.00000	0.000000	442	88284	0.00700	0.00130	0.00042	0.000097	3127	7287345.7	7.30E+06	0.26
25	12100	0.00085	0.00015	0.000011	429	88284	0.00700	0.00140	0.00042	0.000104	3127	7323876.7	7.30E+06	0.25
25	12250	0.00085	0.00015	0.000011	434	88284	0.00700	0.00140	0.00042	0.000104	3127	7309456.6	7.30E+06	0.25
Average	12277	0.00085	0.00010	0.000007	435	88284	0.00700	0.00137	0.00042	0.000102	3127	7306893	7.30E+06	0.26
26	11460	0.00085	0.00015	0.000011	415	88284	0.00820	0.00135	0.00049	0.000102	3196	6318384.4	6.30E+06	0.21
26	11540	0.00085	0.00005	0.000004	418	88284	0.00810	0.00125	0.00048	0.000094	3196	6398700.8	6.40E+06	0.21
26	11100	0.00085	0.00015	0.000011	402	88284	0.00820	0.00135	0.00049	0.000102	3196	6347992.6	6.35E+06	0.21
Average	11367	0.00085	0.00012	0.000009	412	88284	0.00817	0.00132	0.00049	0.000099	3196	6355025.9	6.35E+06	0.21
27	12510	0.00085	0.00020	0.000015	447	88284	0.00740	0.00140	0.00044	0.000105	3154	6899187.4	6.90E+06	0.23
27	13220	0.00085	0.00020	0.000015	472	88284	0.00730	0.00140	0.00044	0.000105	3154	6940280.6	6.95E+06	0.23
27	13840	0.00085	0.00020	0.000015	494	88284	0.00720	0.00140	0.00043	0.000105	3154	6991117.2	7.00E+06	0.24
Average	13190	0.00085	0.00020	0.000015	471	88284	0.00730	0.00140	0.00044	0.000105	3154	6943528.4	6.95E+06	0.23
Overall Average	12278	0.00085	0.00014	0.000010	439	88284	0.00749	0.00136	0.00045	0.000102	3159	6868482.4	6.85E+06	0.23

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

BUS: (601) 856-2332
 FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

BCD JOB NO. 140241

Mix Number Mix 9 Set No: 9
 Mix Date Monday, May 19, 2014
 Mix Time 3:36 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
33	10.0000	0.8125	0.8130	11.60100	1.6255	9.9755
34	10.0000	0.8155	0.8450	11.60350	1.6605	9.9430
35	10.0000	0.8165	0.8135	11.59850	1.6300	9.9685
36	10.0000	0.8125	0.8125	11.58800	1.6250	9.9630

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
10		Specimen 33	Reference Bar 33	Δ Length 33	Specimen 34	Reference Bar 34	Δ Length 34	Specimen 35	Reference Bar 35	Δ Length 35	Specimen 36	Reference Bar 36	Δ Length 36	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Tuesday, May 20, 2014	0.0765	0.0980	-0.0215	0.0789	0.0980	-0.0191	0.0747	0.0980	-0.0233	0.0650	0.0980	-0.0330	-0.0242
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
		Specimen 33	Reference Bar 33	Δ Length 33	Specimen 34	Reference Bar 34	Δ Length 34	Specimen 35	Reference Bar 35	Δ Length 35	Specimen 36	Reference Bar 36	Δ Length 36	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001%)
7	Monday, May 26, 2014	0.0765	0.0979	0.0010	0.0791	0.0979	0.0030	0.0747	0.0979	0.0010	0.0650	0.0979	0.0010	0.0015
11	Friday, May 30, 2014	0.0755	0.0979	-0.0090	0.0783	0.0979	-0.0050	0.0738	0.0979	-0.0080	0.0640	0.0979	-0.0090	-0.0077
14	Monday, June 02, 2014	0.0752	0.0978	-0.0110	0.0780	0.0978	-0.0070	0.0735	0.0978	-0.0100	0.0638	0.0978	-0.0100	-0.0095
21	Monday, June 09, 2014	0.0749	0.0979	-0.0150	0.0776	0.0979	-0.0120	0.0732	0.0979	-0.0140	0.0635	0.0979	-0.0140	-0.0138
35	Monday, June 23, 2014	0.0743	0.0977	-0.0190	0.0772	0.0977	-0.0140	0.0727	0.0977	-0.0170	0.0629	0.0977	-0.0180	-0.0170
63	Monday, July 21, 2014	0.0737	0.0976	-0.0240	0.0767	0.0976	-0.0180	0.0721	0.0976	-0.0220	0.0623	0.0976	-0.0230	-0.0218
119	Monday, September 15, 2014	0.0732	0.0975	-0.0280	0.0761	0.0975	-0.0230	0.0716	0.0975	-0.0260	0.0617	0.0975	-0.0280	-0.0263
231	Monday, January 05, 2015	0.0727	0.0976	-0.0340	0.0757	0.0976	-0.0280	0.0712	0.0976	-0.0310	0.0613	0.0976	-0.0330	-0.0315
455	Monday, August 17, 2015	0.0721	0.0971	-0.0350	0.0751	0.0971	-0.0290	0.0706	0.0971	-0.0320	0.0607	0.0971	-0.0340	-0.0325
42	Calculated 35 Day Shrinkage			-0.0205			-0.0159			-0.0190			-0.0200	-0.0188
Note: Lowest Reading Value Recorded (Minimum) Reported by: <u>Scott Bivings</u> Reviewed by: <u>Robert Varner 10/9/2015</u>														

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 9 Set No: 9
Mix Date Monday, May 19, 2014
Mix Time 3:36 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
33	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
34	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
35	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
36	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

	Reference Bar Length (in.)	INITIAL READINGS												
	10	Specimen 33	Reference Bar 33	Δ Length 33	Specimen 34	Reference Bar 34	Δ Length 34	Specimen 35	Reference Bar 35	Δ Length 35	Specimen 36	Reference Bar 36	Δ Length 36	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
819	Monday, August 15, 2016	0.0717	0.0970	-0.0380	0.0747	0.0970	-0.0320	0.0703	0.0970	-0.0340	0.0603	0.0970	-0.0370	-0.0353
	Reintroduce to Waterbath	LENGTH CHANGE CALCULATIONS												
		Specimen 33	Reference Bar 33	Δ Length 33	Specimen 34	Reference Bar 34	Δ Length 34	Specimen 35	Reference Bar 35	Δ Length 35	Specimen 36	Reference Bar 36	Δ Length 36	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
820	Tuesday, August 16, 2016	0.0733	0.0971	-0.0230	0.0762	0.0971	-0.0180	0.0716	0.0971	-0.0220	0.0618	0.0971	-0.0230	-0.0215
822	Thursday, August 18, 2016	0.0735	0.0971	-0.0210	0.0764	0.0971	-0.0160	0.0719	0.0971	-0.0190	0.0621	0.0971	-0.0200	-0.0190
826	Monday, August 22, 2016	0.0736	0.0971	-0.0200	0.0766	0.0971	-0.0140	0.0721	0.0971	-0.0170	0.0622	0.0971	-0.0190	-0.0175
833	Monday, August 29, 2016	0.0737	0.0971	-0.0190	0.0766	0.0971	-0.0140	0.0722	0.0971	-0.0160	0.0623	0.0971	-0.0180	-0.0168
847	Monday, September 12, 2016	0.0739	0.0971	-0.0170	0.0768	0.0971	-0.0120	0.0723	0.0971	-0.0150	0.0624	0.0971	-0.0170	-0.0153
854	Monday, September 19, 2016	0.0739	0.0971	-0.0170	0.0769	0.0971	-0.0110	0.0723	0.0971	-0.0150	0.0624	0.0971	-0.0170	-0.0150
875	Monday, October 10, 2016	0.0740	0.0971	-0.0160	0.0769	0.0971	-0.0110	0.0725	0.0971	-0.0130	0.0626	0.0971	-0.0150	-0.0138
955	Thursday, December 29, 2016	0.0742	0.0968	-0.0110	0.0771	0.0968	-0.0060	0.0726	0.0968	-0.0090	0.0627	0.0968	-0.0110	-0.0092

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:		
Customer: MDOT		Project: SP-9999-09(110)/106812-101000				Lab #: BCD						
MIX NUMBER		Mix 10.1				Set #: 10						
Date: 5/21/2014		Mix Code: Mix 10		f'c: 3,500 psi		Size(c.f.): 6.25		Factor: 0.23				
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorp- tion	Agg. FM			
Material	Vol. (c.f.)									Roller Meter Air: 4.25		
Cement 1:	2.09	411.00	95.14	95.14	95.14	Type I-II Cement	3.15			Coarseness and Workability (volume)		
Cement 2:	0.00	0.00	0.00	0.00			0.00			Cumulative % retained on 3/8" 51.42		
Fly Ash:	1.01	137.00	31.71	31.71	31.71	Class F Fly Ash	2.18			Cumulative % retained on No 8 63.16		
Slag:	0.00	0.00	0.00	0.00			0.00			Cumulative % passing No 8 36.71		
Sand 1:	7.12	1171.74	271.24	281.71	281.71	Sand	2.636	0.52%	2.36	Coarseness Factor 81.41		
Coarse Aggregate 1:	11.82	2029.00	469.68	473.33	473.33	CA_ID3 - 57 Crushed Limestone AL	2.750	0.35%	7.00	Workability Factor 36.71		
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%		Adjusted Workability Factor 36.28		
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%				
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%				
Air:	4.50%	1.22	0.00	0.00								
Water:	3.74	233.33	54.01	39.89	39.89		1.00					
"+-Air:	0.50%											
Total:	27.00	3982.07	921.78	921.78								
UW w/o Air:		154.43	154.43	154.43								
ADMIX INFORMATION							Aggregate Moistures					
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)				
Air	0.80	4.4	129.7	30.0	30.0	Hunt Process - AIR-IN-XT	Sand: 3.88%	10.47				
Water Reducer	5.00	27.4	810.3	187.6	187.6	Hunt Process - HPS-R	CA 1: 0.78%	3.65				
							CA 2: 0.00%	0.00				
							CA 3: 0.00%	0.00				
							CA 4: 0.00%	0.00				
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.				
Batch Time	12:26 PM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4					
Sample Time	12:35 PM		37.6	62.4	0	0	0					
Slump, in.	2.75	2 in.	0.0	0.0	0.0	0.0	0.0					
Mix Temp.	78.0	1.5 in.	0.0	0.0	0.0	0.0	0.0					
Air Temp.	75.5	1.0 in.	0.0	2.7	0.0	0.0	0.0					
ACF Air %	4.8	3/4 in.	0.0	24.0	0.0	0.0	0.0					
Unit Weight (pcf)	148.60	1/2 in.	0.0	37.5	0.0	0.0	0.0					
Design Unit Wt.	147.48	3/8 in.	0.0	18.2	0.0	0.0	0.0					
Yield	6.20	No. 4	0.4	15.0	0.0	0.0	0.0					
Relative Yield	0.99	No. 8	4.5	0.9	0.0	0.0	0.0					
Design w/c	0.426	No. 16	8.4	0.3	0.0	0.0	0.0					
Actual w/c	0.426	No. 30	17.0	0.1	0.0	0.0	0.0					
Fine/Coarse	0.58	No. 50	57.8	0.1	0.0	0.0	0.0					
Bag Factor	5.83	No. 100	11.3	0.1	0.0	0.0	0.0					
Theoretical Air (%)	3.78	Pan	0.2	1.1	0.0	0.0	0.0					

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
 Fax: (601) 856-3552

Mix ID: _____ Mix 10

BDC Project NO. 140241

Made Date: Wednesday, May 21, 2014

COMPRESSION TESTS RESULTS

Specimen Age	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	5/28/2014	6.02	6.04	12.10	12.20	12.20	30.39	151.13	28.56	155810	5456	4	5320
6	7	5/28/2014	6.04	6.03	12.05	12.10	12.15	30.30	151.27	28.61	150280	5253	3	
7	7	5/28/2014	6.03	6.04	12.15	12.15	12.10	30.40	151.35	28.61	155550	5437	3	
8	7	5/28/2014	6.02	6.03	12.15	12.15	12.10	30.24	151.05	28.51	149420	5241	4	
9	7	5/28/2014	6.03	6.04	12.10	12.05	12.10	30.33	151.62	28.61	149720	5233	3	
11	14	6/4/2014	6.02	6.04	12.05	12.05	12.10	30.33	152.09	28.56	164360	5755	3	6080
12	14	6/4/2014	6.01	6.01	12.05	12.00	12.10	30.15	152.40	28.37	172870	6093	3	
13	14	6/4/2014	5.96	5.94	12.05	12.00	12.05	29.71	153.43	27.81	178880	6432	3	
14	14	6/4/2014	5.94	5.92	12.00	12.00	11.95	29.57	154.38	27.62	175460	6353	3	
15	14	6/4/2014	5.97	6.00	12.05	11.95	11.95	29.52	151.30	28.13	161720	5749	3	
17	28	6/18/2014	5.98	6.01	12.00	12.00	11.95	29.48	150.59	28.23	185660	6577	3	6810
18	28	6/18/2014	6.02	6.05	12.10	12.10	12.10	30.34	151.47	28.61	196250	6859	3	
19	28	6/18/2014	5.96	5.95	12.00	12.00	12.00	29.47	152.36	27.85	197000	7074	3	
20	28	6/18/2014	6.01	6.01	12.05	12.10	12.05	30.23	152.60	28.37	193550	6822	3	
21	28	6/18/2014	6.02	6.01	12.00	12.10	12.10	30.34	152.90	28.42	191240	6729	3	
23	90	8/19/2014	5.97	5.97	12.00	11.95	11.95	29.50	152.17	27.99	252290	9014	3	8840
24	90	8/19/2014	5.93	5.96	12.00	11.95	12.00	29.39	152.67	27.76	233710	8419	3	
25	90	8/19/2014	6.01	6.01	12.10	12.10	12.10	30.26	152.33	28.37	258360	9107	3	
26	90	8/19/2014	5.99	5.95	12.00	12.00	12.00	29.63	152.42	27.99	242480	8663	3	
27	90	8/19/2014	6.01	6.03	12.15	12.05	12.10	30.37	152.37	28.46	256200	9002	3	

Reported By: _____ Scott Bivings _____ Date: _____

Reviewed By: _____ Robert Varner _____ Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
 CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
 AASHTO T97 Flexural Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID: Mix 10

BDC Project NO. 140241

Made Date: Wednesday, May 21, 2014

Specimen No.	Specimen Age	Test Date	Depth 1 (0.05 in)	Depth 2 (0.05 in)	Depth 3 (0.05 in)	Avg Depth (in.)	Width 1 (0.05 in)	Width 2 (0.05 in)	Width 3 (0.05 in)	Avg Width (in.)	Max Load	Flex Strength (psi)	Avg (psi)
29	7	5/28/2014	6.05	6.05	6.05	6.05	6.05	6.05	6.05	6.05	8800	715	725
30	7	5/28/2014	6.10	6.10	6.10	6.10	6.05	6.05	6.10	6.07	9200	733	
31	7	5/28/2014	6.05	6.05	6.05	6.05	6.10	6.05	6.05	6.07	8890	720	
32	14	6/4/2014	6.10	6.10	6.05	6.08	6.10	6.10	6.10	6.10	10070	804	850
33	14	6/4/2014	6.05	6.10	6.10	6.08	6.00	5.90	5.90	5.93	10980	902	
34	14	6/4/2014	6.10	6.10	6.10	6.10	6.20	6.10	6.15	6.15	10710	842	
35	28	6/18/2014	6.05	6.05	6.05	6.05	5.95	5.95	6.00	5.97	11680	962	935
36	28	6/18/2014	6.10	6.10	6.05	6.08	6.15	6.05	6.05	6.08	11740	940	
37	28	6/18/2014	6.05	6.05	6.00	6.03	5.95	5.95	6.00	5.97	10810	896	
38	90	8/19/2014	6.10	6.10	6.10	6.10	5.95	5.95	5.95	5.95	12080	982	1010
39	90	8/19/2014	6.05	6.05	6.05	6.05	6.00	6.00	6.05	6.02	12840	1049	
40	90	8/19/2014	6.05	6.10	6.05	6.07	6.05	6.00	6.05	6.03	12300	997	

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 10

Project No. 140241

Mix Date Wednesday, May 21, 2014

Mix Time: 12:26 PM

7 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in.²)	Length Cap (0.01 in.)	Ultimate Load
5	6.03	28.56	12.32	155810
6	6.04	28.61	12.31	150280
7	6.04	28.61	12.29	
8	6.03	28.51	12.25	
9	6.04	28.61	12.23	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 61218

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
7	15120	0.00085	0.00020	0.000015	528	61218	0.00480	0.00090	0.00029	0.000067	2140	6799790.9	6.80E+06	0.22
7	16560	0.00085	0.00015	0.000011	579	61218	0.00485	0.00080	0.00029	0.000059	2140	6505317.9	6.50E+06	0.20
7	15980	0.00085	0.00015	0.000011	559	61218	0.00490	0.00085	0.00029	0.000063	2140	6508723.7	6.50E+06	0.21
Average	15887	0.00085	0.00017	0.000012	555	61218	0.00485	0.00085	0.00029	0.000063	2140	6604610.9	6.60E+06	0.21
8	11640	0.00085	0.00010	0.000007	408	61218	0.00560	0.00090	0.00033	0.000067	2147	6106302.6	6.10E+06	0.21
8	10400	0.00085	0.00015	0.000011	365	61218	0.00565	0.00095	0.00034	0.000070	2147	6194014.4	6.20E+06	0.21
8	9490	0.00085	0.00005	0.000004	333	61218	0.00575	0.00080	0.00034	0.000059	2147	6176615.9	6.20E+06	0.19
Average	10510	0.00085	0.00010	0.000007	369	61218	0.00567	0.00088	0.00034	0.000065	2147	6158977.6	6.15E+06	0.20
9	9950	0.00085	0.00000	0.000000	348	61218	0.00540	0.00080	0.00032	0.000059	2140	6568143.4	6.55E+06	0.22
9	15100	0.00085	0.00005	0.000004	528	61218	0.00465	0.00080	0.00028	0.000059	2140	7070310.1	7.05E+06	0.24
9	9900	0.00085	0.00010	0.000007	346	61218	0.00520	0.00095	0.00031	0.000070	2140	6875882.6	6.90E+06	0.24
Average	11650	0.00085	0.00005	0.000004	407	61218	0.00508	0.00085	0.00030	0.000063	2140	6838112	6.85E+06	0.23
Overall Average	12682	0.00085	0.00011	0.000008	444	61218	0.00520	0.00086	0.00031	0.000064	2142	6533900.2	6.55E+06	0.21

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 10 _____

Project No. 140241

Mix Date Wednesday, May 21, 2014

Mix Time: 12:26 PM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	6.03	28.56	12.32	164360
12	6.01	28.37	12.23	172870
13	5.95	27.81	12.21	
14	5.93	27.62	12.16	
15	5.98	28.13	12.17	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 67446

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	10510	0.00085	0.00000	0.000000	378	67446	0.00670	0.00085	0.00040	0.000064	2425	5840419.9	5.85E+06	0.18
13	8390	0.00085	0.00000	0.000000	302	67446	0.00690	0.00085	0.00041	0.000064	2425	5858076.4	5.85E+06	0.18
13	10250	0.00085	0.00000	0.000000	369	67446	0.00665	0.00090	0.00040	0.000068	2425	5917550.1	5.90E+06	0.19
Average	9717	0.00085	0.00000	0.000000	349	67446	0.00675	0.00087	0.00040	0.000065	2425	5872015.4	5.85E+06	0.18
14	10180	0.00085	0.00000	0.000000	369	67446	0.00660	0.00090	0.00039	0.000068	2442	6017301	6.00E+06	0.20
14	9790	0.00085	0.00005	0.000004	354	67446	0.00680	0.00095	0.00041	0.000072	2442	5855106.8	5.85E+06	0.19
14	10410	0.00085	0.00000	0.000000	377	67446	0.00700	0.00090	0.00042	0.000068	2442	5604198.6	5.60E+06	0.18
Average	10127	0.00085	0.00002	0.000001	367	67446	0.00680	0.00092	0.00041	0.000069	2442	5825535.5	5.85E+06	0.19
15	10850	0.00085	0.00010	0.000007	386	67446	0.00595	0.00095	0.00036	0.000071	2398	6581294.2	6.60E+06	0.21
15	11500	0.00085	0.00015	0.000011	409	67446	0.00595	0.00095	0.00036	0.000071	2398	6505708.6	6.50E+06	0.20
15	10760	0.00085	0.00015	0.000011	383	67446	0.00620	0.00095	0.00037	0.000071	2398	6284516.8	6.30E+06	0.19
Average	11037	0.00085	0.00013	0.000010	392	67446	0.00603	0.00095	0.00036	0.000071	2398	6457173.2	6.45E+06	0.20
Overall Average	10293	0.00085	0.00005	0.000004	369	67446	0.00653	0.00091	0.00039	0.000068	2422	6051574.7	6.05E+06	0.19

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 10 _____

Project No. 140241

Mix Date Wednesday, May 21, 2014

Mix Time: 12:26 PM

28 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	6.00	28.23	12.21	185660
18	6.04	28.61	12.33	196250
19	5.96	27.85	12.19	
20	6.01	28.37	12.24	
21	6.02	28.42	12.25	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 76382

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	11900	0.00085	0.00015	0.000011	427	76382	0.00710	0.00120	0.00042	0.000090	2743	6183180.2	6.20E+06	0.21
19	12150	0.00085	0.00010	0.000007	436	76382	0.00730	0.00110	0.00044	0.000082	2743	5968627.4	5.95E+06	0.19
19	11050	0.00085	0.00010	0.000007	397	76382	0.00725	0.00105	0.00043	0.000079	2743	6118170.3	6.10E+06	0.19
Average	11700	0.00085	0.00012	0.000009	420	76382	0.00722	0.00112	0.00043	0.000084	2743	6089992.6	6.10E+06	0.20
20	12520	0.00085	0.00015	0.000011	441	76382	0.00650	0.00115	0.00039	0.000085	2692	6648335.9	6.65E+06	0.22
20	12310	0.00085	0.00010	0.000007	434	76382	0.00650	0.00115	0.00039	0.000085	2692	6670197.9	6.65E+06	0.23
20	11180	0.00085	0.00010	0.000007	394	76382	0.00665	0.00110	0.00040	0.000082	2692	6612700.5	6.60E+06	0.21
Average	12003	0.00085	0.00012	0.000009	423	76382	0.00655	0.00113	0.00039	0.000084	2692	6643744.8	6.65E+06	0.22
21	11880	0.00085	0.00010	0.000007	418	76382	0.00625	0.00110	0.00037	0.000082	2688	7012698.5	7.00E+06	0.23
21	11680	0.00085	0.00010	0.000007	411	76382	0.00630	0.00120	0.00038	0.000089	2688	6970067.5	6.95E+06	0.25
21	11320	0.00085	0.00000	0.000000	398	76382	0.00630	0.00110	0.00038	0.000082	2688	7008848.7	7.00E+06	0.25
Average	11627	0.00085	0.00007	0.000005	409	76382	0.00628	0.00113	0.00038	0.000084	2688	6997204.9	7.00E+06	0.24
Overall Average	11777	0.00085	0.00010	0.000007	417	76382	0.00668	0.00113	0.00040	0.000084	2708	6576980.8	6.60E+06	0.22

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 10 _____

Project No. 140241

Mix Date Wednesday, May 21, 2014

Mix Time: 12:26 PM

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	5.97	27.99	12.18	252290
24	5.95	27.76	12.23	233710
25	6.01	28.37	12.27	
26	5.97	27.99	12.21	
27	6.02	28.46	12.28	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 97200

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	12380	0.00085	0.00010	0.000007	436	97200	0.00825	0.00135	0.00049	0.000100	3426	6745789.6	6.75E+06	0.21
25	11300	0.00085	0.00010	0.000007	398	97200	0.00825	0.00145	0.00049	0.000108	3426	6831682.7	6.85E+06	0.23
25	12830	0.00085	0.00015	0.000011	452	97200	0.00815	0.00145	0.00049	0.000108	3426	6801747.2	6.80E+06	0.22
Average	12170	0.00085	0.00012	0.000009	429	97200	0.00822	0.00142	0.00049	0.000105	3426	6793073.2	6.80E+06	0.22
26	12850	0.00085	0.00000	0.000000	459	97200	0.00880	0.00120	0.00053	0.000090	3473	6329886.2	6.35E+06	0.19
26	11050	0.00085	0.00005	0.000004	395	97200	0.00880	0.00135	0.00053	0.000101	3473	6464963.8	6.45E+06	0.20
26	11770	0.00085	0.00010	0.000007	421	97200	0.00880	0.00130	0.00053	0.000097	3473	6410932.8	6.40E+06	0.19
Average	11890	0.00085	0.00005	0.000004	425	97200	0.00880	0.00128	0.00053	0.000096	3473	6401927.6	6.40E+06	0.19
27	12530	0.00085	0.00020	0.000015	440	97200	0.00775	0.00145	0.00046	0.000108	3415	7198023.6	7.20E+06	0.22
27	11800	0.00085	0.00010	0.000007	415	97200	0.00770	0.00145	0.00046	0.000108	3415	7312970.9	7.30E+06	0.24
27	12990	0.00085	0.00015	0.000011	456	97200	0.00755	0.00155	0.00045	0.000115	3415	7372182.8	7.35E+06	0.26
Average	12440	0.00085	0.00015	0.000011	437	97200	0.00767	0.00148	0.00046	0.000110	3415	7294392.5	7.30E+06	0.24
Overall Average	12167	0.00085	0.00011	0.000008	430	97200	0.00823	0.00139	0.00049	0.000104	3438	6829797.7	6.85E+06	0.22

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/28/2014

Draft Report

**BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS**

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 10 Set No: 10
Mix Date Wednesday, May 21, 2014
Mix Time 12:26 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
37	10.0000	0.8145	0.8120	11.57850	1.6265	9.9520
38	10.0000	0.8120	0.8140	11.61650	1.6260	9.9905
39	10.0000	0.8115	0.8135	11.59800	1.6250	9.9730
40	10.0000	0.8125	0.8120	11.57550	1.6245	9.9510

SHRINKAGE TESTING - AASHTO T160

	Reference Bar Length (in.)	INITIAL READINGS												
		Specimen 37	Reference Bar 37	Δ Length 37	Specimen 38	Reference Bar 38	Δ Length 38	Specimen 39	Reference Bar 39	Δ Length 39	Specimen 40	Reference Bar 40	Δ Length 40	Average
	10													
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Thursday, May 22, 2014	0.0352	0.0980	-0.0628	0.0911	0.0980	-0.0069	0.0772	0.0980	-0.0208	0.0543	0.0980	-0.0437	-0.0336
		LENGTH CHANGE CALCULATIONS												
	Moisture Cure for 7 Days	Specimen 37	Reference Bar 37	Δ Length 37	Specimen 38	Reference Bar 38	Δ Length 38	Specimen 39	Reference Bar 39	Δ Length 39	Specimen 40	Reference Bar 40	Δ Length 40	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
7	Wednesday, May 28, 2014	0.0355	0.0979	0.0040	0.0911	0.0979	0.0010	0.0775	0.0979	0.0040	0.0545	0.0979	0.0030	0.0030
10	Saturday, May 31, 2014	0.0347	0.0979	-0.0040	0.0904	0.0979	-0.0060	0.0767	0.0979	-0.0040	0.0538	0.0979	-0.0040	-0.0045
14	Wednesday, June 04, 2014	0.0342	0.0979	-0.0090	0.0899	0.0979	-0.0110	0.0763	0.0979	-0.0080	0.0533	0.0979	-0.0090	-0.0093
21	Wednesday, June 11, 2014	0.0338	0.0979	-0.0130	0.0896	0.0979	-0.0140	0.0759	0.0979	-0.0120	0.0529	0.0979	-0.0130	-0.0130
35	Wednesday, June 25, 2014	0.0331	0.0977	-0.0180	0.0889	0.0977	-0.0190	0.0753	0.0977	-0.0160	0.0523	0.0977	-0.0170	-0.0175
63	Wednesday, July 23, 2014	0.0325	0.0976	-0.0230	0.0883	0.0976	-0.0240	0.0747	0.0976	-0.0210	0.0516	0.0976	-0.0230	-0.0228
119	Wednesday, September 17, 2014	0.0320	0.0975	-0.0270	0.0879	0.0975	-0.0270	0.0743	0.0975	-0.0240	0.0511	0.0975	-0.0270	-0.0263
231	Wednesday, January 07, 2015	0.0317	0.0976	-0.0310	0.0876	0.0976	-0.0310	0.0739	0.0976	-0.0290	0.0507	0.0976	-0.0320	-0.0308
455	Wednesday, August 19, 2015	0.0310	0.0971	-0.0330	0.0870	0.0971	-0.0320	0.0734	0.0971	-0.0290	0.0502	0.0971	-0.0320	-0.0315
42	Calculated 35 Day Shrinkage			-0.0195			-0.0200			-0.0175			-0.0190	-0.0190

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 10/9/2015

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 10 Set No: 10
Mix Date Wednesday, May 21, 2014
Mix Time 12:26 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
37	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
38	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
39	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
40	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

	Reference Bar Length (in.)	INITIAL READINGS												
	10	Specimen 37	Reference Bar 37	Δ Length 37	Specimen 38	Reference Bar 38	Δ Length 38	Specimen 39	Reference Bar 39	Δ Length 39	Specimen 40	Reference Bar 40	Δ Length 40	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
819	Wednesday, August 17, 2016	0.0307	0.0971	-0.0360	0.0866	0.0971	-0.0360	0.0730	0.0971	-0.0330	0.0497	0.0971	-0.0370	-0.0355

LENGTH CHANGE CALCULATIONS

	Reintroduce to Waterbath	Specimen 37	Reference Bar 37	Δ Length 37	Specimen 38	Reference Bar 38	Δ Length 38	Specimen 39	Reference Bar 39	Δ Length 39	Specimen 40	Reference Bar 40	Δ Length 40	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001%)
820	Thursday, August 18, 2016	0.0319	0.0971	-0.0240	0.0877	0.0971	-0.0250	0.0741	0.0971	-0.0220	0.0510	0.0971	-0.0240	-0.0238
822	Saturday, August 20, 2016	0.0320	0.0971	-0.0230	0.0879	0.0971	-0.0230	0.0742	0.0971	-0.0210	0.0512	0.0971	-0.0220	-0.0223
826	Wednesday, August 24, 2016	0.0322	0.0971	-0.0210	0.0882	0.0971	-0.0200	0.0743	0.0971	-0.0200	0.0513	0.0971	-0.0210	-0.0205
833	Wednesday, August 31, 2016	0.0323	0.0971	-0.0200	0.0880	0.0971	-0.0220	0.0744	0.0971	-0.0190	0.0517	0.0971	-0.0170	-0.0195
847	Wednesday, September 14, 2016	0.0326	0.0971	-0.0170	0.0880	0.0971	-0.0220	0.0745	0.0971	-0.0180	0.0518	0.0971	-0.0160	-0.0183
854	Wednesday, September 21, 2016	0.0327	0.0971	-0.0160	0.0880	0.0971	-0.0220	0.0746	0.0971	-0.0170	0.0518	0.0971	-0.0160	-0.0178
875	Wednesday, October 12, 2016	0.0327	0.0971	-0.0160	0.0881	0.0971	-0.0210	0.0744	0.0971	-0.0190	0.0520	0.0971	-0.0140	-0.0175
953	Thursday, December 29, 2016	0.0326	0.0968	-0.0140	0.0882	0.0968	-0.0170	0.0746	0.0968	-0.0140	0.0519	0.0968	-0.0120	-0.0143

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:		
Customer: MDOT		Project: SP-9999-09(110)/106812-101000				Lab #: BCD						
MIX NUMBER		Mix 11.1				Set #: 11						
Date: 5/27/2014		Mix Code: Mix 11		f _c : 3,500 psi		Size(c.f.): 6.50		Factor: 0.24				
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorp- tion	Agg. FM	Roller Meter Air 5.25		
Cement 1:	2.09	411.00	98.94	98.94	98.94	Type I-II Cement	3.15			Coarseness and Workability (volume)		
Cement 2:	0.00	0.00	0.00	0.00			0.00			Cumulative % retained on 3/8" 50.45		
Fly Ash:	0.84	137.00	32.98	32.98	32.98	Class C Fly Ash	2.60			Cumulative % retained on No 8 62.07		
Slag:	0.00	0.00	0.00	0.00			0.00			Cumulative % passing No 8 37.79		
Sand 1:	7.49	1231.45	296.46	306.75	306.75	Sand	2.636	0.52%	2.36	Coarseness Factor 81.29		
Coarse Aggregate 1:	11.82	2029.00	488.46	492.26	492.26	CA_ID3 - 57 Crushed Limestone AL	2.750	0.35%	7.00	Workability Factor 37.79		
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%		Adjusted Workability Factor 37.36		
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%				
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%				
Air:	4.50%	1.22	0.00	0.00	0.00							
Water:	3.54	220.83	53.16	39.07	39.07		1.00					
"+-Air:	0.50%											
Total:	27.00	4029.28	970.01	970.01								
UW w/o Air:		156.26	156.26	156.26								
ADMIX INFORMATION							Aggregate Moistures					
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)				
Air	0.79	4.3	127.2	30.6	30.6	Air	Sand: 3.49%	10.29				
Water Reducer	5.00	27.4	810.3	195.1	195.1	Water Reducer	CA 1 0.78%	3.80				
							CA 2 0.00%	0.00				
							CA 3 0.00%	0.00				
							CA 4 0.00%	0.00				
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.				
Batch Time	1:55 PM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4					
Sample Time	2:30 PM		38.77	61.23	0	0	0					
Slump, in.	2.75	2 in.	0.0	0.0	0.0	0.0	0.0					
Mix Temp.	83.8	1.5 in.	0.0	0.0	0.0	0.0	0.0					
Air Temp.	78.6	1.0 in.	0.0	2.7	0.0	0.0	0.0					
ACF Air %	5.2	3/4 in.	0.0	24.0	0.0	0.0	0.0					
Unit Weight (pcf)	147.80	1/2 in.	0.0	37.5	0.0	0.0	0.0					
Design Unit Wt.	149.23	3/8 in.	0.0	18.2	0.0	0.0	0.0					
Yield	6.56	No. 4	0.4	15.0	0.0	0.0	0.0					
Relative Yield	1.01	No. 8	4.5	0.9	0.0	0.0	0.0					
Design w/c	0.403	No. 16	8.4	0.3	0.0	0.0	0.0					
Actual w/c	0.403	No. 30	17.0	0.1	0.0	0.0	0.0					
Fine/Coarse	0.61	No. 50	57.8	0.1	0.0	0.0	0.0					
Bag Factor	5.83	No. 100	11.3	0.1	0.0	0.0	0.0					
Theoretical Air (%)	5.42	Pan	0.2	1.1	0.0	0.0	0.0					

Draft Report

**BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength**

278 COMMERCE PARK DRIVE
RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
Fax: (601) 856-3552

Mix ID: _____ Mix 11

BDC Project NO. 140241

Made Date: _____ Tuesday, May 27, 2014

COMPRESSION TESTS RESULTS

Specimen Age	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	6/3/2014	6.00	6.01	12.10	12.15	12.10	30.23	152.22	28.32	159480	5631	3	5620
6	7	6/3/2014	6.01	5.99	12.25	12.20	12.20	30.17	150.92	28.28	144530	5111	4	
7	7	6/3/2014	6.01	6.03	12.15	12.10	12.05	30.12	151.12	28.46	164090	5766	3	
8	7	6/3/2014	6.02	6.05	12.20	12.15	12.15	30.39	150.88	28.61	171080	5980	3	
9	7	6/3/2014	6.02	6.04	12.10	12.10	12.10	30.14	150.72	28.56	160350	5614	3	
11	14	6/10/2014	6.01	6.04	12.10	12.10	12.05	30.25	151.73	28.51	185000	6489	3	6620
12	14	6/10/2014	6.03	6.02	12.05	12.05	12.10	30.25	151.94	28.51	183510	6437	3	
13	14	6/10/2014	5.98	6.00	12.05	12.00	12.00	29.60	151.04	28.18	188030	6672	3	
14	14	6/10/2014	6.02	6.02	12.10	12.10	12.10	30.25	151.77	28.46	193530	6800	3	
15	14	6/10/2014	6.04	6.04	12.15	12.10	12.10	30.55	152.05	28.65	191610	6688	3	
17	28	6/24/2014	6.03	6.05	12.15	12.10	12.15	30.28	150.50	28.65	209520	7313	3	7300
18	28	6/24/2014	6.03	6.04	12.05	12.05	12.10	30.25	151.43	28.61	213580	7465	3	
19	28	6/24/2014	6.03	6.06	12.05	12.05	12.05	30.30	151.39	28.7	205480	7160	3	
20	28	6/24/2014	6.02	6.03	12.10	12.05	12.10	30.34	152.18	28.51	205570	7210	3	
21	28	6/24/2014	5.99	5.99	11.95	11.95	12.00	29.55	151.42	28.18	206680	7334	3	
23	90	8/25/2014	6.01	6.02	12.10	12.10	12.05	30.44	153.19	28.42	251340	8844	3	8640
24	90	8/25/2014	6.01	6.01	12.15	12.10	12.20	30.32	152.00	28.37	219970	7754	3	
25	90	8/25/2014	6.01	6.02	12.20	12.25	12.25	30.52	151.71	28.42	243290	8561	3	
26	90	8/25/2014	6.01	6.02	12.05	12.10	12.10	30.25	152.21	28.42	257880	9074	3	
27	90	8/25/2014	6.01	6.03	12.05	12.10	12.15	30.28	151.92	28.46	255790	8988	3	

Reported By: _____ Scott Bivings _____ Date: _____

Reviewed By: _____ Robert Varner _____ Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
 CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
 AASHTO T97 Flexural Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID: _____ Mix 11

BDC Project NO. 140241

Made Date: _____ Tuesday, May 27, 2014

Specimen No.	Specimen Age	Test Date	Depth 1 (0.05 in)	Depth 2 (0.05 in)	Depth 3 (0.05 in)	Avg Depth (in.)	Width 1 (0.05 in)	Width 2 (0.05 in)	Width 3 (0.05 in)	Avg Width (in.)	Max Load	Flex Strength (psi)	Avg (psi)
29	7	6/3/2014	6.05	6.05	6.05	6.05	6.05	6.05	6.05	6.05	9260	753	760
30	7	6/3/2014	6.05	6.05	6.05	6.05	6.10	6.05	6.05	6.07	9020	731	
31	7	6/3/2014	6.05	6.10	6.10	6.08	6.10	6.00	5.95	6.02	9790	792	
32	14	6/10/2014	6.05	6.10	6.10	6.08	6.00	5.95	6.00	5.98	10930	890	895
33	14	6/10/2014	6.10	6.10	6.05	6.08	6.05	6.00	6.05	6.03	11360	917	
34	14	6/10/2014	6.10	6.10	6.05	6.08	5.95	5.95	6.00	5.97	10780	879	
35	28	6/24/2014	6.10	6.10	6.05	6.08	5.95	5.90	5.90	5.92	12070	993	975
36	28	6/24/2014	6.00	6.00	6.00	6.00	6.05	6.00	5.95	6.00	11730	978	
37	28	6/24/2014	6.05	6.05	6.05	6.05	5.95	5.95	6.00	5.97	11510	948	
38	90	8/25/2014	6.05	6.05	6.05	6.05	5.95	5.95	5.95	5.95	12810	1059	1050
39	90	8/25/2014	6.10	6.10	6.05	6.08	6.15	6.10	6.15	6.13	12710	1010	
40	90	8/25/2014	6.10	6.10	6.05	6.08	6.10	6.05	6.10	6.08	13590	1088	

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Varner _____

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 11

Project No. 140241

Mix Date Tuesday, May 27, 2014

Mix Time: 1:55 PM

7 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	6.01	28.32	12.25	159480
6	6.00	28.28	12.25	144530
7	6.02	28.46	12.27	
8	6.04	28.61	12.37	
9	6.03	28.56	12.25	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 60802

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
7	11620	0.00085	0.00010	0.000007	408	60802	0.00590	0.00085	0.00035	0.000063	2136	5708656.6	5.70E+06	0.18
7	9700	0.00085	0.00005	0.000004	341	60802	0.00605	0.00090	0.00036	0.000067	2136	5760861.1	5.75E+06	0.20
7	10680	0.00085	0.00000	0.000000	375	60802	0.00595	0.00080	0.00036	0.000059	2136	5760879.5	5.75E+06	0.19
Average	10667	0.00085	0.00005	0.000004	375	60802	0.00597	0.00085	0.00036	0.000063	2136	5743465.7	5.75E+06	0.19
8	10280	0.00085	0.00005	0.000004	359	60802	0.00530	0.00085	0.00032	0.000063	2125	6617577.1	6.60E+06	0.22
8	9660	0.00085	0.00010	0.000007	338	60802	0.00535	0.00090	0.00032	0.000067	2125	6624581.1	6.60E+06	0.22
8	9700	0.00085	0.00015	0.000011	339	60802	0.00535	0.00095	0.00032	0.000070	2125	6619399.8	6.60E+06	0.22
Average	9880	0.00085	0.00010	0.000007	345	60802	0.00533	0.00090	0.00032	0.000067	2125	6620519.3	6.60E+06	0.22
9	9300	0.00085	0.00000	0.000000	326	60802	0.00605	0.00075	0.00036	0.000056	2129	5785625.1	5.80E+06	0.18
9	9460	0.00085	0.00015	0.000011	331	60802	0.00575	0.00090	0.00034	0.000067	2129	6119792.6	6.10E+06	0.19
9	7720	0.00085	0.00010	0.000007	270	60802	0.00605	0.00085	0.00036	0.000063	2129	5963119	5.95E+06	0.18
Average	8827	0.00085	0.00008	0.000006	309	60802	0.00595	0.00083	0.00036	0.000062	2129	5956178.9	5.95E+06	0.18
Overall Average	9791	0.00085	0.00008	0.000006	343	60802	0.00575	0.00086	0.00034	0.000064	2130	6106721.3	6.10E+06	0.20

Reported By: _____ Date: _____

Reviewed By: Robert Vamer

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 11

Project No. 140241

Mix Date Tuesday, May 27, 2014

Mix Time: 1:55 PM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	6.03	28.51	12.30	185000
12	6.03	28.51	12.26	183510
13	5.99	28.18	12.20	
14	6.02	28.46	12.26	
15	6.04	28.65	12.26	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 73702

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	11810	0.00085	0.00005	0.000004	419	73702	0.00565	0.00095	0.00034	0.000071	2615	7632123.5	7.65E+06	0.23
13	12550	0.00085	0.00005	0.000004	445	73702	0.00625	0.00095	0.00037	0.000071	2615	6705107.3	6.70E+06	0.21
13	11560	0.00085	0.00005	0.000004	410	73702	0.00640	0.00095	0.00038	0.000071	2615	6629955.9	6.65E+06	0.20
Average	11973	0.00085	0.00005	0.000004	425	73702	0.00610	0.00095	0.00036	0.000071	2615	6989062.2	7.00E+06	0.21
14	11710	0.00085	0.00005	0.000004	411	73702	0.00605	0.00105	0.00036	0.000078	2590	6988519	7.00E+06	0.24
14	10860	0.00085	0.00005	0.000004	382	73702	0.00620	0.00105	0.00037	0.000078	2590	6886220.3	6.90E+06	0.23
14	10220	0.00085	0.00000	0.000000	359	73702	0.00625	0.00105	0.00037	0.000078	2590	6892103	6.90E+06	0.24
Average	10930	0.00085	0.00003	0.000002	384	73702	0.00617	0.00105	0.00037	0.000078	2590	6922280.8	6.90E+06	0.24
15	11500	0.00085	0.00005	0.000004	401	73702	0.00635	0.00105	0.00038	0.000078	2572	6586682.7	6.60E+06	0.22
15	9370	0.00085	0.00005	0.000004	327	73702	0.00640	0.00110	0.00038	0.000081	2572	6751011.2	6.75E+06	0.23
15	10050	0.00085	0.00005	0.000004	351	73702	0.00645	0.00100	0.00039	0.000074	2572	6620157	6.60E+06	0.21
Average	10307	0.00085	0.00005	0.000004	360	73702	0.00640	0.00105	0.00038	0.000078	2572	6652617	6.65E+06	0.22
Overall Average	11070	0.00085	0.00004	0.000003	390	73702	0.00622	0.00102	0.00037	0.000075	2593	6854653.3	6.85E+06	0.22

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 6/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 11 _____

Project No. 140241

Mix Date Tuesday, May 27, 2014

Mix Time: 1:55 PM

28 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	6.04	28.65	12.29	209520
18	6.04	28.61	12.32	213580
19	6.05	28.7	12.24	
20	6.03	28.51	12.28	
21	5.99	28.18	12.21	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 84620

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	12860	0.00085	0.00020	0.000015	448	84620	0.00710	0.00125	0.00042	0.000092	2948	6677273	6.70E+06	0.21
19	12200	0.00085	0.00015	0.000011	425	84620	0.00705	0.00105	0.00042	0.000077	2948	6792911.1	6.80E+06	0.18
19	12020	0.00085	0.00020	0.000015	419	84620	0.00705	0.00125	0.00042	0.000092	2948	6809794.8	6.80E+06	0.21
Average	12360	0.00085	0.00018	0.000014	431	84620	0.00707	0.00118	0.00042	0.000087	2948	6759993	6.75E+06	0.20
20	13320	0.00085	0.00015	0.000011	467	84620	0.00705	0.00125	0.00042	0.000093	2968	6732426.4	6.75E+06	0.22
20	12700	0.00085	0.00005	0.000004	445	84620	0.00730	0.00110	0.00044	0.000081	2968	6528308.7	6.55E+06	0.20
20	12920	0.00085	0.00010	0.000007	453	84620	0.00730	0.00115	0.00044	0.000085	2968	6508338.9	6.50E+06	0.20
Average	12980	0.00085	0.00010	0.000007	455	84620	0.00722	0.00117	0.00043	0.000086	2968	6589691.4	6.60E+06	0.21
21	11380	0.00085	0.00000	0.000000	404	84620	0.00745	0.00115	0.00045	0.000086	3003	6573432	6.55E+06	0.22
21	11940	0.00085	0.00005	0.000004	424	84620	0.00740	0.00120	0.00044	0.000089	3003	6572862.6	6.55E+06	0.22
21	12070	0.00085	0.00000	0.000000	428	84620	0.00735	0.00115	0.00044	0.000086	3003	6611470.4	6.60E+06	0.22
Average	11797	0.00085	0.00002	0.000001	419	84620	0.00740	0.00117	0.00044	0.000087	3003	6585921.7	6.60E+06	0.22
Overall Average	12379	0.00085	0.00010	0.000007	435	84620	0.00723	0.00117	0.00043	0.000087	2973	6645202	6.65E+06	0.21

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/28/2014

Draft Report

**BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio**

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

PHONE: (601) 856-2332
FAX: (601) 856-3552

Mix ID _____ Mix 11 _____

Project No. 140241

Mix Date Tuesday, May 27, 2014

Mix Time: 1:55 PM

90 DAY CYLINDER DATA

Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	6.02	28.42	12.43	251340
24	6.01	28.37	12.56	219970
25	6.02	28.42	12.55	
26	6.02	28.42	12.40	
27	6.02	28.46	12.39	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00
Extensometer Calibration	
Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), P
- Longitudinal gage reading, G_{long}
- Longitudinal Strain, ε_{long}
- Transverse gage reading, G_{tran}
- Transverse Strain, ε_{tran}
- Compressive Stress, σ

40% of Ultimate Load (lbs.) 94262

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data						40 % Ultimate Load Data							Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ		P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ		MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	11510	0.00085	0.00015	0.000011	405	94262	0.00845	0.00145	0.00051	0.000108	3317	6397163.2	6.40E+06	0.21		
25	13880	0.00085	0.00020	0.000015	488	94262	0.00800	0.00140	0.00048	0.000104	3317	6604293.1	6.60E+06	0.21		
25	11660	0.00085	0.00015	0.000011	410	94262	0.00820	0.00145	0.00049	0.000108	3317	6602361.4	6.60E+06	0.22		
Average	12350	0.00085	0.00017	0.000012	435	94262	0.00822	0.00143	0.00049	0.000106	3317	6534605.9	6.55E+06	0.21		
26	13290	0.00085	0.00005	0.000004	468	94262	0.00860	0.00135	0.00051	0.000100	3317	6138619.9	6.15E+06	0.21		
26	12770	0.00085	0.00010	0.000007	449	94262	0.00830	0.00140	0.00050	0.000104	3317	6426367.7	6.45E+06	0.22		
26	12110	0.00085	0.00005	0.000004	426	94262	0.00845	0.00135	0.00051	0.000100	3317	6350780.1	6.35E+06	0.21		
Average	12723	0.00085	0.00007	0.000005	448	94262	0.00845	0.00137	0.00051	0.000101	3317	6305255.9	6.30E+06	0.21		
27	14230	0.00085	0.00005	0.000004	500	94262	0.00740	0.00130	0.00044	0.000096	3312	7166537.9	7.15E+06	0.24		
27	12810	0.00085	0.00015	0.000011	450	94262	0.00750	0.00140	0.00045	0.000104	3312	7184237.9	7.20E+06	0.23		
27	12140	0.00085	0.00015	0.000011	427	94262	0.00755	0.00150	0.00045	0.000111	3312	7189388.4	7.20E+06	0.25		
Average	13060	0.00085	0.00012	0.000009	459	94262	0.00748	0.00140	0.00045	0.000104	3312	7180054.7	7.20E+06	0.24		
Overall Average	12711	0.00085	0.00012	0.000009	447	94262	0.00805	0.00140	0.00048	0.000104	3315	6673305.5	6.65E+06	0.22		

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/28/2014

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241
Mix Number Mix 11 Set No: 11
Mix Date Tuesday, May 27, 2014
Mix Time 1:55 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
41	10.0000	0.8130	0.8110	11.60500	1.6240	9.9810
42	10.0000	0.8105	0.8120	11.61750	1.6225	9.9950
43	10.0000	0.8125	0.8120	11.57850	1.6245	9.9540
44	10.0000	0.8120	0.8130	11.60250	1.6250	9.9775

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
		Specimen 41	Reference Bar 41	Δ Length 41	Specimen 42	Reference Bar 42	Δ Length 42	Specimen 43	Reference Bar 43	Δ Length 43	Specimen 44	Reference Bar 44	Δ Length 44	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Wednesday, May 28, 2014	0.0899	0.0979	-0.0080	0.0899	0.0979	-0.0080	0.0567	0.0979	-0.0412	0.0761	0.0979	-0.0218	-0.0198
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
		Specimen 41	Reference Bar 41	Δ Length 41	Specimen 42	Reference Bar 42	Δ Length 42	Specimen 43	Reference Bar 43	Δ Length 43	Specimen 44	Reference Bar 44	Δ Length 44	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
7	Tuesday, June 03, 2014	0.0902	0.0979	0.0030	0.0902	0.0979	0.0030	0.0568	0.0979	0.0010	0.0764	0.0979	0.0030	0.0025
10	Friday, June 06, 2014	0.0893	0.0979	-0.0060	0.0895	0.0979	-0.0040	0.0560	0.0979	-0.0070	0.0755	0.0979	-0.0060	-0.0057
14	Tuesday, June 10, 2014	0.0887	0.0979	-0.0120	0.0887	0.0979	-0.0120	0.0553	0.0979	-0.0140	0.0749	0.0979	-0.0120	-0.0125
21	Tuesday, June 17, 2014	0.0879	0.0978	-0.0190	0.0880	0.0978	-0.0180	0.0545	0.0978	-0.0210	0.0741	0.0978	-0.0190	-0.0192
35	Tuesday, July 01, 2014	0.0873	0.0977	-0.0240	0.0872	0.0977	-0.0250	0.0538	0.0977	-0.0270	0.0734	0.0977	-0.0250	-0.0252
63	Tuesday, July 29, 2014	0.0867	0.0976	-0.0290	0.0865	0.0976	-0.0310	0.0532	0.0976	-0.0320	0.0727	0.0976	-0.0310	-0.0308
119	Tuesday, September 23, 2014	0.0863	0.0975	-0.0320	0.0861	0.0975	-0.0340	0.0527	0.0975	-0.0360	0.0723	0.0975	-0.0340	-0.0340
231	Tuesday, January 13, 2015	0.0859	0.0975	-0.0360	0.0856	0.0975	-0.0390	0.0524	0.0975	-0.0390	0.0719	0.0975	-0.0380	-0.0380
455	Tuesday, August 25, 2015	0.0855	0.0971	-0.0360	0.0851	0.0971	-0.0400	0.0519	0.0971	-0.0400	0.0715	0.0971	-0.0380	-0.0385
42	Calculated 35 Day Shrinkage			-0.0250			-0.0260			-0.0281			-0.0265	-0.0264
Note: Lowest Reading Value Recorded (Minimum)														
Reported by: <u>Scott Bivings</u>					Reviewed by: <u>Robert Varner 10/9/2015</u>									

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 11 Set No: 11
Mix Date Tuesday, May 27, 2014
Mix Time 1:55 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
41	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
42	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
43	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
44	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

Specimen Age	Reference Bar Length (in.)	INITIAL READINGS												Average
		Specimen 41	Reference Bar 41	Δ Length 41	Specimen 42	Reference Bar 42	Δ Length 42	Specimen 43	Reference Bar 43	Δ Length 43	Specimen 44	Reference Bar 44	Δ Length 44	
	10	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
819	Tuesday, August 23, 2016	0.0850	0.0971	-0.0410	0.0849	0.0971	-0.0420	0.0515	0.0971	-0.0440	0.0710	0.0971	-0.0430	-0.0425
	Reintroduce to Waterbath	LENGTH CHANGE CALCULATIONS												
		Specimen 41	Reference Bar 41	Δ Length 41	Specimen 42	Reference Bar 42	Δ Length 42	Specimen 43	Reference Bar 43	Δ Length 43	Specimen 44	Reference Bar 44	Δ Length 44	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
820	Wednesday, August 24, 2016	0.0862	0.0971	-0.0290	0.0860	0.0971	-0.0310	0.0527	0.0971	-0.0320	0.0723	0.0971	-0.0300	-0.0305
822	Friday, August 26, 2016	0.0864	0.0971	-0.0270	0.0863	0.0971	-0.0280	0.0531	0.0971	-0.0280	0.0724	0.0971	-0.0290	-0.0280
826	Tuesday, August 30, 2016	0.0867	0.0971	-0.0240	0.0864	0.0971	-0.0270	0.0533	0.0971	-0.0260	0.0727	0.0971	-0.0260	-0.0258
833	Tuesday, September 06, 2016	0.0869	0.0971	-0.0220	0.0866	0.0971	-0.0250	0.0534	0.0971	-0.0250	0.0728	0.0971	-0.0250	-0.0243
847	Tuesday, September 20, 2016	0.0871	0.0971	-0.0200	0.0867	0.0971	-0.0240	0.0535	0.0971	-0.0240	0.0730	0.0971	-0.0230	-0.0228
854	Tuesday, September 27, 2016	0.0871	0.0971	-0.0200	0.0867	0.0971	-0.0240	0.0535	0.0971	-0.0240	0.0730	0.0971	-0.0230	-0.0228
875	Tuesday, October 18, 2016	0.0871	0.0971	-0.0200	0.0867	0.0971	-0.0240	0.0535	0.0971	-0.0240	0.0731	0.0971	-0.0220	-0.0225
947	Thursday, December 29, 2016	0.0873	0.0968	-0.0150	0.0869	0.0968	-0.0190	0.0537	0.0968	-0.0190	0.0732	0.0968	-0.0180	-0.0177

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:		
Customer: MDOT		Project: SP-9999-09(110)/106812-101000				Lab #: BCD						
MIX NUMBER		Mix 12.1				Set #: 12						
Date: 6/2/2014		Mix Code: Mix 12		f'c: 3,500 psi		Size(c.f.): 6.25		Factor: 0.23				
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorp- tion	Agg. FM			
Material	Vol. (c.f.)									Roller Meter Air 5.75		
Cement 1:	1.39	274.00	63.43	63.43	63.43	Type II Cement	3.15			Coarseness and Workability (volume)		
Cement 2:	0.00	0.00	0.00	0.00			0.00			Cumulative % retained on 3/8" 51.10		
Fly Ash:	0.00	0.00	0.00	0.00			2.60			Cumulative % retained on No 8 62.81		
Slag:	1.52	274.00	63.43	63.43	63.43	Slag Cement	2.89			Cumulative % passing No 8 37.06		
Sand 1:	7.24	1191.13	275.72	286.07	286.07	Sand	2.636	0.52%	2.36	Coarseness Factor 81.37		
Coarse Aggregate 1:	11.82	2029.00	469.68	473.33	473.33	CA_ID3 - 57 Crushed Limestone AL	2.750	0.35%	7.00	Workability Factor 37.06		
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%		Adjusted Workability Factor 36.63		
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%				
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%				
Air:	4.50%	1.22	0.00	0.00								
Water:	3.81	237.50	54.98	40.99	40.99		1.00					
"+-Air:	0.50%											
Total:	27.00	4005.63	927.23	927.23								
UW w/o Air:		155.35	155.35	155.35								
ADMIX INFORMATION							Aggregate Moistures					
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)				
Air	0.64	3.5	103.7	24.0	24.0	Hunt Process - AIR-IN-XT	Sand: 3.77%	10.34				
Water Reducer	5.00	27.4	810.3	187.6	187.6	Hunt Process - HPS-R	CA 1: 0.78%	3.65				
							CA 2: 0.00%	0.00				
							CA 3: 0.00%	0.00				
							CA 4: 0.00%	0.00				
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.				
Batch Time	1:06 PM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4					
Sample Time	1:15 PM		37.98	62.02	0	0	0					
Slump, in.	2.25	2 in.	0.0	0.0	0.0	0.0	0.0	0.0				
Mix Temp.	79.7	1.5 in.	0.0	0.0	0.0	0.0	0.0	0.0				
Air Temp.	76.8	1.0 in.	0.0	2.7	0.0	0.0	0.0	1.7				
ACF Air %	5.2	3/4 in.	0.0	24.0	0.0	0.0	0.0	14.9				
Unit Weight (pcf)	147.40	1/2 in.	0.0	37.5	0.0	0.0	0.0	23.3				
Design Unit Wt.	148.36	3/8 in.	0.0	18.2	0.0	0.0	0.0	11.3				
Yield	6.29	No. 4	0.4	15.0	0.0	0.0	0.0	9.4				
Relative Yield	1.01	No. 8	4.5	0.9	0.0	0.0	0.0	2.3				
Design w/c	0.433	No. 16	8.4	0.3	0.0	0.0	0.0	3.4				
Actual w/c	0.433	No. 30	17.0	0.1	0.0	0.0	0.0	6.5				
Fine/Coarse	0.59	No. 50	57.8	0.1	0.0	0.0	0.0	22.0				
Bag Factor	5.83	No. 100	11.3	0.1	0.0	0.0	0.0	4.4				
Theoretical Air (%)	5.12	Pan	0.2	1.1	0.0	0.0	0.0	0.7				

Draft Report

BURNS COOLEY DENNIS, INC.
 CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
 AASHTO T97 Flexural Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID: _____ Mix 12 _____

BDC Project NO. 140241

Made Date: _____ Monday, June 02, 2014 _____

Specimen No.	Specimen Age	Test Date	Depth 1 (0.05 in)	Depth 2 (0.05 in)	Depth 3 (0.05 in)	Avg Depth (in.)	Width 1 (0.05 in)	Width 2 (0.05 in)	Width 3 (0.05 in)	Avg Width (in.)	Max Load	Flex Strength (psi)	Avg (psi)
29	7	6/9/2014	6.10	6.10	6.10	6.10	6.10	6.10	6.10	6.10	9190	729	740
30	7	6/9/2014	6.10	6.05	6.05	6.07	6.00	5.95	5.95	5.97	8600	704	
31	7	6/9/2014	6.05	6.10	6.10	6.08	6.00	6.00	6.00	6.00	9740	790	
32	14	6/16/2014	6.05	6.05	6.05	6.05	6.00	5.95	6.00	5.98	11960	984	945
33	14	6/16/2014	6.10	6.10	6.10	6.10	6.10	6.05	6.10	6.08	11660	928	
34	14	6/16/2014	6.10	6.10	6.10	6.10	6.15	6.15	6.10	6.13	11650	919	
35	28	6/30/2014	6.05	6.10	6.05	6.07	6.00	6.00	6.05	6.02	12560	1019	1045
36	28	6/30/2014	6.10	6.10	6.10	6.10	6.00	6.00	6.00	6.00	13130	1059	
37	28	6/30/2014	6.15	6.10	6.05	6.10	6.00	5.95	5.95	5.97	13130	1064	
38	92	9/2/2014	6.10	6.10	6.10	6.10	6.10	6.10	6.10	6.10	14280	1132	1070
39	92	9/2/2014	6.05	6.10	6.10	6.08	6.05	6.05	6.15	6.08	13320	1067	
40	92	9/2/2014	6.05	6.05	6.05	6.05	6.10	6.10	6.15	6.12	12600	1012	

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Varner _____

Date: _____ 9/3/2014 _____

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 12

Project No. 140241

Mix Date Monday, June 02, 2014

Mix Time: 1:06 PM

7 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	6.03	28.51	12.22	143920
6	6.02	28.42	12.20	152450
7	6.02	28.46	12.25	
8	6.04	28.65	12.29	
9	6.01	28.37	12.28	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 59274

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
7	9700	0.00085	0.00005	0.000004	341	59274	0.00560	0.00090	0.00033	0.000067	2083	6116536.9	6.10E+06	0.22
7	9130	0.00085	0.00015	0.000011	321	59274	0.00560	0.00090	0.00033	0.000067	2083	6186864.6	6.20E+06	0.20
7	9830	0.00085	0.00005	0.000004	345	59274	0.00560	0.00090	0.00033	0.000067	2083	6100497.3	6.10E+06	0.22
Average	9553	0.00085	0.00008	0.000006	336	59274	0.00560	0.00090	0.00033	0.000067	2083	6134633	6.15E+06	0.21
8	11160	0.00085	0.00010	0.000007	390	59274	0.00520	0.00100	0.00031	0.000074	2069	6437591.6	6.45E+06	0.25
8	11040	0.00085	0.00010	0.000007	385	59274	0.00520	0.00100	0.00031	0.000074	2069	6453647.5	6.45E+06	0.25
8	11040	0.00085	0.00005	0.000004	385	59274	0.00520	0.00095	0.00031	0.000070	2069	6453647.5	6.45E+06	0.25
Average	11080	0.00085	0.00008	0.000006	387	59274	0.00520	0.00098	0.00031	0.000073	2069	6448295.5	6.45E+06	0.25
9	10380	0.00085	0.00010	0.000007	366	59274	0.00525	0.00100	0.00031	0.000074	2089	6531678.8	6.55E+06	0.25
9	10660	0.00085	0.00005	0.000004	376	59274	0.00500	0.00085	0.00030	0.000063	2089	6884214.1	6.90E+06	0.24
9	11130	0.00085	0.00015	0.000011	392	59274	0.00490	0.00100	0.00029	0.000074	2089	6985429.8	7.00E+06	0.26
Average	10723	0.00085	0.00010	0.000007	378	59274	0.00505	0.00095	0.00030	0.000071	2089	6800440.9	6.80E+06	0.25
Overall Average	10452	0.00085	0.00009	0.000007	367	59274	0.00528	0.00094	0.00032	0.000070	2080	6461123.1	6.45E+06	0.24

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 12

Project No. 140241

Mix Date _____ Monday, June 02, 2014

Mix Time: _____ 1:06 PM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	6.02	28.46	12.15	189630
12	6.03	28.56	12.26	191940
13	6.02	28.46	12.28	
14	6.03	28.51	12.42	
15	6.03	28.51	12.25	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) _____ 76314

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) _____ 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	10160	0.00085	0.00010	0.000007	357	76314	0.00780	0.00115	0.00047	0.000085	2681	5583548.2	5.60E+06	0.19
13	10960	0.00085	0.00005	0.000004	385	76314	0.00760	0.00100	0.00045	0.000074	2681	5679134.6	5.70E+06	0.17
13	11120	0.00085	0.00015	0.000011	391	76314	0.00730	0.00120	0.00044	0.000089	2681	5928174.2	5.95E+06	0.20
Average	10747	0.00085	0.00010	0.000007	378	76314	0.00757	0.00112	0.00045	0.000083	2681	5730285.7	5.75E+06	0.19
14	11390	0.00085	0.00005	0.000004	400	76314	0.00680	0.00100	0.00041	0.000074	2677	6387369.4	6.40E+06	0.20
14	11350	0.00085	0.00005	0.000004	398	76314	0.00695	0.00105	0.00042	0.000078	2677	6234492	6.25E+06	0.20
14	11320	0.00085	0.00000	0.000000	397	76314	0.00695	0.00100	0.00042	0.000074	2677	6237371.1	6.25E+06	0.20
Average	11353	0.00085	0.00003	0.000002	398	76314	0.00690	0.00102	0.00041	0.000075	2677	6286410.9	6.30E+06	0.20
15	11750	0.00085	0.00015	0.000011	412	76314	0.00690	0.00120	0.00041	0.000089	2677	6247197	6.25E+06	0.21
15	12220	0.00085	0.00020	0.000015	429	76314	0.00695	0.00130	0.00042	0.000096	2677	6150999.5	6.15E+06	0.22
15	11600	0.00085	0.00020	0.000015	407	76314	0.00700	0.00130	0.00042	0.000096	2677	6160119.8	6.15E+06	0.22
Average	11857	0.00085	0.00018	0.000014	416	76314	0.00695	0.00127	0.00042	0.000094	2677	6186105.4	6.20E+06	0.22
Overall Average	11319	0.00085	0.00011	0.000008	397	76314	0.00714	0.00113	0.00043	0.000084	2678	6067600.6	6.05E+06	0.20

Reported By: _____ Scott Bivings

Date: _____

Reviewed By: _____ Robert Vamer

Date: _____ 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 12

Project No. 140241

Mix Date Monday, June 02, 2014

Mix Time: 1:06 PM

28 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	6.03	28.56	12.19	215280
18	6.04	28.61	12.24	203160
19	6.05	28.7	12.24	
20	6.05	28.7	12.31	
21	6.02	28.46	12.36	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 83688

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	11630	0.00085	0.00000	0.000000	405	83688	0.00720	0.00120	0.00043	0.000089	2916	6599637.6	6.60E+06	0.23
19	12130	0.00085	0.00000	0.000000	423	83688	0.00730	0.00120	0.00044	0.000089	2916	6452448.1	6.45E+06	0.23
19	11070	0.00085	0.00000	0.000000	386	83688	0.00715	0.00125	0.00043	0.000092	2916	6703598	6.70E+06	0.24
Average	11610	0.00085	0.00000	0.000000	405	83688	0.00722	0.00122	0.00043	0.000090	2916	6585227.9	6.60E+06	0.24
20	11620	0.00085	0.00000	0.000000	405	83688	0.00715	0.00125	0.00043	0.000092	2916	6652825.7	6.65E+06	0.24
20	9580	0.00085	0.00000	0.000000	334	83688	0.00730	0.00120	0.00044	0.000089	2916	6682383.8	6.70E+06	0.23
20	9590	0.00085	0.00000	0.000000	334	83688	0.00725	0.00120	0.00043	0.000089	2916	6733570.2	6.75E+06	0.23
Average	10263	0.00085	0.00000	0.000000	358	83688	0.00723	0.00122	0.00043	0.000090	2916	6689593.3	6.70E+06	0.23
21	12750	0.00085	0.00015	0.000011	448	83688	0.00750	0.00125	0.00045	0.000093	2941	6256881	6.25E+06	0.20
21	10430	0.00085	0.00005	0.000004	366	83688	0.00755	0.00125	0.00045	0.000093	2941	6413387.6	6.40E+06	0.22
21	10630	0.00085	0.00005	0.000004	374	83688	0.00755	0.00125	0.00045	0.000093	2941	6395878.5	6.40E+06	0.22
Average	11270	0.00085	0.00008	0.000006	396	83688	0.00753	0.00125	0.00045	0.000093	2941	6355382.4	6.35E+06	0.22
Overall Average	11048	0.00085	0.00003	0.000002	386	83688	0.00733	0.00123	0.00044	0.000091	2924	6543401.2	6.55E+06	0.23

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 12 _____

Project No. 140241

Mix Date Monday, June 02, 2014

Mix Time: 1:06 PM

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	6.02	28.42	12.38	244080
24	6.03	28.51	12.22	235240
25	6.01	28.37	12.37	
26	6.02	28.46	12.22	
27	6.01	28.32	12.28	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 95864

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	9230	0.00085	0.00010	0.000007	325	95864	0.00895	0.00140	0.00054	0.000104	3379	6295621.8	6.30E+06	0.20
25	11520	0.00085	0.00015	0.000011	406	95864	0.00840	0.00145	0.00050	0.000108	3379	6574903.1	6.55E+06	0.21
25	11340	0.00085	0.00015	0.000011	400	95864	0.00835	0.00140	0.00050	0.000104	3379	6632781.2	6.65E+06	0.21
Average	10697	0.00085	0.00013	0.000010	377	95864	0.00857	0.00142	0.00051	0.000105	3379	6501102	6.50E+06	0.21
26	12230	0.00085	0.00010	0.000007	430	95864	0.00725	0.00145	0.00043	0.000108	3368	7664234.4	7.65E+06	0.26
26	12310	0.00085	0.00010	0.000007	433	95864	0.00725	0.00155	0.00043	0.000115	3368	7656903.2	7.65E+06	0.28
26	12040	0.00085	0.00005	0.000004	423	95864	0.00725	0.00135	0.00043	0.000100	3368	7681646	7.70E+06	0.25
Average	12193	0.00085	0.00008	0.000006	428	95864	0.00725	0.00145	0.00043	0.000108	3368	7667594.5	7.65E+06	0.26
27	12610	0.00085	0.00005	0.000004	445	95864	0.00790	0.00135	0.00047	0.000100	3385	6961593.6	6.95E+06	0.23
27	11610	0.00085	0.00010	0.000007	410	95864	0.00795	0.00145	0.00048	0.000108	3385	6995693.2	7.00E+06	0.24
27	11140	0.00085	0.00015	0.000011	393	95864	0.00790	0.00150	0.00047	0.000111	3385	7084513.1	7.10E+06	0.24
Average	11787	0.00085	0.00010	0.000007	416	95864	0.00792	0.00143	0.00047	0.000106	3385	7013933.3	7.00E+06	0.23
Overall Average	11559	0.00085	0.00011	0.000008	407	95864	0.00791	0.00143	0.00047	0.000106	3377	7060876.6	7.05E+06	0.23

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 9/3/2014

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241
Mix Number Mix 12 Set No: 12
Mix Date Monday, June 02, 2014
Mix Time 1:06 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
45	10.0000	0.8145	0.8145	11.59800	1.6290	9.9690
46	10.0000	0.8135	0.8130	11.62000	1.6265	9.9935
47	10.0000	0.8160	0.8145	11.59600	1.6305	9.9655
48	10.0000	0.8180	0.8150	11.60450	1.6330	9.9715

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
10		Specimen 45	Reference Bar 45	Δ Length 45	Specimen 46	Reference Bar 46	Δ Length 46	Specimen 47	Reference Bar 47	Δ Length 47	Specimen 48	Reference Bar 48	Δ Length 48	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Tuesday, June 03, 2014	0.0702	0.0979	-0.0277	0.0902	0.0979	-0.0077	0.0677	0.0979	-0.0302	0.0766	0.0979	-0.0213	-0.0217
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
		Specimen 45	Reference Bar 45	Δ Length 45	Specimen 46	Reference Bar 46	Δ Length 46	Specimen 47	Reference Bar 47	Δ Length 47	Specimen 48	Reference Bar 48	Δ Length 48	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
7	Monday, June 09, 2014	0.0705	0.0979	0.0030	0.0909	0.0979	0.0070	0.0682	0.0979	0.0050	0.0770	0.0979	0.0040	0.0047
11	Friday, June 13, 2014	0.0696	0.0979	-0.0060	0.0900	0.0979	-0.0020	0.0673	0.0979	-0.0040	0.0762	0.0978	-0.0030	-0.0038
14	Monday, June 16, 2014	0.0694	0.0978	-0.0070	0.0898	0.0979	-0.0040	0.0671	0.0978	-0.0050	0.0760	0.0978	-0.0050	-0.0052
21	Monday, June 23, 2014	0.0690	0.0976	-0.0090	0.0894	0.0976	-0.0050	0.0667	0.0977	-0.0080	0.0757	0.0977	-0.0070	-0.0073
35	Monday, July 07, 2014	0.0685	0.0975	-0.0130	0.0888	0.0975	-0.0100	0.0662	0.0975	-0.0110	0.0751	0.0975	-0.0110	-0.0113
63	Monday, August 04, 2014	0.0681	0.0975	-0.0170	0.0884	0.0975	-0.0140	0.0657	0.0975	-0.0160	0.0747	0.0975	-0.0150	-0.0155
119	Monday, September 29, 2014	0.0676	0.0975	-0.0220	0.0879	0.0975	-0.0190	0.0651	0.0975	-0.0220	0.0743	0.0975	-0.0190	-0.0205
231	Monday, January 19, 2015	0.0670	0.0974	-0.0270	0.0872	0.0974	-0.0250	0.0645	0.0974	-0.0270	0.0737	0.0974	-0.0240	-0.0258
455	Monday, August 31, 2015	0.0663	0.0971	-0.0310	0.0865	0.0971	-0.0290	0.0638	0.0971	-0.0310	0.0731	0.0971	-0.0270	-0.0295
42	Calculated 35 Day Shrinkage			-0.0144			-0.0111			-0.0135			-0.0124	-0.0129
Note: Lowest Reading Value Recorded (Minimum)														
Reported by: <u>Scott Bivings</u>					Reviewed by: <u>Robert Varner 10/12/2015</u>									

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 12 Set No: 12
Mix Date Monday, June 02, 2014
Mix Time 1:06 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
45	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
46	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
47	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
48	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

Specimen Age	Reference Bar Length (in.)	INITIAL READINGS												Average
		Specimen 45	Reference Bar 45	Δ Length 45	Specimen 46	Reference Bar 46	Δ Length 46	Specimen 47	Reference Bar 47	Δ Length 47	Specimen 48	Reference Bar 48	Δ Length 48	
	10	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
819	Monday, August 29, 2016	0.0657	0.0971	-0.0370	0.0858	0.0971	-0.0360	0.0632	0.0971	-0.0370	0.0726	0.0971	-0.0320	-0.0355
	Reintroduce to Waterbath	LENGTH CHANGE CALCULATIONS												
		Specimen 45	Reference Bar 45	Δ Length 45	Specimen 46	Reference Bar 46	Δ Length 46	Specimen 47	Reference Bar 47	Δ Length 47	Specimen 48	Reference Bar 48	Δ Length 48	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
820	Tuesday, August 30, 2016	0.0670	0.0971	-0.0240	0.0871	0.0971	-0.0230	0.0646	0.0971	-0.0230	0.0739	0.0971	-0.0190	-0.0223
822	Thursday, September 01, 2016	0.0674	0.0971	-0.0200	0.0874	0.0971	-0.0200	0.0650	0.0971	-0.0190	0.0743	0.0971	-0.0150	-0.0185
826	Monday, September 05, 2016	0.0676	0.0970	-0.0170	0.0878	0.0970	-0.0150	0.0652	0.0970	-0.0160	0.0745	0.0970	-0.0120	-0.0150
833	Monday, September 12, 2016	0.0677	0.0971	-0.0170	0.0879	0.0971	-0.0150	0.0653	0.0971	-0.0160	0.0746	0.0971	-0.0120	-0.0150
847	Monday, September 26, 2016	0.0679	0.0971	-0.0150	0.0881	0.0971	-0.0130	0.0655	0.0971	-0.0140	0.0747	0.0971	-0.0110	-0.0133
854	Monday, October 03, 2016	0.0681	0.0970	-0.0120	0.0883	0.0970	-0.0100	0.0656	0.0970	-0.0120	0.0750	0.0970	-0.0070	-0.0103
875	Monday, October 24, 2016	0.0680	0.0968	-0.0110	0.0882	0.0968	-0.0090	0.0656	0.0968	-0.0100	0.0748	0.0968	-0.0070	-0.0092
941	Thursday, December 29, 2016	0.0683	0.0968	-0.0080	0.0884	0.0968	-0.0070	0.0658	0.0968	-0.0080	0.0751	0.0968	-0.0040	-0.0067

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

BCD 140241										Notes:	
Customer: MDOT		Project: SP-9999-09(110)/106812-101000				Lab #: BCD					
MIX NUMBER		Mix 13.1				Set #: 13					
Date: 6/9/2014		Mix Code: Mix 13		fc: 3,500 psi		Size(c.f.): 6.25		Factor: 0.23			
MIX DESIGN INFO		SSD mix	SSD mix	Adjusted	Actual lab	Material Source	SSD Specific Gravity	Agg. absorption	Agg. FM		
Material	Vol. (c.f.)	1 cu. yd. Wt. (lbs.)	lab batch Wt. (lbs.)	lab batch Wt. (lbs.)	batch Wt. (lbs.)					Roller Meter Air	4.5
Cement 1:	2.79	548.00	126.85	126.85	126.85	Type I-II Cement	3.15			Coarseness and Workability (volume) Cumulative % retained on 3/8" 56.71 Cumulative % retained on No 8 65.84 Cumulative % passing No 8 33.93 Coarseness Factor 86.13 Workability Factor 33.93 Adjusted Workability Factor 33.50	
Cement 2:	0.00	0.00	0.00	0.00			0.00				
Fly Ash:	0.00	0.00	0.00	0.00			2.42				
Slag:	0.00	0.00	0.00	0.00			0.00				
Sand 1:	7.00	1152.01	266.67	274.84	274.84	Sand	2.636	0.52%	2.36		
Coarse Aggregate 1:	12.65	2031.00	470.14	470.37	470.37	CA_ID4 - 57 Gravel Low Absorption	2.572	1.42%	7.30		
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%			
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%			
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%			
Air:	4.50%	1.22	0.00	0.00	0.00						
Water:	3.34	208.33	48.22	39.82	39.82		1.00				
"+-Air:	0.50%										
Total:	27.00	3939.34	911.88	911.88							
UW w/o Air:		152.78	152.78	152.78							
ADMIX INFORMATION							Aggregate Moistures				
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)			
Air	0.50	2.7	81.0	18.8	18.8	Air	Sand: 3.08%	8.17			
Water Reducer	5.00	27.4	810.3	187.6	187.6	Water Reducer	CA 1 0.05%	0.23			
							CA 2 0.00%	0.00			
							CA 3 0.00%	0.00			
							CA 4 0.00%	0.00			
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.			
Batch Time	1:51 PM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4				
Sample Time	2:00 PM		35.63	64.37	0	0	0				
Slump, in.	1.50	2 in.	0.0	0.0	0.0	0.0	0.0	0.0			
Mix Temp.	84.0	1.5 in.	0.0	0.0	0.0	0.0	0.0	0.0			
Air Temp.	80.0	1.0 in.	0.0	19.8	0.0	0.0	0.0	12.7			
ACF Air %	4.9	3/4 in.	0.0	24.8	0.0	0.0	0.0	16.0			
Unit Weight (pcf)	146.20	1/2 in.	0.0	29.3	0.0	0.0	0.0	18.9			
Design Unit Wt.	145.90	3/8 in.	0.0	14.2	0.0	0.0	0.0	9.1			
Yield	6.24	No. 4	0.4	10.0	0.0	0.0	0.0	6.6			
Relative Yield	1.00	No. 8	4.5	1.5	0.0	0.0	0.0	2.6			
Design w/c	0.380	No. 16	8.4	0.1	0.0	0.0	0.0	3.1			
Actual w/c	0.380	No. 30	17.0	0.0	0.0	0.0	0.0	6.0			
Fine/Coarse	0.57	No. 50	57.8	0.1	0.0	0.0	0.0	20.7			
Bag Factor	5.83	No. 100	11.3	0.0	0.0	0.0	0.0	4.0			
Theoretical Air (%)	4.30	Pan	0.2	0.1	0.0	0.0	0.0	0.1			

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
 AASHTO T97 Flexural Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID: _____ Mix 13

BDC Project NO. 140241

Made Date: _____ Monday, June 09, 2014

Specimen No.	Specimen Age	Test Date	Depth 1 (0.05 in)	Depth 2 (0.05 in)	Depth 3 (0.05 in)	Avg Depth (in.)	Width 1 (0.05 in)	Width 2 (0.05 in)	Width 3 (0.05 in)	Avg Width (in.)	Max Load	Flex Strength (psi)	Avg (psi)
29	7	6/16/2014	6.05	6.05	6.10	6.07	6.10	6.10	6.15	6.12	9170	732	775
30	7	6/16/2014	6.05	6.15	6.15	6.12	6.10	6.00	6.10	6.07	10590	838	
31	7	6/16/2014	6.10	6.10	6.10	6.10	6.15	6.10	6.15	6.13	9540	753	
32	14	6/23/2014	6.10	6.05	6.05	6.07	5.95	5.95	6.00	5.97	10970	898	870
33	14	6/23/2014	6.05	6.10	6.05	6.07	6.05	6.00	6.00	6.02	11020	894	
34	14	6/23/2014	6.10	6.10	6.10	6.10	6.05	6.05	6.10	6.07	10180	811	
35	28	7/7/2014	6.10	6.10	6.10	6.10	6.00	6.00	6.05	6.02	10250	824	860
36	28	7/7/2014	6.05	6.05	6.05	6.05	6.10	6.00	6.00	6.03	10450	852	
37	28	7/7/2014	6.10	6.10	6.05	6.08	6.05	6.00	6.05	6.03	11130	899	
38	90	9/7/2014	6.05	6.05	6.10	6.07	6.05	6.00	6.00	6.00	11110	905	920
39	90	9/7/2014	6.05	6.10	6.10	6.08	6.05	5.95	6.00	6.00	11490	932	
40	90	9/7/2014	6.10	6.10	6.10	6.10	5.95	5.95	6.00	5.95	11280	917	

Reported By: _____ Scott Bivings

Date: _____

Reviewed By: _____ Robert Varner

Date: 9/11/2014

Draft Report

**BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio**

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

PHONE: (601) 856-2332
FAX: (601) 856-3552

Mix ID Mix 13

Project No. 140241

Mix Date Monday, June 09, 2014

Mix Time: 1:51 PM

7 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	5.98	28.04	12.16	158340
6	6.03	28.51	12.27	160260
7	6.03	28.51	12.29	
8	5.98	28.13	12.25	
9	5.98	28.04	12.23	

Compressometer Calibration
 Pivot rod to yoke supports (0.01 in.) 4.95
 Longitudinal gage to yoke supports (0.01 in.) 5.40
 Longitudinal Gage length (0.01 in.) 8.00
Extensometer Calibration
 Hinge to mid yoke supports (0.01 in.) 3.91
 Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:
 Machine applied load (lbs.), **P**
 Longitudinal gage reading, **G_{long}**
 Longitudinal Strain, **ε_{long}**
 Transverse gage reading, **G_{tran}**
 Transverse Strain, **ε_{tran}**
 Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 63720

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data						40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ		P	G _{long}	G _{tran}	ε _{long}	ε _{tran}		σ	MOE (psi)	MOE (50,000 psi)
7	9300	0.00085	0.00010	0.000007	326	63720	0.00565	0.00070	0.00034	0.000052	2235	6633048.6	6.65E+06	0.15	
7	10770	0.00085	0.00000	0.000000	378	63720	0.00550	0.00060	0.00033	0.000044	2235	6661456.6	6.65E+06	0.16	
7	11520	0.00085	0.00015	0.000011	404	63720	0.00550	0.00080	0.00033	0.000059	2235	6567101.7	6.55E+06	0.17	
Average	10530	0.00085	0.00008	0.000006	369	63720	0.00555	0.00070	0.00033	0.000052	2235	6620535.6	6.60E+06	0.16	
8	12560	0.00085	0.00015	0.000011	446	63720	0.00500	0.00065	0.00030	0.000049	2265	7306563.3	7.30E+06	0.15	
8	11630	0.00085	0.00005	0.000004	413	63720	0.00495	0.00055	0.00030	0.000041	2265	7529807.3	7.55E+06	0.15	
8	12220	0.00085	0.00000	0.000000	434	63720	0.00495	0.00045	0.00030	0.000034	2265	7444520.6	7.45E+06	0.14	
Average	12137	0.00085	0.00007	0.000005	431	63720	0.00497	0.00055	0.00030	0.000041	2265	7426963.7	7.45E+06	0.15	
9	10770	0.00085	0.00005	0.000004	384	63720	0.00630	0.00060	0.00038	0.000045	2272	5781377.2	5.80E+06	0.13	
9	11080	0.00085	0.00000	0.000000	395	63720	0.00590	0.00060	0.00035	0.000045	2272	6201553.6	6.20E+06	0.15	
9	10830	0.00085	0.00000	0.000000	386	63720	0.00585	0.00055	0.00035	0.000041	2272	6293146.8	6.30E+06	0.14	
Average	10893	0.00085	0.00002	0.000001	388	63720	0.00602	0.00058	0.00036	0.000044	2272	6092025.9	6.10E+06	0.14	
Overall Average	11187	0.00085	0.00006	0.000004	396	63720	0.00551	0.00061	0.00033	0.000045	2258	6713175.1	6.70E+06	0.15	

Reported By: Scott Bivings

Date:

Reviewed By: Robert Varner

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 13

Project No. 140241

Mix Date Monday, June 09, 2014

Mix Time: 1:51 PM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	5.97	27.95	12.22	175500
12	6.01	28.32	12.27	177480
13	5.98	28.04	12.16	
14	6.01	28.37	12.33	
15	6.04	28.61	12.26	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 70596

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data						40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ		P	G _{long}	G _{tran}	ε _{long}	ε _{tran}		σ	MOE (psi)	MOE (50,000 psi)
13	10590	0.00085	0.00015	0.000011	378										
						70596	0.00680	0.00080	0.00041	0.000060	2518	6002479	6.00E+06	0.14	
13	11270	0.00085	0.00005	0.000004	402										
						70596	0.00670	0.00075	0.00040	0.000056	2518	6035665.5	6.05E+06	0.15	
13	10720	0.00085	0.00005	0.000004	382										
						70596	0.00675	0.00080	0.00040	0.000060	2518	6040116.2	6.05E+06	0.16	
Average	10860	0.00085	0.00008	0.000006	387										
						70596	0.00675	0.00078	0.00040	0.000058	2518	6026086.9	6.05E+06	0.15	
14	12250	0.00085	0.00010	0.000007	432										
						70596	0.00620	0.00070	0.00037	0.000052	2488	6413831.8	6.40E+06	0.14	
14	10470	0.00085	0.00010	0.000007	369										
						70596	0.00620	0.00070	0.00037	0.000052	2488	6609502.8	6.60E+06	0.14	
14	11430	0.00085	0.00005	0.000004	403										
						70596	0.00610	0.00065	0.00036	0.000048	2488	6627536.6	6.65E+06	0.14	
Average	11383	0.00085	0.00008	0.000006	401										
						70596	0.00617	0.00068	0.00037	0.000051	2488	6550290.4	6.55E+06	0.14	
15	12330	0.00085	0.00000	0.000000	431										
						70596	0.00580	0.00055	0.00035	0.000041	2468	6863134.8	6.85E+06	0.14	
15	10700	0.00085	0.00000	0.000000	374										
						70596	0.00595	0.00060	0.00036	0.000044	2468	6848181.4	6.85E+06	0.15	
15	11630	0.00085	0.00000	0.000000	407										
						70596	0.00590	0.00065	0.00035	0.000048	2468	6808421.6	6.80E+06	0.16	
Average	11553	0.00085	0.00000	0.000000	404										
						70596	0.00588	0.00060	0.00035	0.000044	2468	6839912.6	6.85E+06	0.15	
Overall Average	11266	0.00085	0.00006	0.000004	397										
						70596	0.00627	0.00069	0.00037	0.000051	2491	6472096.6	6.45E+06	0.14	

Reported By: Scott Bivings

Date:

Reviewed By: Robert Varner

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 13

Project No. 140241

Mix Date Monday, June 09, 2014

Mix Time: 1:51 PM

28 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	5.98	28.09	12.22	196610
18	5.98	28.04	12.21	197580
19	5.93	27.62	12.25	
20	6.04	28.61	12.24	
21	6.00	28.28	12.24	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 78838

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	10030	0.00085	0.00000	0.000000	363	78838	0.00735	0.00075	0.00044	0.000056	2854	6397597.1	6.40E+06	0.14
19	11490	0.00085	0.00010	0.000008	416	78838	0.00720	0.00080	0.00043	0.000060	2854	6409450.7	6.40E+06	0.14
19	11210	0.00085	0.00005	0.000004	406	78838	0.00715	0.00080	0.00043	0.000060	2854	6487067.9	6.50E+06	0.15
Average	10910	0.00085	0.00005	0.000004	395	78838	0.00723	0.00078	0.00043	0.000059	2854	6431371.9	6.45E+06	0.14
20	10360	0.00085	0.00015	0.000011	362	78838	0.00760	0.00125	0.00045	0.000092	2756	5919405.6	5.90E+06	0.20
20	10110	0.00085	0.00015	0.000011	353	78838	0.00760	0.00125	0.00045	0.000092	2756	5941016.2	5.95E+06	0.20
20	10860	0.00085	0.00005	0.000004	380	78838	0.00740	0.00120	0.00044	0.000089	2756	6055237.1	6.05E+06	0.22
Average	10443	0.00085	0.00012	0.000009	365	78838	0.00753	0.00123	0.00045	0.000091	2756	5971886.3	5.95E+06	0.21
21	12210	0.00085	0.00005	0.000004	432	78838	0.00630	0.00070	0.00038	0.000052	2788	7213079.6	7.20E+06	0.15
21	12500	0.00085	0.00010	0.000007	442	78838	0.00615	0.00075	0.00037	0.000056	2788	7384418.1	7.40E+06	0.15
21	11860	0.00085	0.00005	0.000004	419	78838	0.00620	0.00075	0.00037	0.000056	2788	7386157.8	7.40E+06	0.16
Average	12190	0.00085	0.00007	0.000005	431	78838	0.00622	0.00073	0.00037	0.000055	2788	7327885.1	7.35E+06	0.15
Overall Average	11181	0.00085	0.00008	0.000006	397	78838	0.00699	0.00092	0.00042	0.000068	2799	6577047.8	6.60E+06	0.17

Reported By: Scott Bivings

Date:

Reviewed By: Robert Varnar

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157 PHONE: (601) 856-2332
FAX: (601) 856-3552

Mix ID Mix 13 Project No. 140241

Mix Date Monday, June 09, 2014 Mix Time: 1:51 PM

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	6.01	28.32	12.21	204170
24	6.01	28.37	12.19	206790
25	5.99	28.13	12.22	
26	6.01	28.37	12.21	
27	5.96	27.85	12.17	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 82192 Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	12730	0.00085	0.00005	0.000004	453	82192	0.00705	0.00075	0.00042	0.000056	2922	6647477.2	6.65E+06	0.14
25	11890	0.00085	0.00010	0.000007	423	82192	0.00685	0.00080	0.00041	0.000060	2922	6951618.4	6.95E+06	0.15
25	11630	0.00085	0.00000	0.000000	413	82192	0.00680	0.00075	0.00041	0.000056	2922	7035826.7	7.05E+06	0.16
Average	12083	0.00085	0.00005	0.000004	430	82192	0.00690	0.00077	0.00041	0.000057	2922	6878307.4	6.90E+06	0.15
26	10900	0.00085	0.00005	0.000004	384	82192	0.00755	0.00070	0.00045	0.000052	2897	6261073.3	6.25E+06	0.12
26	11830	0.00085	0.00005	0.000004	417	82192	0.00680	0.00075	0.00041	0.000056	2897	6956532.6	6.95E+06	0.15
26	11730	0.00085	0.00005	0.000004	413	82192	0.00730	0.00075	0.00044	0.000056	2897	6427526.2	6.45E+06	0.13
Average	11487	0.00085	0.00005	0.000004	405	82192	0.00722	0.00073	0.00043	0.000054	2897	6548377.3	6.55E+06	0.13
27	12500	0.00085	0.00000	0.000000	449	82192	0.00745	0.00070	0.00045	0.000052	2951	6329108.7	6.35E+06	0.13
27	11760	0.00085	0.00005	0.000004	422	82192	0.00745	0.00080	0.00045	0.000060	2951	6396312.1	6.40E+06	0.14
27	12690	0.00085	0.00005	0.000004	456	82192	0.00735	0.00080	0.00044	0.000060	2951	6408755.9	6.40E+06	0.14
Average	12317	0.00085	0.00003	0.000002	442	82192	0.00742	0.00077	0.00044	0.000057	2951	6378058.9	6.40E+06	0.14
Overall Average	11962	0.00085	0.00004	0.000003	426	82192	0.00718	0.00076	0.00043	0.000056	2923	6601581.2	6.60E+06	0.14

Reported By: Scott Bivings Date:

Reviewed By: Robert Varnar Date: 9/11/2014

Draft Report

**BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS**

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 13

Mix Date Monday, June 09, 2014

Mix Time 1:51 PM

Set No: 13

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
49	10.0000	0.8120	0.8130	11.58150	1.6250	9.9565
50	10.0000	0.8115	0.8125	11.60650	1.6240	9.9825
51	10.0000	0.8135	0.8135	11.63150	1.6270	10.0045
52	10.0000	0.8140	0.8135	11.57300	1.6275	9.9455

SHRINKAGE TESTING - AASHTO T160

Specimen Age	Reference Bar Length (in.)	INITIAL READINGS													
		Specimen 49	Reference Bar 49	Δ Length 49	Specimen 50	Reference Bar 50	Δ Length 50	Specimen 51	Reference Bar 51	Δ Length 51	Specimen 52	Reference Bar 52	Δ Length 52	Average	
	10	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches	
1	Tuesday, June 10, 2014	0.0539	0.0979	-0.0440	0.0773	0.0979	-0.0206	0.1023	0.0979	0.0044	0.0438	0.0979	-0.0541	-0.0286	
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS													
		Specimen 49	Reference Bar 49	Δ Length 49	Specimen 50	Reference Bar 50	Δ Length 50	Specimen 51	Reference Bar 51	Δ Length 51	Specimen 52	Reference Bar 52	Δ Length 52	Average	
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)	
7	Monday, June 16, 2014	0.0537	0.0978	-0.0010	0.0772	0.0978	0.0000	0.1022	0.0978	0.0000	0.0437	0.0978	0.0000	-0.0002	
11	Friday, June 20, 2014	0.0530	0.0978	-0.0080	0.0765	0.0978	-0.0070	0.1014	0.0978	-0.0080	0.0429	0.0978	-0.0080	-0.0077	
14	Monday, June 23, 2014	0.0527	0.0977	-0.0100	0.0762	0.0977	-0.0090	0.1011	0.0977	-0.0100	0.0427	0.0977	-0.0090	-0.0095	
21	Monday, June 30, 2014	0.0525	0.0977	-0.0120	0.0760	0.0977	-0.0110	0.1007	0.0976	-0.0130	0.0423	0.0976	-0.0120	-0.0120	
35	Monday, July 14, 2014	0.0517	0.0975	-0.0180	0.0752	0.0974	-0.0160	0.1000	0.0974	-0.0180	0.0416	0.0974	-0.0170	-0.0173	
63	Monday, August 11, 2014	0.0509	0.0976	-0.0270	0.0747	0.0976	-0.0230	0.0994	0.0976	-0.0260	0.0410	0.0976	-0.0250	-0.0253	
119	Monday, October 06, 2014	0.0503	0.0975	-0.0320	0.0741	0.0975	-0.0280	0.0988	0.0975	-0.0310	0.0404	0.0975	-0.0300	-0.0303	
231	Monday, January 26, 2015	0.0495	0.0974	-0.0390	0.0734	0.0974	-0.0340	0.0982	0.0974	-0.0360	0.0397	0.0974	-0.0360	-0.0363	
455	Monday, September 07, 2015	0.0492	0.0971	-0.0390	0.0732	0.0971	-0.0330	0.0978	0.0971	-0.0370	0.0393	0.0971	-0.0370	-0.0365	
42	Calculated 35 Day Shrinkage			-0.0212			-0.0186			-0.0207			-0.0197	-0.0201	

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 10/12/2015

Draft Report

**BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS**

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 13 Set No: 13
Mix Date Monday, June 09, 2014
Mix Time 1:51 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
49	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
50	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
51	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
52	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

	Reference Bar Length (in.)	INITIAL READINGS												
	10	Specimen 49	Reference Bar 49	Δ Length 49	Specimen 50	Reference Bar 50	Δ Length 50	Specimen 51	Reference Bar 51	Δ Length 51	Specimen 52	Reference Bar 52	Δ Length 52	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
819	Monday, September 05, 2016	0.0487	0.0970	-0.0430	0.0728	0.0970	-0.0360	0.0974	0.0970	-0.0400	0.0389	0.0970	-0.0400	-0.0398
Reintroduce to Waterbath		LENGTH CHANGE CALCULATIONS												
		Specimen 49	Reference Bar 49	Δ Length 49	Specimen 50	Reference Bar 50	Δ Length 50	Specimen 51	Reference Bar 51	Δ Length 51	Specimen 52	Reference Bar 52	Δ Length 52	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
820	Tuesday, September 06, 2016	0.0502	0.0971	-0.0290	0.0744	0.0971	-0.0210	0.0986	0.0971	-0.0290	0.0402	0.0971	-0.0280	-0.0268
822	Thursday, September 08, 2016	0.0507	0.0970	-0.0230	0.0748	0.0970	-0.0160	0.0991	0.0970	-0.0230	0.0407	0.0970	-0.0220	-0.0210
826	Monday, September 12, 2016	0.0509	0.0970	-0.0210	0.0750	0.0970	-0.0140	0.0992	0.0970	-0.0220	0.0408	0.0970	-0.0210	-0.0195
833	Monday, September 19, 2016	0.0511	0.0971	-0.0200	0.0752	0.0971	-0.0130	0.0993	0.0971	-0.0220	0.0409	0.0971	-0.0210	-0.0190
847	Monday, October 03, 2016	0.0513	0.0971	-0.0180	0.0754	0.0971	-0.0110	0.0998	0.0971	-0.0170	0.0415	0.0971	-0.0150	-0.0153
854	Monday, October 10, 2016	0.0511	0.0971	-0.0200	0.0754	0.0971	-0.0110	0.0994	0.0971	-0.0210	0.0411	0.0971	-0.0190	-0.0178
875	Monday, October 31, 2016	0.0512	0.0968	-0.0160	0.0757	0.0968	-0.0050	0.0996	0.0968	-0.0160	0.0413	0.0968	-0.0140	-0.0127
934	Thursday, December 29, 2016	0.0515	0.0968	-0.0130	0.0754	0.0968	-0.0080	0.0999	0.0968	-0.0130	0.0415	0.0968	-0.0120	-0.0115

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:				
Customer: MDOT		Project: SP-9999-09(110)/106812-101000				Lab #: BCD								
MIX NUMBER		Mix 14.1				Set #: 14								
Date: 6/12/2014		Mix Code: Mix 14		f'c: 3,500 psi		Size(c.f.): 6.25		Factor: 0.23						
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorp- tion	Agg. FM	Roller Meter Air 3.75				
Cement 1:	2.09	411.00	95.14	95.14	95.14	Type II Cement	3.15			Coarseness and Workability (volume)				
Cement 2:	0.00	0.00	0.00	0.00			0.00			Cumulative % retained on 3/8" 57.33				
Fly Ash:	1.01	137.00	31.71	31.71	31.71	Class F Fly Ash	2.18			Cumulative % retained on No 8 66.50				
Slag:	0.00	0.00	0.00	0.00			0.00			Cumulative % passing No 8 33.27				
Sand 1:	6.79	1117.46	258.67	269.35	269.35	Sand	2.636	0.52%	2.36	Coarseness Factor 86.20				
Coarse Aggregate 1:	12.65	2031.00	470.14	470.37	470.37	CA_ID4 - 57 Gravel Low Absorption	2.572	1.42%	7.30	Workability Factor 33.27				
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%		Adjusted Workability Factor 32.84				
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%						
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%						
Air:	4.50%	1.22	0.00	0.00										
Water:	3.34	208.33	48.22	37.31	37.31		1.00							
"-Air:	0.50%													
Total:	27.10	3904.79	903.89	903.89										
UW w/o Air:		150.85	151.44	151.44										
ADMIX INFORMATION							Aggregate Moistures							
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)						
Air	0.90	4.9	145.9	33.8	35.0	Hunt Process - AIR-IN-XT	Sand: 4.15%	10.68						
Water Reducer	5.00	27.4	810.3	187.6	187.6	Hunt Process - HPS-R	CA 1: 0.05%	0.23						
							CA 2: 0.00%	0.00						
							CA 3: 0.00%	0.00						
							CA 4: 0.00%	0.00						
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.						
Batch Time	2:45 PM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4							
Sample Time	2:54 PM		34.93	65.07	0	0	0							
Slump, in.	2.75	2 in.	0.0	0.0	0.0	0.0	0.0							
Mix Temp.	79.0	1.5 in.	0.0	0.0	0.0	0.0	0.0							
Air Temp.	91.3	1.0 in.	0.0	19.8	0.0	0.0	0.0							
ACF Air %	4.5	3/4 in.	0.0	24.8	0.0	0.0	0.0							
Unit Weight (pcf)	145.00	1/2 in.	0.0	29.3	0.0	0.0	0.0							
Design Unit Wt.	144.09	3/8 in.	0.0	14.2	0.0	0.0	0.0							
Yield	6.23	No. 4	0.4	10.0	0.0	0.0	0.0							
Relative Yield	1.00	No. 8	4.5	1.5	0.0	0.0	0.0							
Design w/c	0.380	No. 16	8.4	0.1	0.0	0.0	0.0							
Actual w/c	0.380	No. 30	17.0	0.0	0.0	0.0	0.0							
Fine/Coarse	0.55	No. 50	57.8	0.1	0.0	0.0	0.0							
Bag Factor	5.83	No. 100	11.3	0.0	0.0	0.0	0.0							
Theoretical Air (%)	3.88	Pan	0.2	0.1	0.0	0.0	0.0							

Draft Report

BURNS COOLEY DENNIS, INC.
 CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
 AASHTO T97 Flexural Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID: _____ Mix 14

BDC Project NO. 140241

Made Date: _____ Thursday, June 12, 2014

Specimen No.	Specimen Age	Test Date	Depth 1 (0.05 in)	Depth 2 (0.05 in)	Depth 3 (0.05 in)	Avg Depth (in.)	Width 1 (0.05 in)	Width 2 (0.05 in)	Width 3 (0.05 in)	Avg Width (in.)	Max Load	Flex Strength (psi)	Avg (psi)
29	7	6/19/2014	6.10	6.15	6.10	6.12	6.05	6.05	6.05	6.05	8860	704	690
30	7	6/19/2014	6.05	6.10	6.10	6.08	6.00	5.95	6.00	5.98	8300	676	
31	7	6/19/2014	6.10	6.10	6.10	6.10	6.00	6.00	6.05	6.02	8590	690	
32	14	6/26/2014	6.05	6.05	6.05	6.05	5.90	5.95	6.00	5.95	10480	866	815
33	14	6/26/2014	6.05	6.10	6.10	6.08	6.10	6.10	6.10	6.10	9720	776	
34	14	6/26/2014	6.10	6.10	6.15	6.12	5.95	5.90	6.00	5.95	10020	809	
35	28	7/10/2014	6.05	6.05	6.05	6.05	5.95	5.95	5.95	5.95	10240	846	850
36	28	7/10/2014	6.10	6.10	6.10	6.10	6.00	6.00	6.05	6.02	10200	820	
37	28	7/10/2014	6.10	6.10	6.05	6.08	5.95	5.90	5.95	5.93	10780	885	
38	90	9/10/2014	6.05	6.05	6.00	6.03	6.00	6.00	6.00	6.00	11720	967	975
39	90	9/10/2014	6.05	6.05	6.05	6.05	6.00	6.00	6.05	6.02	12290	1004	
40	90	9/10/2014	6.05	6.05	6.05	6.05	6.00	6.00	6.05	6.02	11720	957	

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Varner _____

Date: 9/11/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 14

Project No. _____ 140241

Mix Date _____ Thursday, June 12, 2014

Mix Time: _____ 2:45 PM

7 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	6.04	28.61	12.22	135590
6	6.01	28.37	12.36	134480
7	6.04	28.65	12.23	
8	6.03	28.51	12.23	
9	6.02	28.46	12.24	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) _____ 4.95

Longitudinal gage to yoke supports (0.01 in.) _____ 5.40

Longitudinal Gage length (0.01 in.) _____ 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) _____ 3.91

Transverse gage to mid yoke supports (0.01 in.) _____ 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) _____ 54014

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) _____ 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
7	10070	0.00085	0.00000	0.000000	351	54014	0.00540	0.00050	0.00032	0.000037	1885	5621977	5.60E+06	0.14
7	9930	0.00085	0.00000	0.000000	347	54014	0.00550	0.00050	0.00033	0.000037	1885	5518954.6	5.50E+06	0.13
7	9170	0.00085	0.00000	0.000000	320	54014	0.00555	0.00050	0.00033	0.000037	1885	5554548.7	5.55E+06	0.13
Average	9723	0.00085	0.00000	0.000000	339	54014	0.00548	0.00050	0.00033	0.000037	1885	5565160.1	5.55E+06	0.13
8	11140	0.00085	0.00000	0.000000	391	54014	0.00490	0.00045	0.00029	0.000033	1895	6190234.3	6.20E+06	0.14
8	10080	0.00085	0.00000	0.000000	354	54014	0.00455	0.00050	0.00027	0.000037	1895	6941115.8	6.95E+06	0.17
8	9000	0.00085	0.00000	0.000000	316	54014	0.00515	0.00045	0.00031	0.000033	1895	6122545.1	6.10E+06	0.13
Average	10073	0.00085	0.00000	0.000000	353	54014	0.00487	0.00047	0.00029	0.000035	1895	6417965.1	6.40E+06	0.14
9	11940	0.00085	0.00005	0.000004	420	54014	0.00500	0.00060	0.00030	0.000044	1898	5939245.2	5.95E+06	0.16
9	12510	0.00085	0.00005	0.000004	440	54014	0.00475	0.00055	0.00028	0.000041	1898	6233037.3	6.25E+06	0.16
9	10240	0.00085	0.00000	0.000000	360	54014	0.00515	0.00065	0.00031	0.000048	1898	5964347.6	5.95E+06	0.19
Average	11563	0.00085	0.00003	0.000002	406	54014	0.00497	0.00060	0.00030	0.000044	1898	6045543.3	6.05E+06	0.17
Overall Average	10453	0.00085	0.00001	0.000001	366	54014	0.00511	0.00052	0.00031	0.000039	1893	6009556.2	6.00E+06	0.15

Reported By: _____ Scott Bivings

Date: _____

Reviewed By: _____ Robert Vamer

Date: _____ 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 14

Project No. 140241

Mix Date Thursday, June 12, 2014

Mix Time: 2:45 PM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	6.03	28.56	12.33	160830
12	6.02	28.42	12.23	161670
13	6.05	28.7	12.24	
14	6.03	28.56	12.25	
15	6.02	28.46	12.27	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 64500

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	11550	0.00085	0.00005	0.000004	402	64500	0.00640	0.00055	0.00038	0.000041	2247	5546901.7	5.55E+06	0.11
13	10850	0.00085	0.00010	0.000007	378	64500	0.00645	0.00060	0.00039	0.000044	2247	5570173.1	5.55E+06	0.11
13	11230	0.00085	0.00010	0.000007	391	64500	0.00640	0.00060	0.00038	0.000044	2247	5580424	5.60E+06	0.11
Average	11210	0.00085	0.00008	0.000006	391	64500	0.00642	0.00058	0.00038	0.000043	2247	5565832.9	5.55E+06	0.11
14	10580	0.00085	0.00005	0.000004	370	64500	0.00635	0.00060	0.00038	0.000044	2258	5727679.4	5.75E+06	0.12
14	10060	0.00085	0.00015	0.000011	352	64500	0.00655	0.00075	0.00039	0.000056	2258	5580491.5	5.60E+06	0.13
14	10660	0.00085	0.00010	0.000007	373	64500	0.00650	0.00065	0.00039	0.000048	2258	5567710.2	5.55E+06	0.12
Average	10433	0.00085	0.00010	0.000007	365	64500	0.00647	0.00067	0.00039	0.000049	2258	5625293.7	5.65E+06	0.12
15	11450	0.00085	0.00015	0.000011	402	64500	0.00645	0.00070	0.00039	0.000052	2266	5554325.8	5.55E+06	0.12
15	10870	0.00085	0.00000	0.000000	382	64500	0.00610	0.00075	0.00036	0.000056	2266	5988418.7	6.00E+06	0.18
15	10360	0.00085	0.00010	0.000007	364	64500	0.00665	0.00070	0.00040	0.000052	2266	5473443.4	5.45E+06	0.13
Average	10893	0.00085	0.00008	0.000006	383	64500	0.00640	0.00072	0.00038	0.000053	2266	5672062.7	5.65E+06	0.14
Overall Average	10846	0.00085	0.00009	0.000007	380	64500	0.00643	0.00066	0.00038	0.000049	2257	5621063.1	5.60E+06	0.13

Reported By: Scott Bivings

Date:

Reviewed By: Robert Varner

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 14

Project No. 140241

Mix Date Thursday, June 12, 2014

Mix Time: 2:45 PM

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	6.01	28.37	12.28	229800
24	6.05	28.75	12.24	235180
25	6.02	28.46	12.30	
26	6.02	28.46	12.34	
27	6.01	28.37	12.24	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 92996

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data						40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ		P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	11740	0.00085	0.00005	0.000004	413	92996	0.00740	0.00080	0.00044	0.000059	3268	7276142.1	7.30E+06	0.14	
25	12720	0.00085	0.00005	0.000004	447	92996	0.00735	0.00080	0.00044	0.000059	3268	7243566.6	7.25E+06	0.14	
25	12380	0.00085	0.00010	0.000007	435	92996	0.00740	0.00080	0.00044	0.000059	3268	7218832.7	7.20E+06	0.13	
Average	12280	0.00085	0.00007	0.000005	431	92996	0.00738	0.00080	0.00044	0.000059	3268	7246180.4	7.25E+06	0.14	
26	12340	0.00085	0.00000	0.000000	434	92996	0.00800	0.00080	0.00048	0.000059	3268	6617491.5	6.60E+06	0.14	
26	12460	0.00085	0.00005	0.000004	438	92996	0.00790	0.00085	0.00047	0.000063	3268	6701190.5	6.70E+06	0.14	
26	12850	0.00085	0.00000	0.000000	452	92996	0.00780	0.00085	0.00047	0.000063	3268	6764504.8	6.75E+06	0.15	
Average	12550	0.00085	0.00002	0.000001	441	92996	0.00790	0.00083	0.00047	0.000062	3268	6694395.6	6.70E+06	0.14	
27	12480	0.00085	0.00000	0.000000	440	92996	0.00800	0.00080	0.00048	0.000059	3278	6626961.7	6.65E+06	0.14	
27	12030	0.00085	0.00000	0.000000	424	92996	0.00800	0.00080	0.00048	0.000059	3278	6663999.5	6.65E+06	0.14	
27	11590	0.00085	0.00005	0.000004	409	92996	0.00815	0.00085	0.00049	0.000063	3278	6562795.2	6.55E+06	0.14	
Average	12033	0.00085	0.00002	0.000001	424	92996	0.00805	0.00082	0.00048	0.000061	3278	6617918.8	6.60E+06	0.14	
Overall Average	12288	0.00085	0.00003	0.000002	432	92996	0.00778	0.00082	0.00046	0.000061	3271	6852831.6	6.85E+06	0.14	

Reported By: Scott Bivings

Date:

Reviewed By: Robert Vamer

Date: 9/11/2014

Draft Report

**BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS**

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 14 Set No: 14
Mix Date Thursday, June 12, 2014
Mix Time 2:45 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
53	10.0000	0.8155	0.8140	11.57900	1.6295	9.9495
54	10.0000	0.8130	0.8130	11.60450	1.6260	9.9785
55	10.0000	0.8125	0.8125	11.60800	1.6250	9.9830
56	10.0000	0.8125	0.8125	11.59450	1.6250	9.9695

SHRINKAGE TESTING - AASHTO T160

	Reference Bar Length (in.)	INITIAL READINGS												
	10	Specimen 53	Reference Bar 53	Δ Length 53	Specimen 54	Reference Bar 54	Δ Length 54	Specimen 55	Reference Bar 55	Δ Length 55	Specimen 56	Reference Bar 56	Δ Length 56	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Friday, June 13, 2014	0.0517	0.0979	-0.0462	0.0764	0.0979	-0.0215	0.0797	0.0979	-0.0182	0.0699	0.0979	-0.0280	-0.0285
		LENGTH CHANGE CALCULATIONS												
Moisture Cure for 7 Days		Specimen 53	Reference Bar 53	Δ Length 53	Specimen 54	Reference Bar 54	Δ Length 54	Specimen 55	Reference Bar 55	Δ Length 55	Specimen 56	Reference Bar 56	Δ Length 56	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
7	Thursday, June 19, 2014	0.0517	0.0978	0.0010	0.0765	0.0978	0.0020	0.0797	0.0978	0.0010	0.0699	0.0978	0.0010	0.0013
11	Monday, June 23, 2014	0.0510	0.0976	-0.0040	0.0759	0.0976	-0.0020	0.0790	0.0976	-0.0040	0.0692	0.0976	-0.0040	-0.0035
14	Thursday, June 26, 2014	0.0507	0.0977	-0.0080	0.0755	0.0977	-0.0070	0.0788	0.0977	-0.0070	0.0689	0.0977	-0.0080	-0.0075
21	Thursday, July 03, 2014	0.0503	0.0976	-0.0110	0.0751	0.0976	-0.0100	0.0784	0.0976	-0.0100	0.0685	0.0976	-0.0110	-0.0105
35	Thursday, July 17, 2014	0.0498	0.0976	-0.0160	0.0746	0.0976	-0.0150	0.0780	0.0976	-0.0140	0.0679	0.0976	-0.0170	-0.0155
63	Thursday, August 14, 2014	0.0491	0.0976	-0.0230	0.0741	0.0976	-0.0200	0.0774	0.0976	-0.0200	0.0672	0.0976	-0.0240	-0.0218
119	Thursday, October 09, 2014	0.0487	0.0975	-0.0260	0.0736	0.0975	-0.0240	0.0768	0.0975	-0.0250	0.0667	0.0975	-0.0280	-0.0258
231	Thursday, January 29, 2015	0.0482	0.0975	-0.0310	0.0732	0.0975	-0.0280	0.0764	0.0974	-0.0280	0.0663	0.0974	-0.0310	-0.0295
455	Thursday, September 10, 2015	0.0478	0.0971	-0.0310	0.0727	0.0971	-0.0290	0.0760	0.0971	-0.0290	0.0659	0.0971	-0.0320	-0.0303
42	Calculated 35 Day Shrinkage			-0.0181			-0.0165			-0.0165			-0.0191	-0.0175

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 10/12/2015

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 14
Mix Date Thursday, June 12, 2014
Mix Time 2:45 PM

Set No: 14

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
53	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
54	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
55	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
56	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

Reference Bar Length (in.)		INITIAL READINGS													
		Specimen 53	Reference Bar 53	Δ Length 53	Specimen 54	Reference Bar 54	Δ Length 54	Specimen 55	Reference Bar 55	Δ Length 55	Specimen 56	Reference Bar 56	Δ Length 56	Average	
10		(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches	
Specimen Age	Test date	0.0473	0.0970	-0.0350	0.0723	0.0970	-0.0320	0.0755	0.0970	-0.0330	0.0655	0.0970	-0.0350	-0.0338	
819	Thursday, September 08, 2016														
Reintroduce to Waterbath		LENGTH CHANGE CALCULATIONS													
		Specimen 53	Reference Bar 53	Δ Length 53	Specimen 54	Reference Bar 54	Δ Length 54	Specimen 55	Reference Bar 55	Δ Length 55	Specimen 56	Reference Bar 56	Δ Length 56	Average	
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001%)	
820	Friday, September 09, 2016	0.0483	0.0971	-0.0260	0.0732	0.0971	-0.0240	0.0765	0.0971	-0.0240	0.0665	0.0971	-0.0260	-0.0250	
823	Monday, September 12, 2016	0.0489	0.0971	-0.0200	0.0736	0.0971	-0.0200	0.0771	0.0971	-0.0180	0.0671	0.0971	-0.0200	-0.0195	
826	Thursday, September 15, 2016	0.0490	0.0971	-0.0190	0.0739	0.0971	-0.0170	0.0771	0.0971	-0.0180	0.0671	0.0971	-0.0200	-0.0185	
833	Thursday, September 22, 2016	0.0493	0.0971	-0.0160	0.0740	0.0971	-0.0160	0.0773	0.0971	-0.0160	0.0673	0.0971	-0.0180	-0.0165	
847	Thursday, October 06, 2016	0.0488	0.0971	-0.0210	0.0739	0.0971	-0.0170	0.0770	0.0971	-0.0190	0.0671	0.0971	-0.0200	-0.0193	
854	Thursday, October 13, 2016	0.0491	0.0971	-0.0180	0.0742	0.0971	-0.0140	0.0774	0.0971	-0.0150	0.0673	0.0971	-0.0180	-0.0163	
875	Thursday, November 03, 2016	0.0492	0.0969	-0.0150	0.0742	0.0969	-0.0120	0.0774	0.0969	-0.0130	0.0673	0.0969	-0.0160	-0.0140	
931	Thursday, December 29, 2016	0.0494	0.0968	-0.0120	0.0743	0.0968	-0.0100	0.0776	0.0968	-0.0100	0.0676	0.0968	-0.0120	-0.0110	

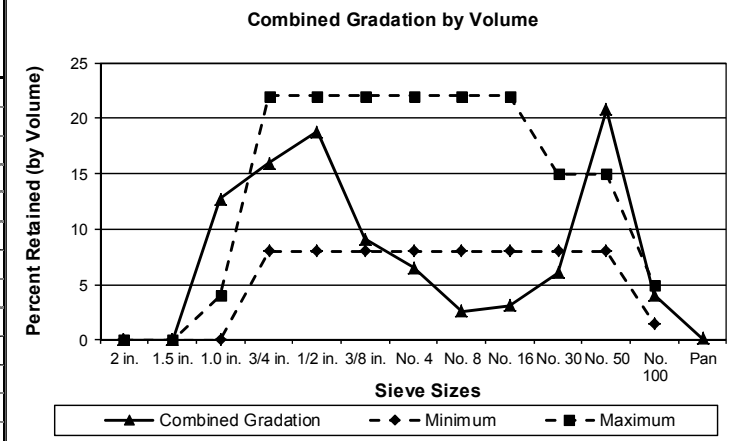
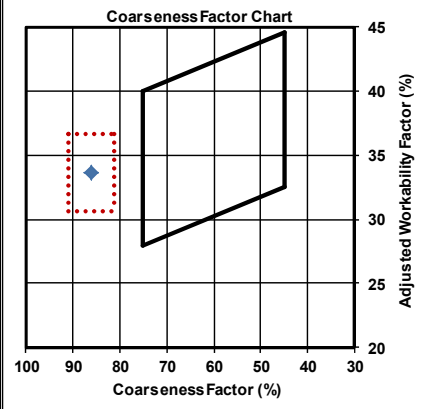
Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: _____

Draft Report

BCD 140241										Notes:	
Customer:	MDOT		Project:	SP-9999-09(110)/106812-101000				Lab #:	BCD		
MIX NUMBER	Mix 15.1						Set #:	15			
Date:	6/16/2014	Mix Code:	Mix 15	f.c.:	3,500 psi	Size(c.f.):	6.25	Factor:	0.23		
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorption	Agg. FM		
Material	Vol. (c.f.)								Roller Meter Air 4.25		
Cement 1:	2.09	411.00	95.14	95.14	95.14	Type I-II Cement	3.15		Coarseness and Workability (volume) Cumulative % retained on 3/8" 56.56 Cumulative % retained on No 8 65.68 Cumulative % passing No 8 34.09 Coarseness Factor 86.12 Workability Factor 34.09 Adjusted Workability Factor 33.66		
Cement 2:	0.00	0.00	0.00	0.00			0.00				
Fly Ash:	0.84	137.00	31.71	31.71	31.71	Class C Fly Ash	2.60				
Slag:	0.00	0.00	0.00	0.00			0.00				
Sand 1:	7.06	1160.70	268.68	278.46	278.46	Sand	2.636	0.52%	2.36		
Coarse Aggregate 1:	12.65	2031.00	470.14	470.37	470.37	CA_ID4 - 57 Gravel Low Absorption	2.572	1.42%	7.30		
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%			
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%			
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%			
Air:	4.50%	1.22	0.00	0.00							
Water:	3.14	195.83	45.33	35.32	35.32		1.00				
"+-Air:	0.50%										
Total:	27.00	3935.53	911.00	911.00							
UW w/o Air:		152.63	152.63	152.63							
ADMIX INFORMATION							Aggregate Moistures				
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)			
Air	0.50	2.7	81.0	18.8	18.8	Air	Sand:	3.66%	9.78		
Water Reducer	5.00	27.4	810.3	187.6	187.6	Water Reducer	CA 1	0.05%	0.23		
							CA 2	0.00%	0.00		
							CA 3	0.00%	0.00		
							CA 4	0.00%	0.00		
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.			
Batch Time	1:21 PM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4				
Sample Time	1:30 PM		35.8	64.2	0	0	0				
Slump, in.	2.25	2 in.	0.0	0.0	0.0	0.0	0.0	0.0			
Mix Temp.	82.0	1.5 in.	0.0	0.0	0.0	0.0	0.0	0.0			
Air Temp.	91.0	1.0 in.	0.0	19.8	0.0	0.0	0.0	12.7			
ACF Air %	5.1	3/4 in.	0.0	24.8	0.0	0.0	0.0	15.9			
Unit Weight (pcf)	145.40	1/2 in.	0.0	29.3	0.0	0.0	0.0	18.8			
Design Unit Wt.	145.76	3/8 in.	0.0	14.2	0.0	0.0	0.0	9.1			
Yield	6.27	No. 4	0.4	10.0	0.0	0.0	0.0	6.5			
Relative Yield	1.00	No. 8	4.5	1.5	0.0	0.0	0.0	2.6			
Design w/c	0.357	No. 16	8.4	0.1	0.0	0.0	0.0	3.1			
Actual w/c	0.357	No. 30	17.0	0.0	0.0	0.0	0.0	6.1			
Fine/Coarse	0.57	No. 50	57.8	0.1	0.0	0.0	0.0	20.8			
Bag Factor	5.83	No. 100	11.3	0.0	0.0	0.0	0.0	4.1			
Theoretical Air (%)	4.74	Pan	0.2	0.1	0.0	0.0	0.0	0.1			



Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
 Fax: (601) 856-3552

Mix ID: _____ Mix 15

BDC Project NO. 140241

Made Date: _____ Monday, June 16, 2014

COMPRESSION TESTS RESULTS

Specimen Age	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	6/23/2014	6.03	6.03	12.05	12.05	12.10	29.66	148.73	28.56	166440	5828	3	5990
6	7	6/23/2014	6.03	6.04	12.05	12.05	12.10	29.59	148.13	28.61	174480	6099	3	
7	7	6/23/2014	6.06	6.06	12.10	12.10	12.10	29.75	147.30	28.84	167880	5821	3	
8	7	6/23/2014	6.05	6.04	12.15	12.15	12.15	29.92	148.26	28.7	175350	6110	3	
9	7	6/23/2014	5.99	6.02	12.10	12.10	12.10	29.60	149.25	28.32	172660	6097	3	
11	14	6/30/2014	6.01	6.04	12.10	12.15	12.15	29.89	149.30	28.51	182270	6393	4	6760
12	14	6/30/2014	6.00	5.96	12.05	11.95	12.05	29.08	148.88	28.09	205380	7311	4	
13	14	6/30/2014	6.00	6.02	12.05	12.05	12.00	29.19	147.75	28.37	194460	6854	4	
14	14	6/30/2014	6.02	6.02	12.10	12.10	12.05	29.84	149.92	28.46	185420	6515	5	
15	14	6/30/2014	6.05	6.07	12.10	12.10	12.10	29.63	146.70	28.84	193340	6704	3	
17	28	7/14/2014	5.96	6.00	12.00	11.95	12.00	28.85	148.12	28.09	221260	7877	3	7620
18	28	7/14/2014	6.02	6.01	12.10	12.10	12.05	29.57	148.81	28.42	195270	6871	3	
19	28	7/14/2014	5.98	5.96	11.95	11.95	11.95	28.72	148.36	27.99	218040	7790	3	
20	28	7/14/2014	6.02	6.02	12.00	12.05	12.10	29.60	149.13	28.46	218380	7673	3	
21	28	7/14/2014	6.03	6.03	12.10	12.10	12.10	29.73	148.67	28.56	224890	7874	3	
23	90	9/14/2014	6.01	6.02	12.05	12.05	12.05	29.66	149.68	28.42	249420	8776	3	8530
24	90	9/14/2014	6.04	6.01	12.15	12.15	12.15	29.78	148.55	28.51	243260	8532	3	
25	90	9/14/2014	6.03	6.03	12.10	12.10	12.10	29.68	148.42	28.56	239970	8402	3	
26	90	9/14/2014	6.02	5.99	12.05	12.05	12.05	29.60	149.87	28.32	247450	8738	4	
27	90	9/14/2014	6.03	6.01	12.05	12.10	12.10	29.63	148.86	28.46	233630	8209	3	

Reported By: _____ Scott Bivings _____ Date: _____

Reviewed By: _____ Robert Vamer _____ Date: 9/17/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 15

Project No. 140241

Mix Date Monday, June 16, 2014

Mix Time: 1:21 PM

7 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	6.03	28.56	12.28	166440
6	6.04	28.61	12.24	174480
7	6.06	28.84	12.28	
8	6.05	28.70	12.29	
9	6.01	28.32	12.28	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 68184

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
7	11660	0.00085	0.00005	0.000004	404	68184	0.00625	0.00065	0.00037	0.000048	2364	6055830.2	6.05E+06	0.14
7	10120	0.00085	0.00000	0.000000	351	68184	0.00635	0.00050	0.00038	0.000037	2364	6107995.6	6.10E+06	0.11
7	10880	0.00085	0.00005	0.000004	377	68184	0.00630	0.00040	0.00038	0.000029	2364	6083213.1	6.10E+06	0.08
Average	10887	0.00085	0.00003	0.000002	377	68184	0.00630	0.00052	0.00038	0.000038	2364	6082346.3	6.10E+06	0.11
8	12720	0.00085	0.00000	0.000000	443	68184	0.00575	0.00050	0.00034	0.000037	2376	6578871.7	6.60E+06	0.13
8	11670	0.00085	0.00000	0.000000	407	68184	0.00600	0.00055	0.00036	0.000041	2376	6378868.3	6.40E+06	0.13
8	11290	0.00085	0.00005	0.000004	393	68184	0.00590	0.00055	0.00035	0.000041	2376	6548580.9	6.55E+06	0.12
Average	11893	0.00085	0.00002	0.000001	414	68184	0.00588	0.00053	0.00035	0.000039	2376	6502107	6.50E+06	0.13
9	8710	0.00085	0.00000	0.000000	308	68184	0.00545	0.00055	0.00033	0.000041	2408	7614049.1	7.60E+06	0.15
9	10980	0.00085	0.00000	0.000000	388	68184	0.00515	0.00060	0.00031	0.000045	2408	7832758.8	7.85E+06	0.17
9	10280	0.00085	0.00000	0.000000	363	68184	0.00515	0.00060	0.00031	0.000045	2408	7928607.6	7.95E+06	0.17
Average	9990	0.00085	0.00000	0.000000	353	68184	0.00525	0.00058	0.00031	0.000043	2408	7791805.2	7.80E+06	0.16
Overall Average	10923	0.00085	0.00002	0.000001	382	68184	0.00581	0.00054	0.00035	0.000040	2383	6792086.2	6.80E+06	0.13

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 15 _____

Project No. _____ 140241 _____

Mix Date _____ Monday, June 16, 2014 _____

Mix Time: _____ 1:21 PM _____

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	6.03	28.51	12.30	182270
12	5.98	28.09	12.20	205380
13	6.01	28.37	12.21	
14	6.02	28.46	12.25	
15	6.06	28.84	12.27	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) _____ 4.95 _____

Longitudinal gage to yoke supports (0.01 in.) _____ 5.40 _____

Longitudinal Gage length (0.01 in.) _____ 8.00 _____

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) _____ 3.91 _____

Transverse gage to mid yoke supports (0.01 in.) _____ 4.85 _____

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) _____ 77530 _____

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) _____ 0.00084 _____

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	11760	0.00085	0.00010	0.000007	415	77530	0.00650	0.00085	0.00039	0.000063	2733	6846967.8	6.85E+06	0.16
13	11880	0.00085	0.00000	0.000000	419	77530	0.00650	0.00045	0.00039	0.000033	2733	6834475.2	6.85E+06	0.10
13	11100	0.00085	0.00005	0.000004	391	77530	0.00675	0.00030	0.00040	0.000022	2733	6623315.4	6.60E+06	0.05
Average	11580	0.00085	0.00005	0.000004	408	77530	0.00658	0.00053	0.00039	0.000040	2733	6768252.8	6.75E+06	0.11
14	11770	0.00085	0.00015	0.000011	414	77530	0.00705	0.00085	0.00042	0.000063	2724	6220226.7	6.20E+06	0.14
14	10860	0.00085	0.00000	0.000000	382	77530	0.00720	0.00050	0.00043	0.000037	2724	6157654.9	6.15E+06	0.10
14	12190	0.00085	0.00010	0.000007	428	77530	0.00700	0.00085	0.00042	0.000063	2724	6230635.8	6.25E+06	0.15
Average	11607	0.00085	0.00008	0.000006	408	77530	0.00708	0.00073	0.00042	0.000054	2724	6202839.1	6.20E+06	0.13
15	11640	0.00085	0.00005	0.000004	404	77530	0.00650	0.00060	0.00039	0.000044	2688	6747673	6.75E+06	0.12
15	10520	0.00085	0.00000	0.000000	365	77530	0.00660	0.00035	0.00039	0.000026	2688	6743306.9	6.75E+06	0.07
15	10350	0.00085	0.00000	0.000000	359	77530	0.00660	0.00060	0.00039	0.000044	2688	6760414.3	6.75E+06	0.13
Average	10837	0.00085	0.00002	0.000001	376	77530	0.00657	0.00052	0.00039	0.000038	2688	6750464.7	6.75E+06	0.11
Overall Average	11341	0.00085	0.00005	0.000004	397	77530	0.00674	0.00059	0.00040	0.000044	2715	6573852.2	6.55E+06	0.11

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Vamer _____

Date: _____ 8/29/2014 _____

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 15

Project No. 140241

Mix Date Monday, June 16, 2014

Mix Time: 1:21 PM

28 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	5.98	28.09	12.14	221260
18	6.02	28.42	12.29	195270
19	5.97	27.99	12.13	
20	6.02	28.46	12.24	
21	6.03	28.56	12.21	

Compressometer Calibration
 Pivot rod to yoke supports (0.01 in.) 4.95
 Longitudinal gage to yoke supports (0.01 in.) 5.40
 Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration
 Hinge to mid yoke supports (0.01 in.) 3.91
 Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:
 Machine applied load (lbs.), **P**
 Longitudinal gage reading, **G_{long}**
 Longitudinal Strain, **ε_{long}**
 Transverse gage reading, **G_{tran}**
 Transverse Strain, **ε_{tran}**
 Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 83306

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	12410	0.00085	0.00005	0.000004	443	83306	0.00755	0.00085	0.00045	0.000064	2976	6310825.3	6.30E+06	0.15
19	11950	0.00085	0.00005	0.000004	427	83306	0.00740	0.00095	0.00044	0.000071	2976	6496930.5	6.50E+06	0.17
19	11400	0.00085	0.00015	0.000011	407	83306	0.00735	0.00100	0.00044	0.000075	2976	6597264	6.60E+06	0.16
Average	11920	0.00085	0.00008	0.000006	426	83306	0.00743	0.00093	0.00044	0.000070	2976	6468339.9	6.45E+06	0.16
20	13220	0.00085	0.00010	0.000007	465	83306	0.00715	0.00090	0.00043	0.000067	2927	6524420.6	6.50E+06	0.16
20	11120	0.00085	0.00010	0.000007	391	83306	0.00740	0.00120	0.00044	0.000089	2927	6463960.7	6.45E+06	0.21
20	11100	0.00085	0.00005	0.000004	390	83306	0.00735	0.00090	0.00044	0.000067	2927	6515384	6.50E+06	0.16
Average	11813	0.00085	0.00008	0.000006	415	83306	0.00730	0.00100	0.00044	0.000074	2927	6501255.1	6.50E+06	0.18
21	13630	0.00085	0.00010	0.000007	477	83306	0.00645	0.00105	0.00039	0.000078	2917	7269522.2	7.25E+06	0.21
21	15650	0.00085	0.00015	0.000011	548	83306	0.00635	0.00105	0.00038	0.000078	2917	7186792.9	7.20E+06	0.20
21	14130	0.00085	0.00000	0.000000	495	83306	0.00695	0.00105	0.00042	0.000078	2917	6627088.6	6.65E+06	0.21
Average	14470	0.00085	0.00008	0.000006	507	83306	0.00658	0.00105	0.00039	0.000078	2917	7027801.3	7.05E+06	0.21
Overall Average	12734	0.00085	0.00008	0.000006	449	83306	0.00711	0.00099	0.00042	0.000074	2940	6665798.8	6.65E+06	0.18

Reported By: Scott Bivings

Date:

Reviewed By: Robert Vamer

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 15

Project No. 140241

Mix Date Monday, June 16, 2014

Mix Time: 1:21 PM

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	6.02	28.42	12.23	249420
24	6.03	28.51	12.36	243260
25	6.03	28.56	12.29	
26	6.01	28.32	12.20	
27	6.02	28.46	12.24	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 98536

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	12570	0.00085	0.00000	0.000000	440	98536	0.00800	0.00090	0.00048	0.000067	3450	7028459.1	7.05E+06	0.16
25	11440	0.00085	0.00000	0.000000	401	98536	0.00800	0.00095	0.00048	0.000070	3450	7120846.3	7.10E+06	0.16
25	11290	0.00085	0.00000	0.000000	395	98536	0.00800	0.00095	0.00048	0.000070	3450	7133110.1	7.15E+06	0.16
Average	11767	0.00085	0.00000	0.000000	412	98536	0.00800	0.00093	0.00048	0.000069	3450	7094138.5	7.10E+06	0.16
26	12020	0.00085	0.00000	0.000000	424	98536	0.00800	0.00075	0.00048	0.000056	3479	7133370.6	7.15E+06	0.13
26	12470	0.00085	0.00005	0.000004	440	98536	0.00795	0.00085	0.00048	0.000063	3479	7146145.4	7.15E+06	0.14
26	11280	0.00085	0.00005	0.000004	398	98536	0.00800	0.00085	0.00048	0.000063	3479	7194384.7	7.20E+06	0.14
Average	11923	0.00085	0.00003	0.000002	421	98536	0.00798	0.00082	0.00048	0.000061	3479	7157966.9	7.15E+06	0.14
27	11510	0.00085	0.00005	0.000004	404	98536	0.00855	0.00090	0.00051	0.000067	3462	6631016.4	6.65E+06	0.14
27	11770	0.00085	0.00010	0.000007	414	98536	0.00830	0.00100	0.00050	0.000074	3462	6832652.7	6.85E+06	0.15
27	10870	0.00085	0.00005	0.000004	382	98536	0.00835	0.00095	0.00050	0.000070	3462	6857586	6.85E+06	0.15
Average	11383	0.00085	0.00007	0.000005	400	98536	0.00840	0.00095	0.00050	0.000070	3462	6773751.7	6.75E+06	0.14
Overall Average	11691	0.00085	0.00003	0.000002	411	98536	0.00813	0.00090	0.00049	0.000067	3464	7008619	7.00E+06	0.15

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 6/17/2014

Draft Report

**BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS**

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241
Mix Number Mix 15 Set No: 15
Mix Date Monday, June 16, 2014
Mix Time 1:21 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
57	10.0000	0.8150	0.8150	11.59600	1.6300	9.9660
58	10.0000	0.8140	0.8135	11.60650	1.6275	9.9790
59	10.0000	0.8125	0.8125	11.60450	1.6250	9.9795
60	10.0000	0.8120	0.8125	11.57200	1.6245	9.9475

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
		Specimen 57	Reference Bar 57	Δ Length 57	Specimen 58	Reference Bar 58	Δ Length 58	Specimen 59	Reference Bar 59	Δ Length 59	Specimen 60	Reference Bar 60	Δ Length 60	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Tuesday, June 17, 2014	0.0678	0.0978	-0.0300	0.0791	0.0978	-0.0187	0.0785	0.0978	-0.0193	0.0397	0.0978	-0.0581	-0.0315
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
		Specimen 57	Reference Bar 57	Δ Length 57	Specimen 58	Reference Bar 58	Δ Length 58	Specimen 59	Reference Bar 59	Δ Length 59	Specimen 60	Reference Bar 60	Δ Length 60	Average
7	Monday, June 23, 2014	0.0678	0.0977	0.0010	0.0791	0.0977	0.0010	0.0785	0.0977	0.0010	0.0396	0.0977	0.0000	0.0008
11	Friday, June 27, 2014	0.0668	0.0977	-0.0090	0.0782	0.0977	-0.0080	0.0776	0.0977	-0.0080	0.0387	0.0977	-0.0090	-0.0085
14	Monday, June 30, 2014	0.0664	0.0976	-0.0120	0.0778	0.0976	-0.0110	0.0773	0.0976	-0.0100	0.0384	0.0976	-0.0110	-0.0110
21	Monday, July 07, 2014	0.0659	0.0975	-0.0160	0.0773	0.0975	-0.0150	0.0767	0.0975	-0.0150	0.0379	0.0975	-0.0150	-0.0153
35	Monday, July 21, 2014	0.0655	0.0976	-0.0210	0.0768	0.0976	-0.0210	0.0763	0.0976	-0.0200	0.0375	0.0976	-0.0200	-0.0205
63	Monday, August 18, 2014	0.0649	0.0975	-0.0260	0.0761	0.0975	-0.0270	0.0756	0.0975	-0.0260	0.0370	0.0975	-0.0240	-0.0258
119	Monday, October 13, 2014	0.0646	0.0975	-0.0290	0.0758	0.0975	-0.0300	0.0752	0.0975	-0.0300	0.0365	0.0975	-0.0290	-0.0295
231	Monday, February 02, 2015	0.0640	0.0974	-0.0340	0.0753	0.0974	-0.0340	0.0748	0.0974	-0.0330	0.0360	0.0974	-0.0330	-0.0335
455	Monday, September 14, 2015	0.0637	0.0971	-0.0340	0.0750	0.0971	-0.0340	0.0745	0.0971	-0.0330	0.0357	0.0971	-0.0330	-0.0335
42	Calculated 35 Day Shrinkage			-0.0220			-0.0225			-0.0220			-0.0211	-0.0219
<p>Note: Lowest Reading Value Recorded (Minimum)</p> <p>Reported by: <u>Scott Bivings</u> Reviewed by: <u>Robert Varner 10/12/2015</u></p>														

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 15 Set No: 15
Mix Date Monday, June 16, 2014
Mix Time 1:21 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
57	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
58	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
59	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
60	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

Specimen Age	Reference Bar Length (in.)	INITIAL READINGS													
		Specimen 57	Reference Bar 57	Δ Length 57	Specimen 58	Reference Bar 58	Δ Length 58	Specimen 59	Reference Bar 59	Δ Length 59	Specimen 60	Reference Bar 60	Δ Length 60	Average	
	10	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches	
819	Monday, September 12, 2016	0.0635	0.0971	-0.0360	0.0745	0.0971	-0.0390	0.0748	0.0971	-0.0300	0.0353	0.0971	-0.0370	-0.0355	
		LENGTH CHANGE CALCULATIONS													
	Reintroduce to Waterbath	Specimen 57	Reference Bar 57	Δ Length 57	Specimen 58	Reference Bar 58	Δ Length 58	Specimen 59	Reference Bar 59	Δ Length 59	Specimen 60	Reference Bar 60	Δ Length 60	Average	
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)	
820	Tuesday, September 13, 2016	0.0647	0.0971	-0.0240	0.0758	0.0971	-0.0260	0.0755	0.0971	-0.0230	0.0365	0.0971	-0.0250	-0.0245	
822	Thursday, September 15, 2016	0.0650	0.0971	-0.0210	0.0761	0.0971	-0.0230	0.0758	0.0971	-0.0200	0.0368	0.0971	-0.0220	-0.0215	
826	Monday, September 19, 2016	0.0651	0.0971	-0.0200	0.0762	0.0971	-0.0220	0.0759	0.0971	-0.0190	0.0369	0.0971	-0.0210	-0.0205	
833	Monday, September 26, 2016	0.0651	0.0971	-0.0200	0.0764	0.0971	-0.0200	0.0761	0.0971	-0.0170	0.0370	0.0971	-0.0200	-0.0193	
847	Monday, October 10, 2016	0.0654	0.0971	-0.0170	0.0765	0.0971	-0.0190	0.0763	0.0971	-0.0150	0.0373	0.0971	-0.0170	-0.0170	
854	Monday, October 17, 2016	0.0654	0.0971	-0.0170	0.0764	0.0971	-0.0200	0.0763	0.0971	-0.0150	0.0373	0.0971	-0.0170	-0.0173	
875	Monday, November 07, 2016	0.0650	0.0968	-0.0180	0.0766	0.0968	-0.0150	0.0765	0.0968	-0.0100	0.0374	0.0968	-0.0130	-0.0140	
927	Thursday, December 29, 2016	0.0655	0.0968	-0.0130	0.0767	0.0968	-0.0140	0.0766	0.0968	-0.0090	0.0375	0.0968	-0.0120	-0.0120	

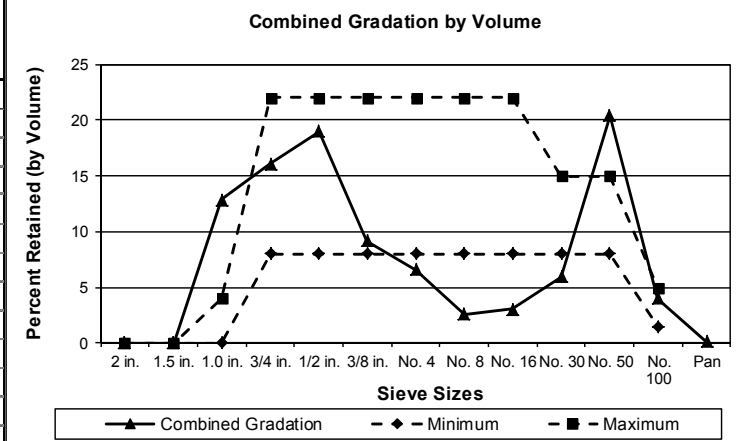
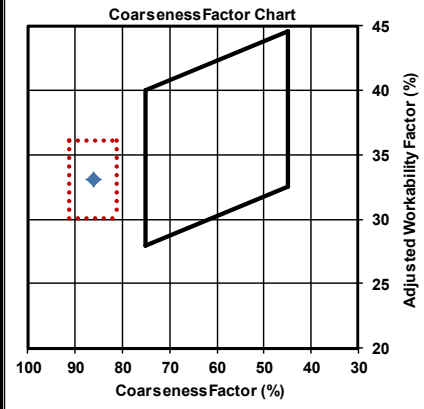
Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:		
Customer: MDOT		Project: SP-9999-09(110)/106812-101000				Lab #: BCD						
MIX NUMBER		Mix 16.1				Set #: 16						
Date: 6/18/2014		Mix Code: Mix 16		f'c: 3,500 psi		Size(c.f.): 6.25		Factor: 0.23				
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorp- tion	Agg. FM			
Material	Vol. (c.f.)									Roller Meter Air 3.75		
Cement 1:	1.39	274.00	63.43	63.43	63.43	Type II Cement	3.15			Coarseness and Workability (volume)		
Cement 2:	0.00	0.00	0.00	0.00			0.00			Cumulative % retained on 3/8" 57.08		
Fly Ash:	0.00	0.00	0.00	0.00			2.60			Cumulative % retained on No 8 66.24		
Slag:	1.52	274.00	63.43	63.43	63.43	Slag Cement	2.89			Cumulative % passing No 8 33.54		
Sand 1:	6.88	1131.38	261.89	271.95	271.95	Sand	2.636	0.52%	2.36	Coarseness Factor 86.17		
Coarse Aggregate 1:	12.65	2031.00	470.14	470.37	470.37	CA_ID4 - 57 Gravel Low Absorption	2.572	1.42%	7.30	Workability Factor 33.54		
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%		Adjusted Workability Factor 33.11		
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%				
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%				
Air:	4.50%	1.22	0.00	0.00								
Water:	3.47	216.67	50.15	39.87	39.87		1.00					
"+-Air:	0.50%											
Total:	27.13	3927.05	909.04	909.04								
UW w/o Air:		151.51	152.30	152.30								
ADMIX INFORMATION						Aggregate Moistures						
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)				
Air	0.56	3.1	90.8	21.0	21.0	Air	Sand: 3.86%	10.06				
Water Reducer	5.00	27.4	810.3	187.6	187.6	Water Reducer	CA 1 0.05%	0.23				
							CA 2 0.00%	0.00				
							CA 3 0.00%	0.00				
							CA 4 0.00%	0.00				
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.				
Batch Time	9:36 AM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4					
Sample Time	9:45 AM		35.21	64.79	0	0	0					
Slump, in.	2.00	2 in.	0.0	0.0	0.0	0.0	0.0					
Mix Temp.	80.0	1.5 in.	0.0	0.0	0.0	0.0	0.0					
Air Temp.	96.0	1.0 in.	0.0	19.8	0.0	0.0	0.0					
ACF Air %	4.6	3/4 in.	0.0	24.8	0.0	0.0	0.0					
Unit Weight (pcf)	145.00	1/2 in.	0.0	29.3	0.0	0.0	0.0					
Design Unit Wt.	144.73	3/8 in.	0.0	14.2	0.0	0.0	0.0					
Yield	6.27	No. 4	0.4	10.0	0.0	0.0	0.0					
Relative Yield	1.00	No. 8	4.5	1.5	0.0	0.0	0.0					
Design w/c	0.395	No. 16	8.4	0.1	0.0	0.0	0.0					
Actual w/c	0.395	No. 30	17.0	0.0	0.0	0.0	0.0					
Fine/Coarse	0.56	No. 50	57.8	0.1	0.0	0.0	0.0					
Bag Factor	5.83	No. 100	11.3	0.0	0.0	0.0	0.0					
Theoretical Air (%)	4.30	Pan	0.2	0.1	0.0	0.0	0.0					



BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength

278 COMMERCE PARK DRIVE
RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
Fax: (601) 856-3552

Mix ID: Mix 16

BDC Project NO. 140241

Made Date: Wednesday, June 18, 2014

COMPRESSION TESTS RESULTS

Specimen Age	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	6/25/2014	6.03	6.04	12.10	12.10	12.10	29.63	147.92	28.61	146970	5137	3	5310
6	7	6/25/2014	6.04	6.01	12.15	12.05	12.05	29.23	146.61	28.51	144010	5051	3	
7	7	6/25/2014	6.02	6.03	12.10	12.10	12.10	29.65	148.51	28.51	154440	5417	3	
8	7	6/25/2014	6.02	6.03	12.10	12.10	12.10	29.68	148.66	28.51	158340	5554	3	
9	7	6/25/2014	6.03	6.03	12.10	12.05	12.10	29.67	148.57	28.56	154540	5411	3	
11	14	7/2/2014	6.03	6.04	12.15	12.10	12.10	29.73	148.22	28.61	193020	6747	3	6510
12	14	7/2/2014	6.01	6.03	12.00	12.05	12.10	29.56	148.92	28.46	187770	6598	3	
13	14	7/2/2014	6.01	6.01	12.10	12.15	12.10	29.57	148.65	28.37	175520	6187	3	
14	14	7/2/2014	6.04	6.05	12.05	12.05	12.05	29.60	147.89	28.7	187560	6535	3	
15	14	7/2/2014	5.97	5.98	12.05	12.00	11.95	28.72	147.49	28.04	181220	6463	3	
17	28	7/16/2014	6.03	6.03	12.15	12.15	12.15	29.84	148.60	28.56	204450	7159	5	7270
18	28	7/16/2014	6.01	6.04	12.10	12.10	12.15	29.74	148.76	28.51	201890	7081	3	
19	28	7/16/2014	6.02	6.02	12.15	12.10	12.05	29.86	149.81	28.46	208820	7337	3	
20	28	7/16/2014	6.01	6.04	12.15	12.15	12.15	29.75	148.40	28.51	209500	7348	3	
21	28	7/16/2014	5.96	5.98	12.05	12.00	11.95	28.90	148.66	27.99	207890	7427	3	
23	90	9/16/2014	6.01	6.02	12.00	12.00	12.00	29.54	149.69	28.42	200580	7058	3	7420
24	90	9/16/2014	6.02	6.03	12.05	12.05	12.05	29.66	149.18	28.51	216930	7609	3	
25	90	9/16/2014	6.03	6.04	12.00	12.05	12.05	29.54	148.29	28.61	201060	7028	3	
26	90	9/16/2014	6.03	6.01	12.05	12.05	12.05	29.53	148.77	28.46	201940	7096	3	
27	90	9/16/2014	6.02	6.00	12.05	12.10	12.10	29.64	149.41	28.37	235640	8306	3	

Reported By: Scott Bivings Date: _____

Reviewed By: Robert Varner Date: 9/17/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 16 _____

Project No. 140241

Mix Date Wednesday, June 18, 2014

Mix Time: 9:36 AM

7 DAY CYLINDER DATA

Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	6.04	28.61	12.40	146970
6	6.03	28.51	12.38	144010
7	6.03	28.51	12.42	
8	6.03	28.51	12.48	
9	6.03	28.56	12.43	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 58196

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
7	12560	0.00085	0.00000	0.000000	441	58196	0.00475	0.00055	0.00028	0.000041	2041	6841558.1	6.85E+06	0.17
7	10560	0.00085	0.00010	0.000007	370	58196	0.00490	0.00060	0.00029	0.000044	2041	6877781.4	6.90E+06	0.15
7	10850	0.00085	0.00005	0.000004	381	58196	0.00490	0.00060	0.00029	0.000044	2041	6835910.6	6.85E+06	0.17
Average	11323	0.00085	0.00005	0.000004	397	58196	0.00485	0.00058	0.00029	0.000043	2041	6851750.1	6.85E+06	0.16
8	11760	0.00085	0.00000	0.000000	412	58196	0.00515	0.00050	0.00031	0.000037	2041	6315957.4	6.30E+06	0.14
8	11460	0.00085	0.00000	0.000000	402	58196	0.00505	0.00055	0.00030	0.000041	2041	6507623.3	6.50E+06	0.16
8	10210	0.00085	0.00000	0.000000	358	58196	0.00515	0.00055	0.00031	0.000041	2041	6526779.5	6.55E+06	0.16
Average	11143	0.00085	0.00000	0.000000	391	58196	0.00512	0.00053	0.00031	0.000039	2041	6450120.1	6.45E+06	0.15
9	11030	0.00085	0.00005	0.000004	386	58196	0.00570	0.00050	0.00034	0.000037	2038	5679824.1	5.70E+06	0.11
9	10870	0.00085	0.00000	0.000000	381	58196	0.00555	0.00050	0.00033	0.000037	2038	5880451.3	5.90E+06	0.13
9	11450	0.00085	0.00010	0.000007	401	58196	0.00560	0.00055	0.00033	0.000041	2038	5747418.1	5.75E+06	0.12
Average	11117	0.00085	0.00005	0.000004	389	58196	0.00562	0.00052	0.00034	0.000038	2038	5769231.1	5.75E+06	0.12
Overall Average	11194	0.00085	0.00003	0.000002	392	58196	0.00519	0.00054	0.00031	0.000040	2040	6357033.8	6.35E+06	0.15

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 16 _____

Project No. 140241

Mix Date Wednesday, June 18, 2014

Mix Time: 9:36 AM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	6.04	28.61	12.31	193020
12	6.02	28.46	12.29	187770
13	6.01	28.37	12.34	
14	6.05	28.7	12.22	
15	5.98	28.04	12.25	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:
 Machine applied load (lbs.), **P**
 Longitudinal gage reading, **G_{long}**
 Longitudinal Strain, **ε_{long}**
 Transverse gage reading, **G_{tran}**
 Transverse Strain, **ε_{tran}**
 Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 76158

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	11110	0.00085	0.00000	0.000000	392	76158	0.00675	0.00075	0.00040	0.000056	2684	6485524.9	6.50E+06	0.16
13	11520	0.00085	0.00000	0.000000	406	76158	0.00665	0.00075	0.00040	0.000056	2684	6555500.4	6.55E+06	0.16
13	11590	0.00085	0.00005	0.000004	409	76158	0.00660	0.00085	0.00039	0.000063	2684	6605209	6.60E+06	0.17
Average	11407	0.00085	0.00002	0.000001	402	76158	0.00667	0.00078	0.00040	0.000058	2684	6548744.8	6.55E+06	0.16
14	10810	0.00085	0.00000	0.000000	377	76158	0.00660	0.00080	0.00039	0.000059	2654	6608135.9	6.60E+06	0.17
14	12170	0.00085	0.00005	0.000004	424	76158	0.00640	0.00080	0.00038	0.000059	2654	6703213.3	6.70E+06	0.17
14	12910	0.00085	0.00010	0.000007	450	76158	0.00635	0.00080	0.00038	0.000059	2654	6685777.5	6.70E+06	0.16
Average	11963	0.00085	0.00005	0.000004	417	76158	0.00645	0.00080	0.00039	0.000059	2654	6665708.9	6.65E+06	0.16
15	12880	0.00085	0.00000	0.000000	459	76158	0.00635	0.00080	0.00038	0.000060	2716	6846391.9	6.85E+06	0.18
15	11370	0.00085	0.00000	0.000000	405	76158	0.00645	0.00080	0.00039	0.000060	2716	6884896.6	6.90E+06	0.18
15	10730	0.00085	0.00000	0.000000	383	76158	0.00660	0.00080	0.00039	0.000060	2716	6771957.1	6.75E+06	0.17
Average	11660	0.00085	0.00000	0.000000	416	76158	0.00647	0.00080	0.00039	0.000060	2716	6834415.2	6.85E+06	0.18
Overall Average	11677	0.00085	0.00002	0.000002	412	76158	0.00653	0.00079	0.00039	0.000059	2685	6682956.3	6.70E+06	0.17

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 16 _____

Project No. 140241

Mix Date _____ Wednesday, June 18, 2014 _____

Mix Time: _____ 9:36 AM _____

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	6.02	28.42	12.22	200580
24	6.03	28.51	12.27	216930
25	6.04	28.61	12.28	
26	6.02	28.46	12.25	
27	6.01	28.37	12.25	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) _____ 4.95 _____

Longitudinal gage to yoke supports (0.01 in.) _____ 5.40 _____

Longitudinal Gage length (0.01 in.) _____ 8.00 _____

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) _____ 3.91 _____

Transverse gage to mid yoke supports (0.01 in.) _____ 4.85 _____

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) _____ 83502 _____

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) _____ 0.00084 _____

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	14570	0.00085	0.00000	0.000000	509	83502	0.00725	0.00075	0.00043	0.000055	2919	6283821.3	6.30E+06	0.14
25	13040	0.00085	0.00005	0.000004	456	83502	0.00745	0.00080	0.00045	0.000059	2919	6229051.7	6.25E+06	0.14
25	12420	0.00085	0.00010	0.000007	434	83502	0.00750	0.00090	0.00045	0.000067	2919	6236711.1	6.25E+06	0.15
Average	13343	0.00085	0.00005	0.000004	466	83502	0.00740	0.00082	0.00044	0.000060	2919	6249861.4	6.25E+06	0.14
26	12450	0.00085	0.00015	0.000011	437	83502	0.00695	0.00080	0.00042	0.000059	2934	6830727.3	6.85E+06	0.13
26	11540	0.00085	0.00010	0.000007	405	83502	0.00720	0.00075	0.00043	0.000056	2934	6646425.1	6.65E+06	0.13
26	12790	0.00085	0.00010	0.000007	449	83502	0.00710	0.00070	0.00042	0.000052	2934	6635242.9	6.65E+06	0.12
Average	12260	0.00085	0.00012	0.000009	431	83502	0.00708	0.00075	0.00042	0.000056	2934	6704131.7	6.70E+06	0.13
27	12420	0.00085	0.00010	0.000007	438	83502	0.00700	0.00075	0.00042	0.000056	2943	6799679.3	6.80E+06	0.13
27	11890	0.00085	0.00000	0.000000	419	83502	0.00710	0.00070	0.00042	0.000052	2943	6741011.5	6.75E+06	0.14
27	11940	0.00085	0.00000	0.000000	421	83502	0.00680	0.00070	0.00041	0.000052	2943	7075173.9	7.10E+06	0.15
Average	12083	0.00085	0.00003	0.000002	426	83502	0.00697	0.00072	0.00042	0.000053	2943	6871954.9	6.85E+06	0.14
Overall Average	12562	0.00085	0.00007	0.000005	441	83502	0.00715	0.00076	0.00043	0.000056	2932	6608649.3	6.60E+06	0.14

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Varner _____

Date: _____ 9/17/2014 _____

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241
Mix Number Mix 16 Set No: 16
Mix Date Wednesday, June 18, 2014
Mix Time 9:36 AM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
61	10.0000	0.8130	0.8130	11.62150	1.6260	9.9955
62	10.0000	0.8110	0.8120	11.60600	1.6230	9.9830
63	10.0000	0.8115	0.8115	11.58450	1.6230	9.9615
64	10.0000	0.8120	0.8115	11.60100	1.6235	9.9775

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
		Specimen 61	Reference Bar 61	Δ Length 61	Specimen 62	Reference Bar 62	Δ Length 62	Specimen 63	Reference Bar 63	Δ Length 63	Specimen 64	Reference Bar 64	Δ Length 64	Average
10														
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Thursday, June 19, 2014	0.0937	0.0978	-0.0041	0.0773	0.0978	-0.0205	0.0565	0.0978	-0.0413	0.0737	0.0978	-0.0241	-0.0225
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
Specimen 61	Reference Bar 61	Δ Length 61	Specimen 62	Reference Bar 62	Δ Length 62	Specimen 63	Reference Bar 63	Δ Length 63	Specimen 64	Reference Bar 64	Δ Length 64	Average		
(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001%)		
7	Wednesday, June 25, 2014	0.0942	0.0977	0.0060	0.0776	0.0977	0.0040	0.0569	0.0977	0.0050	0.0741	0.0977	0.0050	0.0050
10	Saturday, June 28, 2014	0.0936	0.0977	0.0000	0.0770	0.0977	-0.0020	0.0563	0.0977	-0.0010	0.0735	0.0977	-0.0010	-0.0010
14	Wednesday, July 02, 2014	0.0933	0.0976	-0.0020	0.0767	0.0977	-0.0050	0.0560	0.0977	-0.0040	0.0733	0.0976	-0.0020	-0.0033
21	Wednesday, July 09, 2014	0.0931	0.0976	-0.0040	0.0765	0.0976	-0.0060	0.0559	0.0976	-0.0040	0.0731	0.0976	-0.0040	-0.0045
35	Wednesday, July 23, 2014	0.0928	0.0976	-0.0070	0.0762	0.0976	-0.0090	0.0556	0.0976	-0.0070	0.0727	0.0976	-0.0080	-0.0078
63	Wednesday, August 20, 2014	0.0925	0.0976	-0.0100	0.0758	0.0976	-0.0130	0.0551	0.0975	-0.0110	0.0723	0.0975	-0.0110	-0.0113
119	Wednesday, October 15, 2014	0.0919	0.0975	-0.0150	0.0751	0.0975	-0.0190	0.0545	0.0975	-0.0170	0.0718	0.0975	-0.0160	-0.0168
231	Wednesday, February 04, 2015	0.0913	0.0974	-0.0200	0.0745	0.0974	-0.0240	0.0538	0.0974	-0.0230	0.0711	0.0974	-0.0220	-0.0223
455	Wednesday, September 16, 2015	0.0906	0.0971	-0.0240	0.0737	0.0971	-0.0290	0.0531	0.0971	-0.0270	0.0703	0.0971	-0.0270	-0.0268
42	Calculated 35 Day Shrinkage			-0.0084			-0.0109			-0.0089			-0.0090	-0.0093
Note: Lowest Reading Value Recorded (Minimum)														
Reported by: <u>Scott Bivings</u>					Reviewed by: <u>Robert Varner 10/12/2015</u>									

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 16 Set No: 16
Mix Date Wednesday, June 18, 2014
Mix Time 9:36 AM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
61	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
62	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
63	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
64	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

	Reference Bar Length (in.)	INITIAL READINGS												
		Specimen 61	Reference Bar 61	Δ Length 61	Specimen 62	Reference Bar 62	Δ Length 62	Specimen 63	Reference Bar 63	Δ Length 63	Specimen 64	Reference Bar 64	Δ Length 64	Average
	10													
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
819	Wednesday, September 14, 2016	0.0902	0.0971	-0.0280	0.0731	0.0971	-0.0350	0.0525	0.0971	-0.0330	0.0698	0.0971	-0.0320	-0.0320
		LENGTH CHANGE CALCULATIONS												
Reintroduce to Waterbath		Specimen 61	Reference Bar 61	Δ Length 61	Specimen 62	Reference Bar 62	Δ Length 62	Specimen 63	Reference Bar 63	Δ Length 63	Specimen 64	Reference Bar 64	Δ Length 64	Average
		(.0001 in.)	(.0001 in.)	(.0001%)	(.0001 in.)	(.0001 in.)	(.0001%)	(.0001 in.)	(.0001 in.)	(.0001%)	(.0001 in.)	(.0001 in.)	(.0001%)	(.0001%)
820	Thursday, September 15, 2016	0.0914	0.0971	-0.0160	0.0744	0.0971	-0.0220	0.0538	0.0971	-0.0200	0.0711	0.0971	-0.0190	-0.0193
824	Monday, September 19, 2016	0.0918	0.0971	-0.0120	0.0749	0.0971	-0.0170	0.0542	0.0971	-0.0160	0.0716	0.0971	-0.0140	-0.0148
826	Wednesday, September 21, 2016	0.0918	0.0971	-0.0120	0.0750	0.0971	-0.0160	0.0543	0.0971	-0.0150	0.0717	0.0971	-0.0130	-0.0140
833	Wednesday, September 28, 2016	0.0920	0.0971	-0.0100	0.0751	0.0971	-0.0150	0.0544	0.0971	-0.0140	0.0719	0.0971	-0.0110	-0.0125
847	Wednesday, October 12, 2016	0.0921	0.0971	-0.0090	0.0753	0.0971	-0.0130	0.0547	0.0971	-0.0110	0.0720	0.0971	-0.0100	-0.0108
854	Wednesday, October 19, 2016	0.0922	0.0971	-0.0080	0.0753	0.0971	-0.0130	0.0547	0.0971	-0.0110	0.0720	0.0971	-0.0100	-0.0105
875	Wednesday, November 09, 2016	0.0924	0.0967	-0.0020	0.0754	0.0967	-0.0080	0.0548	0.0967	-0.0060	0.0721	0.0967	-0.0050	-0.0052
925	Thursday, December 29, 2016	0.0927	0.0968	0.0000	0.0758	0.0968	-0.0050	0.0552	0.0968	-0.0030	0.0726	0.0968	-0.0010	-0.0022

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:		
Customer: MDOT		Project: SP-9999-09(110)/106812-101000				Lab #: BCD						
MIX NUMBER Mix 17.1						Set #: 17						
Date: 6/24/2014		Mix Code: Mix 17		f'c: 3,500 psi		Size(c.f.): 6.25		Factor: 0.23				
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorption	Agg. FM	Roller Meter Air 5		
Material	Vol. (c.f.)									Coarseness and Workability (volume)		
Cement 1:	2.79	548.00	126.85	126.85	126.85	Type I-II Cement	3.15			Cumulative % retained on 3/8" 38.18		
Cement 2:	0.00	0.00	0.00	0.00			0.00			Cumulative % retained on No 8 67.33		
Fly Ash:	0.00	0.00	0.00	0.00			2.42			Cumulative % passing No 8 32.43		
Slag:	0.00	0.00	0.00	0.00			0.00			Coarseness Factor 56.71		
Sand 1:	6.63	1090.11	252.34	261.70	261.70	Sand	2.636	0.52%	2.36	Workability Factor 32.43		
Coarse Aggregate 1:	12.83	2012.00	465.74	476.01	476.01	CA_ID5 - 67 Gravel	2.513	2.45%	6.54	Adjusted Workability Factor 32.00		
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%				
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%				
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%				
Air:	4.50%	1.22	0.00	0.00	0.00							
Water:	3.67	229.16	53.05	33.41	33.34		1.00					
"+-Air:	0.50%											
Total:	27.13	3879.27	897.98	897.98								
UW w/o Air:		149.67	150.45	150.45								
ADMIX INFORMATION							Aggregate Moistures					
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)				
Air	0.50	2.7	81.0	18.8	18.8	Air	Sand: 3.73%	9.36				
Water Reducer	5.00	27.4	810.3	187.6	187.6	Water Reducer	CA 1 2.26%	10.27				
							CA 2 0.00%	0.00				
							CA 3 0.00%	0.00				
							CA 4 0.00%	0.00				
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.				
Batch Time	8:06 AM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4					
Sample Time	8:15 AM		34.06	65.94	0	0	0					
Slump, in.	1.25	2 in.	0.0	0.0	0.0	0.0	0.0	0.0				
Mix Temp.	79.0	1.5 in.	0.0	0.0	0.0	0.0	0.0	0.0				
Air Temp.	78.3	1.0 in.	0.0	0.0	0.0	0.0	0.0	0.0				
ACF Air %	5.0	3/4 in.	0.0	2.2	0.0	0.0	0.0	1.5				
Unit Weight (pcf)	143.80	1/2 in.	0.0	32.6	0.0	0.0	0.0	21.5				
Design Unit Wt.	142.97	3/8 in.	0.0	23.1	0.0	0.0	0.0	15.2				
Yield	6.24	No. 4	0.4	37.3	0.0	0.0	0.0	24.7				
Relative Yield	1.00	No. 8	4.5	4.4	0.0	0.0	0.0	4.4				
Design w/c	0.418	No. 16	8.4	0.2	0.0	0.0	0.0	3.0				
Actual w/c	0.418	No. 30	17.0	0.0	0.0	0.0	0.0	5.8				
Fine/Coarse	0.54	No. 50	57.8	0.0	0.0	0.0	0.0	19.7				
Bag Factor	5.83	No. 100	11.3	0.0	0.0	0.0	0.0	3.9				
Theoretical Air (%)	3.92	Pan	0.2	0.1	0.0	0.0	0.0	0.1				

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
 Fax: (601) 856-3552

Mix ID: _____ Mix 17

BDC Project NO. 140241

Made Date: Tuesday, June 24, 2014

COMPRESSION TESTS RESULTS

Specimen Age	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	7/1/2014	5.98	6.00	12.00	12.05	12.00	28.47	145.27	28.18	173560	6159	3	6100
6	7	7/1/2014	6.01	6.02	12.05	12.00	12.00	28.60	144.73	28.42	167790	5904	3	
7	7	7/1/2014	5.97	5.95	11.95	11.95	12.00	28.29	146.42	27.9	169710	6083	3	
8	7	7/1/2014	6.02	6.04	12.05	12.10	12.15	29.07	145.37	28.56	171430	6002	3	
9	7	7/1/2014	5.96	5.95	12.00	12.00	12.00	28.49	147.29	27.85	177140	6361	3	
11	14	7/8/2014	6.00	5.95	12.00	12.00	12.00	28.60	146.88	28.04	195520	6973	3	6960
12	14	7/8/2014	6.00	5.93	11.95	12.00	12.00	28.23	145.66	27.95	166680	5964	3	
13	14	7/8/2014	5.97	5.96	12.00	12.05	12.05	28.64	147.17	27.95	210150	7519	3	
14	14	7/8/2014	6.02	6.02	12.10	12.10	12.05	29.21	146.75	28.46	210540	7398	3	
15	14	7/8/2014	5.97	5.98	12.05	12.05	12.05	28.55	146.01	28.04	194990	6954	3	
17	28	7/22/2014	5.96	6.00	12.05	12.00	11.95	28.17	144.42	28.09	186180	6628	3	7220
18	28	7/22/2014	5.95	5.96	12.00	12.00	12.00	28.48	147.24	27.85	201900	7250	3	
19	28	7/22/2014	5.97	5.96	12.05	12.00	12.00	28.65	147.42	27.95	206490	7388	3	
20	28	7/22/2014	5.95	5.94	11.95	12.00	12.00	28.47	147.89	27.76	202590	7298	3	
21	28	7/22/2014	5.93	5.99	11.95	12.00	12.00	28.47	147.15	27.9	209870	7522	3	
23	90	9/22/2014	5.99	6.01	12.05	12.05	12.10	29.21	147.94	28.28	233290	8249	3	8090
24	90	9/22/2014	5.96	5.98	11.95	11.95	11.95	28.55	147.48	27.99	219760	7851	3	
25	90	9/22/2014	5.98	6.01	12.05	12.05	12.05	29.20	148.34	28.23	229850	8142	3	
26	90	9/22/2014	5.96	5.96	11.95	12.05	12.05	28.58	147.31	27.9	235420	8438	3	
27	90	9/22/2014	5.94	5.99	12.00	12.00	12.00	28.53	147.01	27.95	217520	7782	3	

Reported By: _____ Scott Bivings _____ Date: _____

Reviewed By: _____ Robert Varner _____ Date: 9/25/2014

Draft Report

BURNS COOLEY DENNIS, INC.
 CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
 AASHTO T97 Flexural Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID: _____ Mix 17
 Made Date: _____ Tuesday, June 24, 2014

BDC Project NO. 140241

Specimen No.	Specimen Age	Test Date	Depth 1 (0.05 in)	Depth 2 (0.05 in)	Depth 3 (0.05 in)	Avg Depth (in.)	Width 1 (0.05 in)	Width 2 (0.05 in)	Width 3 (0.05 in)	Avg Width (in.)	Max Load	Flex Strength (psi)	Avg (psi)
29	7	7/1/2014	6.10	6.10	6.10	6.10	6.00	6.00	6.00	6.00	8910	718	730
30	7	7/1/2014	6.10	6.15	6.15	6.13	6.05	6.00	6.05	6.03	9180	729	
31	7	7/1/2014	6.10	6.15	6.10	6.12	6.00	6.00	6.05	6.02	9280	741	
32	14	7/8/2014	6.10	6.10	6.10	6.10	6.00	5.95	6.00	6.00	10430	841	810
33	14	7/8/2014	6.05	6.05	6.05	6.05	6.00	6.00	6.00	6.00	9730	797	
34	14	7/8/2014	6.05	6.10	6.05	6.07	5.90	5.95	6.05	5.95	9700	796	
35	28	7/22/2014	6.10	6.10	6.05	6.08	6.00	6.00	6.00	6.00	10250	832	810
36	28	7/22/2014	6.15	6.10	6.05	6.10	5.95	5.95	6.00	5.97	10150	822	
37	28	7/22/2014	6.05	6.05	6.00	6.03	6.00	5.95	6.00	5.98	9400	778	
38	90	9/22/2014	6.05	6.05	6.05	6.05	5.95	5.95	6.00	5.97	10650	877	870
39	90	9/22/2014	6.05	6.05	6.05	6.05	5.95	5.95	5.95	5.95	10580	874	
40	90	9/22/2014	6.05	6.05	6.05	6.05	6.00	5.95	6.00	5.98	10360	852	

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Varner _____

Date: 9/25/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 17

Project No. 140241

Mix Date Tuesday, June 24, 2014

Mix Time: 8:06 AM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	5.98	28.04		195520
12	5.97	27.95		166680
13	5.97	27.95		
14	6.02	28.46		
15	5.98	28.04		

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 72440

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	10460	0.00085	0.00005	0.000004	374	72440	0.00720	0.00080	0.00043	0.000060	2592	5828939.4	5.85E+06	0.15
13	9630	0.00085	0.00000	0.000000	345	72440	0.00720	0.00085	0.00043	0.000064	2592	5906997.2	5.90E+06	0.17
13	9690	0.00085	0.00000	0.000000	347	72440	0.00720	0.00085	0.00043	0.000064	2592	5901354.5	5.90E+06	0.17
Average	9927	0.00085	0.00002	0.000001	355	72440	0.00720	0.00083	0.00043	0.000062	2592	5879097	5.90E+06	0.16
14	9880	0.00085	0.00005	0.000004	347	72440	0.00690	0.00095	0.00041	0.000070	2545	6063925.2	6.05E+06	0.18
14	9450	0.00085	0.00010	0.000007	332	72440	0.00670	0.00095	0.00040	0.000070	2545	6313858.2	6.30E+06	0.18
14	9780	0.00085	0.00010	0.000007	344	72440	0.00675	0.00095	0.00040	0.000070	2545	6227676.1	6.25E+06	0.18
Average	9703	0.00085	0.00008	0.000006	341	72440	0.00678	0.00095	0.00041	0.000070	2545	6201819.8	6.20E+06	0.18
15	10040	0.00085	0.00010	0.000007	358	72440	0.00745	0.00090	0.00045	0.000067	2583	5628483.6	5.65E+06	0.15
15	10620	0.00085	0.00015	0.000011	379	72440	0.00740	0.00090	0.00044	0.000067	2583	5618645.3	5.60E+06	0.14
15	9620	0.00085	0.00010	0.000007	343	72440	0.00760	0.00085	0.00045	0.000063	2583	5540702.2	5.55E+06	0.14
Average	10093	0.00085	0.00012	0.000009	360	72440	0.00748	0.00088	0.00045	0.000066	2583	5595943.7	5.60E+06	0.14
Overall Average	9908	0.00085	0.00007	0.000005	352	72440	0.00716	0.00089	0.00043	0.000066	2574	5892286.8	5.90E+06	0.16

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 17 _____

Project No. 140241

Mix Date Tuesday, June 24, 2014

Mix Time: 8:06 AM

28 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	5.98	28.09	12.27	186180
18	5.96	27.85	12.20	201900
19	5.97	27.95	12.20	
20	5.95	27.76	12.21	
21	5.96	27.9	12.21	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 77616

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	10320	0.00085	0.00010	0.000007	369	77616	0.00800	0.00080	0.00048	0.000060	2777	5622106.2	5.60E+06	0.12
19	9460	0.00085	0.00000	0.000000	338	77616	0.00810	0.00075	0.00048	0.000056	2777	5615563.3	5.60E+06	0.13
19	9900	0.00085	0.00010	0.000007	354	77616	0.00785	0.00090	0.00047	0.000067	2777	5778184.1	5.80E+06	0.14
Average	9893	0.00085	0.00007	0.000005	354	77616	0.00798	0.00082	0.00048	0.000061	2777	5671951.2	5.65E+06	0.13
20	11140	0.00085	0.00000	0.000000	401	77616	0.00760	0.00075	0.00045	0.000056	2796	5922298.7	5.90E+06	0.14
20	8960	0.00085	0.00005	0.000004	323	77616	0.00775	0.00085	0.00046	0.000064	2796	5983807.9	6.00E+06	0.15
20	9900	0.00085	0.00010	0.000008	357	77616	0.00750	0.00090	0.00045	0.000068	2796	6123302.1	6.10E+06	0.15
Average	10000	0.00085	0.00005	0.000004	360	77616	0.00762	0.00083	0.00046	0.000063	2796	6009802.9	6.00E+06	0.14
21	10370	0.00085	0.00010	0.000007	372	77616	0.00770	0.00090	0.00046	0.000067	2782	5873988.9	5.85E+06	0.15
21	9830	0.00085	0.00010	0.000007	352	77616	0.00775	0.00095	0.00046	0.000071	2782	5878336	5.90E+06	0.15
21	9970	0.00085	0.00000	0.000000	357	77616	0.00780	0.00095	0.00047	0.000071	2782	5824075.2	5.80E+06	0.17
Average	10057	0.00085	0.00007	0.000005	360	77616	0.00775	0.00093	0.00046	0.000070	2782	5858800	5.85E+06	0.16
Overall Average	9983	0.00085	0.00006	0.000005	358	77616	0.00778	0.00086	0.00047	0.000064	2785	5846851.4	5.85E+06	0.14

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 17 _____

Project No. _____ 140241 _____

Mix Date _____ Tuesday, June 24, 2014 _____

Mix Time: _____ 8:06 AM _____

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	6.00	28.28	12.26	233290
24	5.97	27.99	12.11	219760
25	6.00	28.23	12.21	
26	5.96	27.9	12.19	
27	5.97	27.95	12.19	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) _____ 90610 _____

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) _____ 0.00084 _____

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	11750	0.00085	0.00010	0.000007	416	90610	0.00795	0.00105	0.00048	0.000078	3210	6568699.1	6.55E+06	0.17
25	11480	0.00085	0.00010	0.000007	407	90610	0.00795	0.00105	0.00048	0.000078	3210	6591189	6.60E+06	0.17
25	11370	0.00085	0.00010	0.000007	403	90610	0.00795	0.00110	0.00048	0.000082	3210	6600351.5	6.60E+06	0.17
Average	11533	0.00085	0.00010	0.000007	409	90610	0.00795	0.00107	0.00048	0.000079	3210	6586746.6	6.60E+06	0.17
26	10530	0.00085	0.00010	0.000007	377	90610	0.00895	0.00105	0.00054	0.000079	3248	5917380	5.90E+06	0.15
26	10230	0.00085	0.00005	0.000004	367	90610	0.00895	0.00095	0.00054	0.000071	3248	5939548	5.95E+06	0.14
26	9610	0.00085	0.00000	0.000000	344	90610	0.00885	0.00090	0.00053	0.000067	3248	6060051.6	6.05E+06	0.14
Average	10123	0.00085	0.00005	0.000004	363	90610	0.00892	0.00097	0.00053	0.000072	3248	5972326.5	5.95E+06	0.14
27	9690	0.00085	0.00000	0.000000	347	90610	0.00915	0.00095	0.00055	0.000071	3242	5825164.2	5.85E+06	0.14
27	10040	0.00085	0.00005	0.000004	359	90610	0.00895	0.00105	0.00054	0.000079	3242	5942937.3	5.95E+06	0.15
27	10440	0.00085	0.00010	0.000007	374	90610	0.00895	0.00100	0.00054	0.000075	3242	5913432.9	5.90E+06	0.14
Average	10057	0.00085	0.00005	0.000004	360	90610	0.00902	0.00100	0.00054	0.000075	3242	5893844.8	5.90E+06	0.15
Overall Average	10571	0.00085	0.00007	0.000005	377	90610	0.00863	0.00101	0.00052	0.000076	3233	6150972.6	6.15E+06	0.15

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Varner _____

Date: _____ 9/25/2014 _____

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241
Mix Number Mix 17 Set No: 17
Mix Date Tuesday, June 24, 2014
Mix Time 8:06 AM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
65	10.0000	0.8115	0.8120	11.61300	1.6235	9.9895
66	10.0000	0.8105	0.8125	11.57850	1.6230	9.9555
67	10.0000	0.8125	0.8120	11.58450	1.6245	9.9600
68	10.0000	0.8110	0.8095	11.60050	1.6205	9.9800

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
10		Specimen 65	Reference Bar 65	Δ Length 65	Specimen 66	Reference Bar 66	Δ Length 66	Specimen 67	Reference Bar 67	Δ Length 67	Specimen 68	Reference Bar 68	Δ Length 68	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Wednesday, June 25, 2014	0.0882	0.0977	-0.0095	0.0507	0.0977	-0.0470	0.0583	0.0977	-0.0394	0.0781	0.0977	-0.0196	-0.0289
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
		Specimen 65	Reference Bar 65	Δ Length 65	Specimen 66	Reference Bar 66	Δ Length 66	Specimen 67	Reference Bar 67	Δ Length 67	Specimen 68	Reference Bar 68	Δ Length 68	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
7	Tuesday, July 01, 2014	0.0884	0.0977	0.0020	0.0509	0.0977	0.0020	0.0585	0.0977	0.0020	0.0783	0.0977	0.0020	0.0020
10	Friday, July 04, 2014	0.0879	0.0977	-0.0030	0.0505	0.0977	-0.0020	0.0580	0.0977	-0.0030	0.0779	0.0977	-0.0020	-0.0025
14	Tuesday, July 08, 2014	0.0874	0.0975	-0.0060	0.0500	0.0975	-0.0050	0.0575	0.0975	-0.0060	0.0775	0.0975	-0.0040	-0.0053
21	Tuesday, July 15, 2014	0.0871	0.0976	-0.0100	0.0496	0.0976	-0.0100	0.0572	0.0976	-0.0100	0.0771	0.0976	-0.0090	-0.0098
35	Tuesday, July 29, 2014	0.0865	0.0977	-0.0170	0.0493	0.0977	-0.0140	0.0567	0.0977	-0.0160	0.0766	0.0977	-0.0150	-0.0155
63	Tuesday, August 26, 2014	0.0857	0.0975	-0.0230	0.0484	0.0975	-0.0210	0.0558	0.0975	-0.0230	0.0758	0.0975	-0.0210	-0.0220
119	Tuesday, October 21, 2014	0.0850	0.0975	-0.0300	0.0476	0.0975	-0.0290	0.0550	0.0975	-0.0310	0.0751	0.0975	-0.0280	-0.0295
231	Tuesday, February 10, 2015	0.0840	0.0973	-0.0380	0.0467	0.0973	-0.0360	0.0541	0.0972	-0.0370	0.0743	0.0972	-0.0330	-0.0360
455	Tuesday, September 22, 2015	0.0836	0.0971	-0.0400	0.0463	0.0971	-0.0380	0.0537	0.0971	-0.0400	0.0739	0.0971	-0.0360	-0.0385
42	Calculated 35 Day Shrinkage			-0.0188			-0.0172			-0.0187			-0.0172	-0.0180
Note: Lowest Reading Value Recorded (Minimum)														
Reported by: <u>Scott Bivings</u>					Reviewed by: <u>Robert Varner 10/12/2015</u>									

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 17 Set No: 17
Mix Date Tuesday, June 24, 2014
Mix Time 8:06 AM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
65	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
66	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
67	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
68	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

	Reference Bar Length (in.)	INITIAL READINGS												
	10	Specimen 65	Reference Bar 65	Δ Length 65	Specimen 66	Reference Bar 66	Δ Length 66	Specimen 67	Reference Bar 67	Δ Length 67	Specimen 68	Reference Bar 68	Δ Length 68	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
819	Tuesday, September 20, 2016	0.0832	0.0971	-0.0440	0.0460	0.0971	-0.0410	0.0532	0.0971	-0.0450	0.0735	0.0971	-0.0400	-0.0425
Reintroduce to Waterbath		LENGTH CHANGE CALCULATIONS												
		Specimen 65	Reference Bar 65	Δ Length 65	Specimen 66	Reference Bar 66	Δ Length 66	Specimen 67	Reference Bar 67	Δ Length 67	Specimen 68	Reference Bar 68	Δ Length 68	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
820	Wednesday, September 21, 2016	0.0846	0.0971	-0.0300	0.0471	0.0971	-0.0300	0.0545	0.0971	-0.0320	0.0748	0.0971	-0.0270	-0.0298
822	Friday, September 23, 2016	0.0851	0.0971	-0.0250	0.0478	0.0971	-0.0230	0.0551	0.0971	-0.0260	0.0754	0.0971	-0.0210	-0.0238
826	Tuesday, September 27, 2016	0.0854	0.0971	-0.0220	0.0480	0.0971	-0.0210	0.0553	0.0971	-0.0240	0.0756	0.0971	-0.0190	-0.0215
833	Tuesday, October 04, 2016	0.0858	0.0971	-0.0180	0.0485	0.0971	-0.0160	0.0557	0.0971	-0.0200	0.0759	0.0971	-0.0160	-0.0175
847	Tuesday, October 18, 2016	0.0857	0.0971	-0.0190	0.0484	0.0971	-0.0170	0.0555	0.0971	-0.0220	0.0759	0.0971	-0.0160	-0.0185
854	Tuesday, October 25, 2016	0.0858	0.0971	-0.0180	0.0483	0.0971	-0.0180	0.0557	0.0971	-0.0200	0.0760	0.0971	-0.0150	-0.0178
875	Tuesday, November 15, 2016	0.0858	0.0967	-0.0140	0.0483	0.0967	-0.0140	0.0557	0.0967	-0.0160	0.0759	0.0967	-0.0120	-0.0140
919	Thursday, December 29, 2016	0.0860	0.0968	-0.0130	0.0486	0.0968	-0.0120	0.0560	0.0968	-0.0140	0.0763	0.0968	-0.0090	-0.0120

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:		
Customer: MDOT		Project: SP-9999-09(110)/106812-101000				Lab #: BCD						
MIX NUMBER		Mix 18.1				Set #: 18						
Date: 6/26/2014		Mix Code: Mix 18		f'c: 3,500 psi		Size(c.f.): 6.25		Factor: 0.23				
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorp- tion	Agg. FM			
Cement 1:	2.09	411.00	95.14	95.14	95.14	Type I-II Cement	3.15			Roller Meter Air 4.75		
Cement 2:	0.00	0.00	0.00	0.00			0.00			Coarseness and Workability (volume)		
Fly Ash:	1.01	137.00	31.71	31.71	31.71	Class F Fly Ash	2.18			Cumulative % retained on 3/8" 38.93		
Slag:	0.00	0.00	0.00	0.00			0.00			Cumulative % retained on No 8 68.56		
Sand 1:	6.25	1028.11	237.99	246.11	246.11	Sand	2.636	0.52%	2.36	Cumulative % passing No 8 31.21		
Coarse Aggregate 1:	12.83	2012.00	465.74	476.01	476.01	CA_ID5 - 67 Gravel	2.513	2.45%	6.54	Coarseness Factor 56.79		
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%		Workability Factor 31.21		
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%		Adjusted Workability Factor 30.78		
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%				
Air:	4.50%	1.22	0.00	0.00								
Water:	3.74	233.33	54.01	35.62	35.61		1.00					
"+-Air:	0.50%											
Total:	27.13	3821.44	884.59	884.59								
UW w/o Air:		147.44	148.20	148.20								
ADMIX INFORMATION							Aggregate Moistures					
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)				
Air	1.00	5.5	162.1	37.5	37.5	Air	Sand: 3.43%	8.12				
Water Reducer	5.00	27.4	810.3	187.6	187.6	Water Reducer	CA 1: 2.26%	10.27				
							CA 2: 0.00%	0.00				
							CA 3: 0.00%	0.00				
							CA 4: 0.00%	0.00				
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.				
Batch Time	1:06 PM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4					
Sample Time	1:15 PM		32.76	67.24	0	0	0					
Slump, in.	2.50	2 in.	0.0	0.0	0.0	0.0	0.0	0.0				
Mix Temp.	80.0	1.5 in.	0.0	0.0	0.0	0.0	0.0	0.0				
Air Temp.	82.0	1.0 in.	0.0	0.0	0.0	0.0	0.0	0.0				
ACF Air %	5.0	3/4 in.	0.0	2.2	0.0	0.0	0.0	1.5				
Unit Weight (pcf)	141.40	1/2 in.	0.0	32.6	0.0	0.0	0.0	21.9				
Design Unit Wt.	140.84	3/8 in.	0.0	23.1	0.0	0.0	0.0	15.5				
Yield	6.26	No. 4	0.4	37.3	0.0	0.0	0.0	25.2				
Relative Yield	1.00	No. 8	4.5	4.4	0.0	0.0	0.0	4.4				
Design w/c	0.426	No. 16	8.4	0.2	0.0	0.0	0.0	2.9				
Actual w/c	0.426	No. 30	17.0	0.0	0.0	0.0	0.0	5.6				
Fine/Coarse	0.51	No. 50	57.8	0.0	0.0	0.0	0.0	18.9				
Bag Factor	5.83	No. 100	11.3	0.0	0.0	0.0	0.0	3.7				
Theoretical Air (%)	4.10	Pan	0.2	0.1	0.0	0.0	0.0	0.1				

Draft Report

**BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength**

278 COMMERCE PARK DRIVE
RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
Fax: (601) 856-3552

Mix ID: _____ Mix 18 _____

BDC Project NO. 140241

Made Date: _____ Thursday, June 26, 2014 _____

COMPRESSION TESTS RESULTS

Specimen Age	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	7/3/2014	5.99	6.00	11.95	11.95	11.95	28.23	144.61	28.23	139840	4954	3	4840
6	7	7/3/2014	5.98	5.98	12.00	12.00	12.00	28.37	145.45	28.09	133680	4759	3	
7	7	7/3/2014	5.93	5.99	12.00	12.05	12.05	28.32	145.77	27.9	138410	4961	3	
8	7	7/3/2014	6.02	5.94	12.00	12.05	12.05	28.28	144.59	28.09	131300	4674	3	
9	7	7/3/2014	5.99	5.97	12.00	11.95	11.95	28.42	146.11	28.09	136300	4852	3	
11	14	7/10/2014	6.00	5.99	12.05	12.00	12.00	28.47	145.03	28.23	157540	5581	4	5660
12	14	7/10/2014	5.98	5.94	11.95	12.00	11.95	28.37	146.84	27.9	156340	5604	3	
13	14	7/10/2014	6.01	6.01	11.95	12.05	12.00	28.42	144.26	28.37	164030	5782	3	
14	14	7/10/2014	5.99	6.02	12.05	12.10	12.05	29.08	147.03	28.32	168020	5933	3	
15	14	7/10/2014	5.99	5.97	12.05	12.05	12.00	28.39	145.15	28.09	152160	5417	3	
17	28	7/24/2014	5.96	5.98	12.00	12.05	12.00	28.42	145.99	27.99	185650	6633	3	6630
18	28	7/24/2014	5.95	5.98	12.00	12.05	12.00	28.46	146.44	27.95	186230	6663	3	
19	28	7/24/2014	6.00	5.97	11.95	11.95	12.05	28.38	145.46	28.13	185520	6595	3	
20	28	7/24/2014	6.00	5.96	12.00	12.00	11.95	28.43	145.96	28.09	185820	6615	3	
21	28	7/24/2014	5.98	5.97	12.00	12.00	12.00	28.44	146.05	28.04	186380	6647	3	
23	90	9/24/2014	6.03	6.03	12.10	12.10	12.10	29.13	145.67	28.56	232710	8148	3	8000
24	90	9/24/2014	5.97	5.97	12.10	12.10	11.95	28.51	146.05	27.99	223670	7991	3	
25	90	9/24/2014	5.95	6.00	12.00	12.05	12.00	28.42	145.75	28.04	220910	7878	3	
26	90	9/24/2014	5.96	5.95	12.05	12.05	12.05	28.49	146.68	27.85	232630	8353	3	
27	90	9/24/2014	6.04	6.04	12.05	12.05	12.10	29.12	145.54	28.65	218920	7641	3	

Reported By: _____ Scott Bivings _____ Date: _____

Reviewed By: _____ Robert Varner _____ Date: 9/25/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 18 _____

Project No. 140241

Mix Date Thursday, June 26, 2014

Mix Time: 1:06 PM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	6.00	28.23	12.21	157540
12	5.96	27.9	12.14	156340
13	6.01	28.37	12.17	
14	6.01	28.32	12.20	
15	5.98	28.09	12.14	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 62776

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	10880	0.00085	0.00005	0.000004	384	62776	0.00650	0.00080	0.00039	0.000059	2213	5402618.8	5.40E+06	0.16
13	9030	0.00085	0.00000	0.000000	318	62776	0.00665	0.00080	0.00040	0.000059	2213	5450848.2	5.45E+06	0.17
13	8510	0.00085	0.00005	0.000004	300	62776	0.00675	0.00085	0.00040	0.000063	2213	5410519.9	5.40E+06	0.17
Average	9473	0.00085	0.00003	0.000002	334	62776	0.00663	0.00082	0.00040	0.000061	2213	5421329	5.40E+06	0.17
14	9110	0.00085	0.00015	0.000011	322	62776	0.00670	0.00085	0.00040	0.000063	2217	5405851.2	5.40E+06	0.15
14	8510	0.00085	0.00010	0.000007	300	62776	0.00685	0.00090	0.00041	0.000067	2217	5329942.6	5.35E+06	0.17
14	8090	0.00085	0.00005	0.000004	286	62776	0.00685	0.00085	0.00041	0.000063	2217	5371194.6	5.35E+06	0.17
Average	8570	0.00085	0.00010	0.000007	303	62776	0.00680	0.00087	0.00041	0.000064	2217	5368996.1	5.35E+06	0.16
15	10660	0.00085	0.00005	0.000004	379	62776	0.00680	0.00075	0.00041	0.000056	2235	5203952.5	5.20E+06	0.15
15	9840	0.00085	0.00005	0.000004	350	62776	0.00695	0.00075	0.00042	0.000056	2235	5156142.6	5.15E+06	0.14
15	10330	0.00085	0.00005	0.000004	368	62776	0.00665	0.00080	0.00040	0.000060	2235	5372023.5	5.35E+06	0.16
Average	10277	0.00085	0.00005	0.000004	366	62776	0.00680	0.00077	0.00041	0.000057	2235	5244039.5	5.25E+06	0.15
Overall Average	9440	0.00085	0.00006	0.000005	334	62776	0.00674	0.00082	0.00040	0.000061	2221	5344788.2	5.35E+06	0.16

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID Mix 18

Project No. 140241

Mix Date Thursday, June 26, 2014

Mix Time: 1:06 PM

28 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	5.97	27.99	12.22	185650
18	5.97	27.95	12.22	186230
19	5.98	28.13	12.18	
20	5.98	28.09	12.30	
21	5.98	28.04	12.21	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

Machine applied load (lbs.), **P**

Longitudinal gage reading, **G_{long}**

Longitudinal Strain, **ε_{long}**

Transverse gage reading, **G_{tran}**

Transverse Strain, **ε_{tran}**

Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 74376

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	10090	0.00085	0.00010	0.000007	359	74376	0.00780	0.00090	0.00047	0.000067	2644	5489537.1	5.50E+06	0.14
19	9110	0.00085	0.00005	0.000004	324	74376	0.00800	0.00085	0.00048	0.000063	2644	5417624.1	5.40E+06	0.14
19	8610	0.00085	0.00005	0.000004	306	74376	0.00810	0.00090	0.00048	0.000067	2644	5383971.3	5.40E+06	0.15
Average	9270	0.00085	0.00007	0.000005	330	74376	0.00797	0.00088	0.00048	0.000066	2644	5430377.5	5.45E+06	0.14
20	10760	0.00085	0.00010	0.000007	383	74376	0.00720	0.00090	0.00043	0.000067	2648	5952979.7	5.95E+06	0.16
20	10750	0.00085	0.00010	0.000007	383	74376	0.00705	0.00090	0.00042	0.000067	2648	6097645.7	6.10E+06	0.16
20	10840	0.00085	0.00000	0.000000	386	74376	0.00705	0.00080	0.00042	0.000060	2648	6089020.5	6.10E+06	0.16
Average	10783	0.00085	0.00007	0.000005	384	74376	0.00710	0.00087	0.00042	0.000065	2648	6046548.6	6.05E+06	0.16
21	8820	0.00085	0.00005	0.000004	315	74376	0.00790	0.00095	0.00047	0.000071	2652	5536448.2	5.55E+06	0.16
21	9740	0.00085	0.00005	0.000004	347	74376	0.00765	0.00090	0.00046	0.000067	2652	5659038.5	5.65E+06	0.16
21	9650	0.00085	0.00005	0.000004	344	74376	0.00770	0.00090	0.00046	0.000067	2652	5625636	5.65E+06	0.15
Average	9403	0.00085	0.00005	0.000004	335	74376	0.00775	0.00092	0.00046	0.000068	2652	567040.9	5.60E+06	0.16
Overall Average	9819	0.00085	0.00006	0.000005	350	74376	0.00761	0.00089	0.00045	0.000066	2648	5694655.7	5.70E+06	0.15

Reported By: Scott Bivings

Date:

Reviewed By: Robert Varner

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 18 _____

Project No. _____ 140241 _____

Mix Date _____ Thursday, June 26, 2014 _____

Mix Time: _____ 1:06 PM _____

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	6.03	28.56	12.31	232710
24	5.97	27.99	12.27	223670
25	5.98	28.04	12.19	
26	5.96	27.85	12.25	
27	6.04	28.65	12.27	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) _____ 91276 _____

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) _____ 0.00084 _____

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	9620	0.00085	0.00010	0.000007	343	91276	0.00900	0.00110	0.00054	0.000082	3255	5966938.7	5.95E+06	0.15
25	9580	0.00085	0.00010	0.000007	342	91276	0.00900	0.00105	0.00054	0.000078	3255	5969861.7	5.95E+06	0.15
25	9780	0.00085	0.00005	0.000004	349	91276	0.00895	0.00105	0.00054	0.000078	3255	5991945.9	6.00E+06	0.15
Average	9660	0.00085	0.00008	0.000006	345	91276	0.00898	0.00107	0.00054	0.000080	3255	5976248.8	6.00E+06	0.15
26	10880	0.00085	0.00005	0.000004	391	91276	0.00915	0.00095	0.00055	0.000071	3277	5808224	5.80E+06	0.14
26	11060	0.00085	0.00005	0.000004	397	91276	0.00915	0.00095	0.00055	0.000071	3277	5795219.8	5.80E+06	0.14
26	10380	0.00085	0.00010	0.000007	373	91276	0.00915	0.00110	0.00055	0.000082	3277	5844346.6	5.85E+06	0.15
Average	10773	0.00085	0.00007	0.000005	387	91276	0.00915	0.00100	0.00055	0.000075	3277	5815930.1	5.80E+06	0.14
27	10870	0.00085	0.00010	0.000007	379	91276	0.00950	0.00100	0.00057	0.000074	3186	5418620.7	5.40E+06	0.13
27	10000	0.00085	0.00005	0.000004	349	91276	0.00955	0.00095	0.00057	0.000070	3186	5445821.5	5.45E+06	0.13
27	10360	0.00085	0.00010	0.000007	362	91276	0.00960	0.00100	0.00057	0.000074	3186	5390767.1	5.40E+06	0.13
Average	10410	0.00085	0.00008	0.000006	363	91276	0.00955	0.00098	0.00057	0.000073	3186	5418403.1	5.40E+06	0.13
Overall Average	10281	0.00085	0.00008	0.000006	365	91276	0.00923	0.00102	0.00055	0.000076	3240	5736860.7	5.75E+06	0.14

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Vamer _____

Date: _____ 9/25/2014 _____

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241
Mix Number Mix 18 Set No: 18
Mix Date Thursday, June 26, 2014
Mix Time 1:06 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
69	10.0000	0.8140	0.8135	11.61950	1.6275	9.9920
70	10.0000	0.8120	0.8120	11.60000	1.6240	9.9760
71	10.0000	0.8140	0.8110	11.60250	1.6250	9.9775
72	10.0000	0.8135	0.8145	11.60550	1.6280	9.9775

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
10		Specimen 69	Reference Bar 69	Δ Length 69	Specimen 70	Reference Bar 70	Δ Length 70	Specimen 71	Reference Bar 71	Δ Length 71	Specimen 72	Reference Bar 72	Δ Length 72	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Friday, June 27, 2014	0.0895	0.0977	-0.0082	0.0704	0.0977	-0.0273	0.0735	0.0977	-0.0242	0.0807	0.0977	-0.0170	-0.0192
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
		Specimen 69	Reference Bar 69	Δ Length 69	Specimen 70	Reference Bar 70	Δ Length 70	Specimen 71	Reference Bar 71	Δ Length 71	Specimen 72	Reference Bar 72	Δ Length 72	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
7	Thursday, July 03, 2014	0.0895	0.0976	0.0010	0.0704	0.0976	0.0010	0.0735	0.0976	0.0010	0.0807	0.0976	0.0010	0.0010
11	Monday, July 07, 2014	0.0887	0.0976	-0.0070	0.0696	0.0976	-0.0070	0.0727	0.0976	-0.0070	0.0800	0.0976	-0.0060	-0.0068
14	Thursday, July 10, 2014	0.0886	0.0976	-0.0080	0.0695	0.0976	-0.0080	0.0725	0.0976	-0.0090	0.0798	0.0976	-0.0080	-0.0083
21	Thursday, July 17, 2014	0.0882	0.0976	-0.0120	0.0691	0.0976	-0.0120	0.0720	0.0976	-0.0140	0.0794	0.0976	-0.0120	-0.0125
35	Thursday, July 31, 2014	0.0875	0.0976	-0.0190	0.0685	0.0976	-0.0180	0.0715	0.0976	-0.0190	0.0789	0.0976	-0.0170	-0.0183
63	Thursday, August 28, 2014	0.0868	0.0975	-0.0250	0.0679	0.0975	-0.0230	0.0707	0.0975	-0.0260	0.0782	0.0975	-0.0230	-0.0243
119	Thursday, October 23, 2014	0.0862	0.0975	-0.0310	0.0672	0.0975	-0.0300	0.0702	0.0975	-0.0310	0.0775	0.0975	-0.0300	-0.0305
231	Thursday, February 12, 2015	0.0856	0.0975	-0.0370	0.0666	0.0975	-0.0360	0.0696	0.0975	-0.0370	0.0770	0.0975	-0.0350	-0.0363
455	Thursday, September 24, 2015	0.0851	0.0972	-0.0390	0.0661	0.0972	-0.0380	0.0690	0.0972	-0.0400	0.0767	0.0972	-0.0350	-0.0380
42	Calculated 35 Day Shrinkage			-0.0207			-0.0196			-0.0216			-0.0196	-0.0204
Note: Lowest Reading Value Recorded (Minimum)														
Reported by: <u>Scott Bivings</u>					Reviewed by: <u>Robert Varner 10/12/2015</u>									

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 18 Set No: 18
Mix Date Thursday, June 26, 2014
Mix Time 1:06 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
69	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
70	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
71	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
72	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

	Reference Bar Length (in.)	INITIAL READINGS												
	10	Specimen 69	Reference Bar 69	Δ Length 69	Specimen 70	Reference Bar 70	Δ Length 70	Specimen 71	Reference Bar 71	Δ Length 71	Specimen 72	Reference Bar 72	Δ Length 72	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
819	Thursday, September 22, 2016	0.0846	0.0971	-0.0430	0.0656	0.0971	-0.0420	0.0685	0.0971	-0.0440	0.0762	0.0971	-0.0390	-0.0420
Reintroduce to Waterbath		LENGTH CHANGE CALCULATIONS												
		Specimen 69	Reference Bar 69	Δ Length 69	Specimen 70	Reference Bar 70	Δ Length 70	Specimen 71	Reference Bar 71	Δ Length 71	Specimen 72	Reference Bar 72	Δ Length 72	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
820	Friday, September 23, 2016	0.0859	0.0971	-0.0300	0.0669	0.0971	-0.0290	0.0697	0.0971	-0.0320	0.0773	0.0971	-0.0280	-0.0298
823	Monday, September 26, 2016	0.0867	0.0971	-0.0220	0.0672	0.0971	-0.0260	0.0702	0.0971	-0.0270	0.0776	0.0971	-0.0250	-0.0250
826	Thursday, September 29, 2016	0.0865	0.0971	-0.0240	0.0676	0.0971	-0.0220	0.0703	0.0971	-0.0260	0.0780	0.0971	-0.0210	-0.0233
833	Thursday, October 06, 2016	0.0866	0.0971	-0.0230	0.0673	0.0971	-0.0250	0.0702	0.0971	-0.0270	0.0777	0.0971	-0.0240	-0.0248
847	Thursday, October 20, 2016	0.0870	0.0971	-0.0190	0.0677	0.0971	-0.0210	0.0706	0.0971	-0.0230	0.0781	0.0971	-0.0200	-0.0208
854	Thursday, October 27, 2016	0.0867	0.0969	-0.0200	0.0675	0.0969	-0.0210	0.0705	0.0969	-0.0220	0.0780	0.0969	-0.0190	-0.0205
875	Thursday, November 17, 2016	0.0867	0.0969	-0.0200	0.0677	0.0969	-0.0190	0.0706	0.0969	-0.0210	0.0782	0.0969	-0.0170	-0.0193
917	Thursday, December 29, 2016	0.0869	0.0968	-0.0170	0.0679	0.0968	-0.0160	0.0708	0.0968	-0.0180	0.0783	0.0968	-0.0150	-0.0165

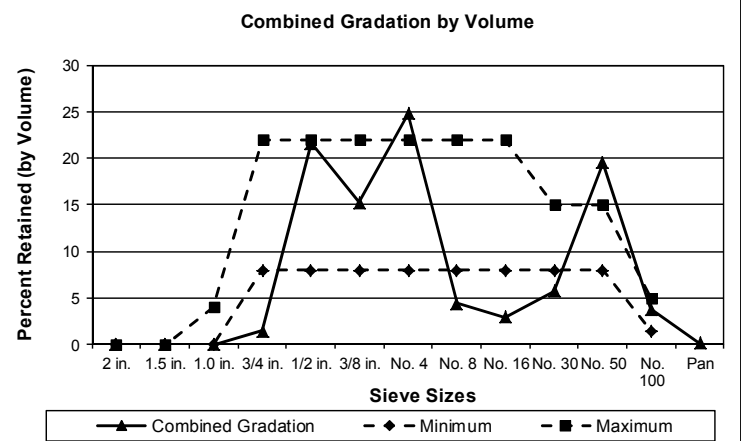
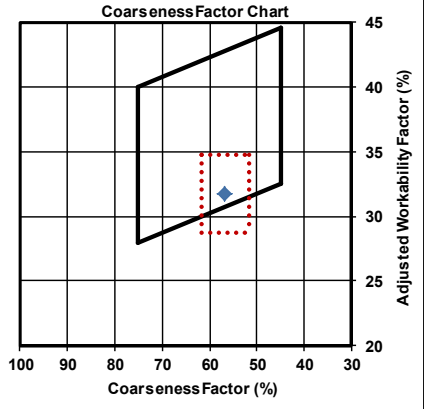
Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:		
Customer:	MDOT		Project:	SP-9999-09(110)/106812-101000				Lab #:	BCD			
MIX NUMBER	Mix 19.1						Set #:	19				
Date:	6/30/2014	Mix Code:	Mix 19	f'c:	3,500 psi	Size(c.f.):	6.25	Factor:	0.23			
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorption	Agg. FM			
Material	Vol. (c.f.)											
Cement 1:	2.09	411.00	95.14	95.14	95.14	Type III Cement	3.15			Roller Meter Air 4.5		
Cement 2:	0.00	0.00	0.00	0.00			0.00			Coarseness and Workability (volume)		
Fly Ash:	0.84	137.00	31.71	31.71	31.71	Class C Fly Ash	2.60			Cumulative % retained on 3/8" 38.34		
Slag:	0.00	0.00	0.00	0.00			0.00			Cumulative % retained on No 8 67.58		
Sand 1:	6.55	1076.84	249.27	262.29	262.29	Sand	2.636	0.52%	2.36	Cumulative % passing No 8 32.18		
Coarse Aggregate 1:	12.83	2012.00	465.74	476.01	476.01	CA_ID5 - 67 Gravel	2.513	2.45%	6.54	Coarseness Factor 56.72		
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%		Workability Factor 32.18		
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%		Adjusted Workability Factor 31.75		
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%				
Air:	4.50%	1.22	0.00	0.00	0.00							
Water:	3.47	216.67	50.15	26.86	26.86		1.00					
"+-Air:	0.50%											
Total:	27.00	3853.51	892.02	892.02								
UW w/o Air:		149.45	149.45	149.45								
ADMIX INFORMATION							Aggregate Moistures					
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)				
Air	0.50	2.7	81.0	18.8	18.8	Air	Sand:	5.25%	13.02			
Water Reducer	5.00	27.4	810.3	187.6	187.6	Water Reducer	CA 1	2.26%	10.27			
							CA 2	0.00%	0.00			
							CA 3	0.00%	0.00			
							CA 4	0.00%	0.00			
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.				
Batch Time	1:21 PM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4					
Sample Time	1:30 PM		33.79	66.21	0	0	0					
Slump, in.	1.25	2 in.	0.0	0.0	0.0	0.0	0.0	0.0				
Mix Temp.	81.8	1.5 in.	0.0	0.0	0.0	0.0	0.0	0.0				
Air Temp.	92.5	1.0 in.	0.0	0.0	0.0	0.0	0.0	0.0				
ACF Air %	4.5	3/4 in.	0.0	2.2	0.0	0.0	0.0	1.5				
Unit Weight (pcf)	145.00	1/2 in.	0.0	32.6	0.0	0.0	0.0	21.6				
Design Unit Wt.	142.72	3/8 in.	0.0	23.1	0.0	0.0	0.0	15.3				
Yield	6.15	No. 4	0.4	37.3	0.0	0.0	0.0	24.8				
Relative Yield	0.98	No. 8	4.5	4.4	0.0	0.0	0.0	4.4				
Design w/c	0.395	No. 16	8.4	0.2	0.0	0.0	0.0	3.0				
Actual w/c	0.395	No. 30	17.0	0.0	0.0	0.0	0.0	5.7				
Fine/Coarse	0.54	No. 50	57.8	0.0	0.0	0.0	0.0	19.5				
Bag Factor	5.83	No. 100	11.3	0.0	0.0	0.0	0.0	3.8				
Theoretical Air (%)	2.98	Pan	0.2	0.1	0.0	0.0	0.0	0.1				



Draft Report

**BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength**

278 COMMERCE PARK DRIVE
RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
Fax: (601) 856-3552

Mix ID: _____ Mix 19

BDC Project NO. 140241

Made Date: _____ Monday, June 30, 2014

COMPRESSION TESTS RESULTS

Specimen Age	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	7/7/2014	5.97	5.98	12.00	12.00	11.95	28.83	148.26	28.04	189270	6750	3	6820
6	7	7/7/2014	6.01	5.98	12.05	12.05	12.10	28.97	146.97	28.23	179700	6366	5	
7	7	7/7/2014	6.02	6.02	12.10	12.10	12.15	29.76	149.11	28.46	197600	6943	3	
8	7	7/7/2014	5.98	5.97	12.05	12.05	12.05	28.90	147.80	28.04	206220	7354	3	
9	7	7/7/2014	6.01	6.00	12.05	12.05	12.05	28.98	146.73	28.32	189670	6697	3	
11	14	7/14/2014	6.00	6.03	12.10	12.10	12.10	29.71	149.31	28.42	217700	7660	3	7980
12	14	7/14/2014	5.98	5.97	12.00	12.00	12.05	28.93	148.36	28.04	225190	8031	4	
13	14	7/14/2014	5.95	5.89	12.00	12.05	12.00	28.73	150.09	27.53	229330	8330	3	
14	14	7/14/2014	6.02	6.04	12.15	12.15	12.15	29.55	147.16	28.56	223790	7836	3	
15	14	7/14/2014	5.93	5.97	12.00	12.05	12.10	28.89	148.99	27.81	223680	8043	3	
17	28	7/28/2014	5.99	5.98	12.00	12.00	12.00	28.68	146.79	28.13	237520	8444	3	8240
18	28	7/28/2014	6.02	6.00	12.05	12.10	12.05	28.67	144.72	28.37	216800	7642	2	
19	28	7/28/2014	6.02	6.04	12.00	11.95	11.95	28.65	144.86	28.56	229260	8027	3	
20	28	7/28/2014	5.93	5.95	12.05	12.05	12.05	28.98	149.96	27.71	236760	8544	3	
21	28	7/28/2014	6.04	6.03	12.15	12.10	12.10	29.69	148.02	28.61	243950	8527	3	
23	90	9/28/2014	5.93	5.99	12.00	11.95	12.05	28.83	148.80	27.9	263090	9430	3	9500
24	90	9/28/2014	5.96	5.94	12.05	12.00	12.10	28.86	148.84	27.81	259820	9343	3	
25	90	9/28/2014	5.93	5.94	12.05	12.05	12.05	28.77	149.12	27.67	260260	9406	3	
26	90	9/28/2014	5.98	6.00	12.00	12.05	12.05	28.87	147.11	28.18	275410	9773	3	
27	90	9/28/2014	5.99	5.95	11.95	12.05	12.05	28.80	147.94	27.99	266910	9536	3	

Reported By: _____ Scott Bivings _____ Date: _____

Reviewed By: _____ Robert Varner _____ Date: 10/1/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
 AASHTO T97 Flexural Strength

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID: _____ Mix 19
 Made Date: _____ Monday, June 30, 2014

BDC Project NO. 140241

Specimen No.	Specimen Age	Test Date	Depth 1 (0.05 in)	Depth 2 (0.05 in)	Depth 3 (0.05 in)	Avg Depth (in.)	Width 1 (0.05 in)	Width 2 (0.05 in)	Width 3 (0.05 in)	Avg Width (in.)	Max Load	Flex Strength (psi)	Avg (psi)
29	7	7/7/2014	6.05	6.05	6.05	6.05	6.05	6.10	6.15	6.10	9740	785	795
30	7	7/7/2014	6.05	6.05	6.05	6.05	6.10	6.05	6.05	6.07	9670	783	
31	7	7/7/2014	6.10	6.10	6.10	6.10	6.00	5.95	6.00	5.98	10020	811	
32	14	7/14/2014	6.05	6.10	6.05	6.07	6.00	6.00	6.00	6.00	10340	842	825
33	14	7/14/2014	6.05	6.10	6.05	6.07	6.05	6.05	6.05	6.05	9760	788	
34	14	7/14/2014	6.10	6.10	6.10	6.10	6.10	6.05	6.05	6.07	10520	838	
35	28	7/28/2014	6.10	6.10	6.05	6.08	6.10	6.05	6.05	6.07	10550	846	845
36	28	7/28/2014	6.10	6.10	6.15	6.12	6.00	6.00	6.00	6.00	10580	847	
37	28	7/28/2014	6.10	6.10	6.05	6.08	6.10	6.05	6.05	6.07	10450	838	
38	90	9/28/2014	6.05	6.05	6.05	6.05	6.00	6.05	6.10	6.05	10750	874	890
39	90	9/28/2014	6.10	6.10	6.05	6.08	6.10	6.10	6.11	6.10	11070	884	
40	90	9/28/2014	6.10	6.10	6.05	6.08	6.05	6.05	6.05	6.05	11320	911	

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Varner _____

Date: _____ 10/1/2014 _____

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 19 _____

Project No. 140241

Mix Date Monday, June 30, 2014

Mix Time: 1:21 PM

7 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	5.98	28.04	12.19	189270
6	6.00	28.23	12.28	179700
7	6.02	28.46	12.38	
8	5.98	28.04	12.29	
9	6.01	28.32	12.21	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.) 4.95

Longitudinal gage to yoke supports (0.01 in.) 5.40

Longitudinal Gage length (0.01 in.) 8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.) 3.91

Transverse gage to mid yoke supports (0.01 in.) 4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 73794

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
7	8480	0.00085	0.00000	0.000000	298	73794	0.00745	0.00080	0.00045	0.000059	2593	5804385	5.80E+06	0.15
7	8630	0.00085	0.00005	0.000004	303	73794	0.00750	0.00095	0.00045	0.000070	2593	5747602	5.75E+06	0.17
7	9390	0.00085	0.00010	0.000007	330	73794	0.00745	0.00085	0.00045	0.000063	2593	5723514.3	5.70E+06	0.14
Average	8833	0.00085	0.00005	0.000004	310	73794	0.00747	0.00087	0.00045	0.000064	2593	5758500.4	5.75E+06	0.15
8	9930	0.00085	0.00005	0.000004	354	73794	0.00735	0.00080	0.00044	0.000060	2632	5848974.6	5.85E+06	0.14
8	10340	0.00085	0.00005	0.000004	369	73794	0.00730	0.00080	0.00044	0.000060	2632	5856379.6	5.85E+06	0.14
8	10320	0.00085	0.00005	0.000004	368	73794	0.00735	0.00090	0.00044	0.000067	2632	5813256.5	5.80E+06	0.16
Average	10197	0.00085	0.00005	0.000004	364	73794	0.00733	0.00083	0.00044	0.000062	2632	5839536.9	5.85E+06	0.15
9	10260	0.00085	0.00005	0.000004	362	73794	0.00755	0.00085	0.00045	0.000063	2606	5589594.1	5.60E+06	0.15
9	10040	0.00085	0.00000	0.000000	355	73794	0.00750	0.00085	0.00045	0.000063	2606	5651035.5	5.65E+06	0.16
9	9000	0.00085	0.00010	0.000007	318	73794	0.00745	0.00085	0.00045	0.000063	2606	5786638.7	5.80E+06	0.14
Average	9767	0.00085	0.00005	0.000004	345	73794	0.00750	0.00085	0.00045	0.000063	2606	5675756.1	5.70E+06	0.15
Overall Average	9599	0.00085	0.00005	0.000004	340	73794	0.00743	0.00085	0.00044	0.000063	2610	5757931.1	5.75E+06	0.15

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 19 _____

Project No. 140241

Mix Date Monday, June 30, 2014

Mix Time: 1:21 PM

14 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	6.02	28.42	12.26	217700
12	5.98	28.04	12.22	225190
13	5.92	27.53	12.14	
14	6.03	28.56	12.27	
15	5.95	27.81	12.29	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:
 Machine applied load (lbs.), **P**
 Longitudinal gage reading, **G_{long}**
 Longitudinal Strain, **ε_{long}**
 Transverse gage reading, **G_{tran}**
 Transverse Strain, **ε_{tran}**
 Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 88578

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	8550	0.00085	0.00010	0.000008	311	88578	0.00955	0.00100	0.00057	0.000075	3218	5580350.2	5.60E+06	0.13
13	9780	0.00085	0.00010	0.000008	355	88578	0.00940	0.00110	0.00056	0.000083	3218	5590825.1	5.60E+06	0.15
13	8970	0.00085	0.00010	0.000008	326	88578	0.00970	0.00125	0.00058	0.000094	3218	5457122.6	5.45E+06	0.16
Average	9100	0.00085	0.00010	0.000008	331	88578	0.00955	0.00112	0.00057	0.000084	3218	5542766	5.55E+06	0.15
14	9940	0.00085	0.00005	0.000004	348	88578	0.00890	0.00120	0.00053	0.000089	3101	5711740.4	5.70E+06	0.18
14	9950	0.00085	0.00005	0.000004	348	88578	0.00895	0.00120	0.00054	0.000089	3101	5675820.1	5.70E+06	0.18
14	10980	0.00085	0.00010	0.000007	384	88578	0.00885	0.00120	0.00053	0.000089	3101	5671368	5.65E+06	0.17
Average	10290	0.00085	0.00007	0.000005	360	88578	0.00890	0.00120	0.00053	0.000089	3101	5686309.5	5.70E+06	0.17
15	10850	0.00085	0.00005	0.000004	390	88578	0.00840	0.00110	0.00050	0.000083	3185	6181174.5	6.20E+06	0.17
15	10500	0.00085	0.00015	0.000011	378	88578	0.00830	0.00135	0.00050	0.000101	3185	6292197.7	6.30E+06	0.20
15	9730	0.00085	0.00010	0.000008	350	88578	0.00850	0.00140	0.00051	0.000105	3185	6188422.3	6.20E+06	0.21
Average	10360	0.00085	0.00010	0.000008	373	88578	0.00840	0.00128	0.00050	0.000096	3185	6220598.1	6.20E+06	0.20
Overall Average	9917	0.00085	0.00009	0.000007	354	88578	0.00895	0.00120	0.00054	0.000090	3168	5816557.9	5.80E+06	0.17

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/29/2014

Draft Report

**BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS**

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241

Mix Number Mix 19 Set No: 19
Mix Date Monday, June 30, 2014
Mix Time 1:21 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
73	10.0000	0.8120	0.8125	11.60300	1.6245	9.9785
74	10.0000	0.8130	0.8110	11.60250	1.6240	9.9785
75	10.0000	0.8135	0.8135	11.60050	1.6270	9.9735
76	10.0000	0.8115	0.8125	11.58900	1.6240	9.9650

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
10		Specimen 73	Reference Bar 73	Δ Length 73	Specimen 74	Reference Bar 74	Δ Length 74	Specimen 75	Reference Bar 75	Δ Length 75	Specimen 76	Reference Bar 76	Δ Length 76	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Tuesday, July 01, 2014	0.0738	0.0977	-0.0239	0.0754	0.0977	-0.0223	0.0759	0.0977	-0.0218	0.0635	0.0977	-0.0342	-0.0256
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
		Specimen 73	Reference Bar 73	Δ Length 73	Specimen 74	Reference Bar 74	Δ Length 74	Specimen 75	Reference Bar 75	Δ Length 75	Specimen 76	Reference Bar 76	Δ Length 76	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
7	Monday, July 07, 2014	0.0739	0.0975	0.0030	0.0755	0.0975	0.0030	0.0759	0.0975	0.0020	0.0637	0.0976	0.0030	0.0027
11	Friday, July 11, 2014	0.0732	0.0975	-0.0040	0.0748	0.0975	-0.0040	0.0751	0.0975	-0.0060	0.0629	0.0975	-0.0040	-0.0045
14	Monday, July 14, 2014	0.0729	0.0975	-0.0070	0.0744	0.0975	-0.0080	0.0748	0.0975	-0.0090	0.0625	0.0975	-0.0080	-0.0080
21	Monday, July 21, 2014	0.0726	0.0976	-0.0110	0.0741	0.0976	-0.0120	0.0744	0.0976	-0.0140	0.0622	0.0976	-0.0120	-0.0123
35	Monday, August 04, 2014	0.0719	0.0975	-0.0170	0.0735	0.0975	-0.0170	0.0737	0.0975	-0.0200	0.0615	0.0975	-0.0180	-0.0180
63	Monday, September 01, 2014	0.0711	0.0975	-0.0250	0.0727	0.0975	-0.0250	0.0730	0.0975	-0.0270	0.0607	0.0975	-0.0260	-0.0258
119	Monday, October 27, 2014	0.0705	0.0975	-0.0310	0.0720	0.0975	-0.0320	0.0724	0.0975	-0.0330	0.0600	0.0975	-0.0330	-0.0323
231	Monday, February 16, 2015	0.0699	0.0973	-0.0350	0.0715	0.0973	-0.0350	0.0717	0.0973	-0.0380	0.0593	0.0973	-0.0380	-0.0365
455	Monday, September 28, 2015	0.0695	0.0972	-0.0380	0.0710	0.0972	-0.0390	0.0713	0.0972	-0.0410	0.0590	0.0972	-0.0400	-0.0395
42	Calculated 35 Day Shrinkage			-0.0197			-0.0202			-0.0222			-0.0209	-0.0208

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 10/12/2015

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 19 Set No: 19
Mix Date Monday, June 30, 2014
Mix Time 1:21 PM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
73	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
74	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
75	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
76	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

Specimen Age	Reference Bar Length (in.)	INITIAL READINGS												
		Specimen 73	Reference Bar 73	Δ Length 73	Specimen 74	Reference Bar 74	Δ Length 74	Specimen 75	Reference Bar 75	Δ Length 75	Specimen 76	Reference Bar 76	Δ Length 76	Average
	10	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
819	Monday, September 26, 2016	0.0691	0.0971	-0.0410	0.0706	0.0971	-0.0420	0.0708	0.0971	-0.0450	0.0584	0.0971	-0.0450	-0.0433
Reintroduce to Waterbath		LENGTH CHANGE CALCULATIONS												
		Specimen 73	Reference Bar 73	Δ Length 73	Specimen 74	Reference Bar 74	Δ Length 74	Specimen 75	Reference Bar 75	Δ Length 75	Specimen 76	Reference Bar 76	Δ Length 76	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
820	Tuesday, September 27, 2016	0.0706	0.0971	-0.0260	0.0720	0.0971	-0.0280	0.0723	0.0971	-0.0300	0.0599	0.0971	-0.0300	-0.0285
822	Thursday, September 29, 2016	0.0710	0.0971	-0.0220	0.0723	0.0971	-0.0250	0.0727	0.0971	-0.0260	0.0602	0.0971	-0.0270	-0.0250
826	Monday, October 03, 2016	0.0712	0.0971	-0.0200	0.0728	0.0971	-0.0200	0.0731	0.0971	-0.0220	0.0607	0.0971	-0.0220	-0.0210
833	Monday, October 10, 2016	0.0711	0.0971	-0.0210	0.0728	0.0971	-0.0200	0.0730	0.0971	-0.0230	0.0606	0.0971	-0.0230	-0.0218
847	Monday, October 24, 2016	0.0714	0.0968	-0.0150	0.0728	0.0968	-0.0170	0.0731	0.0968	-0.0190	0.0607	0.0968	-0.0190	-0.0175
854	Monday, October 31, 2016	0.0714	0.0969	-0.0160	0.0727	0.0969	-0.0190	0.0733	0.0969	-0.0180	0.0607	0.0969	-0.0200	-0.0183
875	Monday, November 21, 2016	0.0716	0.0968	-0.0130	0.0728	0.0968	-0.0170	0.0733	0.0968	-0.0170	0.0608	0.0968	-0.0180	-0.0163
913	Thursday, December 29, 2016	0.0717	0.0969	-0.0130	0.0731	0.0969	-0.0150	0.0735	0.0969	-0.0160	0.0612	0.0969	-0.0150	-0.0148

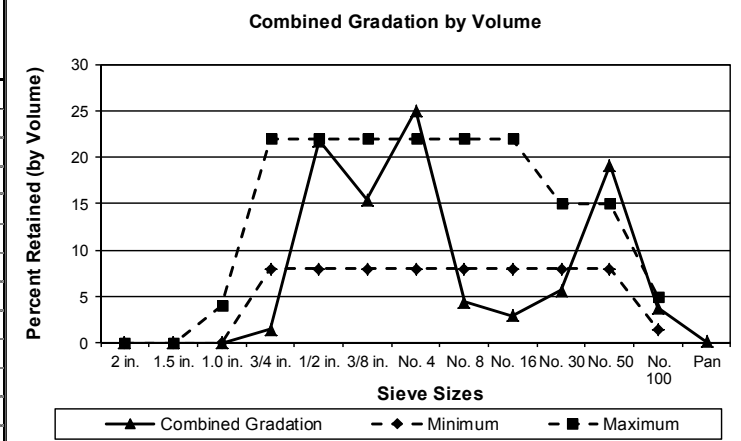
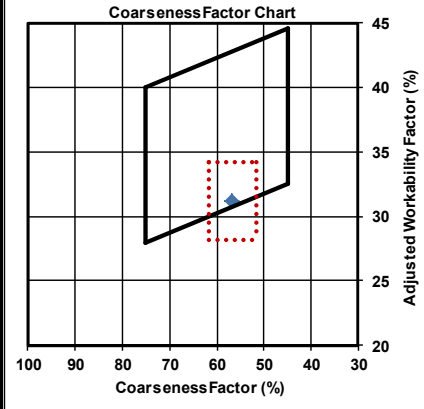
Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varner 12/29/2016

Draft Report

BCD 140241										Notes:		
Customer: MDOT		Project: SP-9999-09(110)/106812-101000				Lab #: BCD						
MIX NUMBER		Mix 20.1				Set #: 20						
Date: 7/2/2014		Mix Code: Mix 20		f'c: 3,500 psi		Size(c.f.): 6.25		Factor: 0.23				
MIX DESIGN INFO		SSD mix 1 cu. yd. Wt. (lbs.)	SSD mix lab batch Wt. (lbs.)	Adjusted lab batch Wt. (lbs.)	Actual lab batch Wt. (lbs.)	Material Source	SSD Specific Gravity	Agg. absorp- tion	Agg. FM			
Material	Vol. (c.f.)									Roller Meter Air 4		
Cement 1:	1.39	274.00	63.43	63.43	63.43	Type II Cement	3.15			Coarseness and Workability (volume)		
Cement 2:	0.00	0.00	0.00	0.00			0.00			Cumulative % retained on 3/8" 38.69		
Fly Ash:	0.00	0.00	0.00	0.00			2.60			Cumulative % retained on No 8 68.17		
Slag:	1.52	274.00	63.43	63.43	63.43	Slag Cement	2.89			Cumulative % passing No 8 31.59		
Sand 1:	6.37	1047.53	242.48	253.44	253.44	Sand	2.636	0.52%	2.36	Coarseness Factor 56.76		
Coarse Aggregate 1:	12.83	2012.00	465.74	476.01	476.01	CA_ID5 - 67 Gravel	2.513	2.45%	6.54	Workability Factor 31.59		
Coarse Aggregate 2:	0.00	0.00	0.00	0.00			1.000	1.00%		Adjusted Workability Factor 31.16		
Coarse Aggregate 3:	0.00	0.00	0.00	0.00			1.000	1.00%				
Coarse Aggregate 4:	0.00	0.00	0.00	0.00			1.000	1.00%				
Air:	4.50%	1.22	0.00	0.00								
Water:	3.67	229.16	53.05	31.82	31.82		1.00					
"+-Air:	0.50%											
Total:	27.00	3836.69	888.12	888.12								
UW w/o Air:		148.80	148.80	148.80								
ADMIX INFORMATION						Aggregate Moistures						
Type	oz /cwt	oz /cy	ml /cy	batch ml	actual ml	Brand / Name	Free H ₂ O Content	Batch free H ₂ O (lbs.)				
Air	0.56	3.1	90.8	21.0	21.0	Air	Sand:	4.54%	10.95			
Water Reducer	5.00	27.4	810.3	187.6	187.6	Water Reducer	CA 1	2.26%	10.27			
							CA 2	0.00%	0.00			
							CA 3	0.00%	0.00			
							CA 4	0.00%	0.00			
PLASTIC TEST RESULTS		Aggregate - Individual Percent Retained, by weight						Comb. Agg Grad., by vol.				
Batch Time	8:21 AM	Vol %	Sand 1	CA 1	CA 2	CA 3	CA 4					
Sample Time	8:30 AM		33.17	66.83	0	0	0					
Slump, in.	1.25	2 in.	0.0	0.0	0.0	0.0	0.0					
Mix Temp.	78.3	1.5 in.	0.0	0.0	0.0	0.0	0.0					
Air Temp.	91.0	1.0 in.	0.0	0.0	0.0	0.0	0.0					
ACF Air %	4.4	3/4 in.	0.0	2.2	0.0	0.0	0.0					
Unit Weight (pcf)	144.00	1/2 in.	0.0	32.6	0.0	0.0	0.0					
Design Unit Wt.	142.10	3/8 in.	0.0	23.1	0.0	0.0	0.0					
Yield	6.17	No. 4	0.4	37.3	0.0	0.0	0.0					
Relative Yield	0.99	No. 8	4.5	4.4	0.0	0.0	0.0					
Design w/c	0.418	No. 16	8.4	0.2	0.0	0.0	0.0					
Actual w/c	0.418	No. 30	17.0	0.0	0.0	0.0	0.0					
Fine/Coarse	0.52	No. 50	57.8	0.0	0.0	0.0	0.0					
Bag Factor	5.83	No. 100	11.3	0.0	0.0	0.0	0.0					
Theoretical Air (%)	3.22	Pan	0.2	0.1	0.0	0.0	0.0					



Draft Report

**BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS AND ENGINEERING TESTING SERVICES
AASHTO T22 Compressive Strength**

278 COMMERCE PARK DRIVE
RIDGELAND, MISSISSIPPI 39157

Phone: (601) 856-2332
Fax: (601) 856-3552

Mix ID: _____ Mix 20

BDC Project NO. 140241

Made Date: Wednesday, July 02, 2014

COMPRESSION TESTS RESULTS

Specimen Age	Specimen Age	Test Date	Dim. 1 (0.01 in.)	Dim 2 (0.01 in.)	Length 1 (0.05 in.)	Length 2 (0.05 in.)	Length 3 (0.05 in.)	Weight (0.01 lbs)	Density (1 pcf)	Area (in. ²)	Maximum Load (lbs)	Strength (psi)	Type Fracture	Average Strength (psi)
5	7	7/9/2014	6.04	6.04	12.05	12.05	12.05	29.39	147.09	28.65	163020	5690	3	5720
6	7	7/9/2014	6.06	6.11	12.10	12.10	12.10	29.40	144.37	29.08	169210	5819	3	
7	7	7/9/2014	6.02	6.02	12.15	12.05	12.05	29.54	148.41	28.46	159300	5597	3	
8	7	7/9/2014	6.03	6.04	12.15	12.10	12.10	29.58	147.47	28.61	160300	5603	3	
9	7	7/9/2014	6.01	6.00	12.15	12.15	12.15	29.61	148.69	28.32	167400	5911	3	
11	14	7/16/2014	6.01	6.03	12.10	12.15	12.15	29.47	147.45	28.46	203230	7141	3	7320
12	14	7/16/2014	6.00	6.03	12.15	12.20	12.20	29.67	148.09	28.42	211640	7447	3	
13	14	7/16/2014	6.03	6.03	12.25	12.25	12.15	29.70	147.10	28.56	209670	7341	3	
14	14	7/16/2014	6.00	6.03	12.15	12.15	12.20	29.63	148.09	28.42	212150	7465	3	
15	14	7/16/2014	6.01	6.05	12.25	12.25	12.10	29.64	147.00	28.56	206080	7216	3	
17	28	7/30/2014	6.03	6.02	12.15	12.15	12.10	29.51	147.41	28.51	228810	8026	3	7910
18	28	7/30/2014	6.03	6.02	12.25	12.25	12.25	29.76	147.24	28.51	228340	8009	3	
19	28	7/30/2014	6.05	6.07	12.10	12.10	12.10	29.55	146.31	28.84	228280	7915	3	
20	28	7/30/2014	6.03	6.02	12.10	12.15	12.15	29.52	147.46	28.51	223460	7838	3	
21	28	7/30/2014	6.03	6.01	12.10	12.15	12.20	29.59	147.85	28.46	220570	7750	3	
23	90	9/30/2014	6.06	6.04	12.15	12.10	12.15	29.51	146.19	28.75	247160	8597	3	8560
24	90	9/30/2014	6.05	6.02	12.20	12.15	12.10	29.54	146.87	28.61	227180	7941	3	
25	90	9/30/2014	6.04	6.05	12.15	12.15	12.10	29.59	146.83	28.7	247010	8607	3	
26	90	9/30/2014	6.04	6.02	12.15	12.10	12.15	29.65	147.86	28.56	249110	8722	3	
27	90	9/30/2014	6.01	6.03	12.10	12.10	12.10	29.51	148.06	28.46	254600	8946	3	

Reported By: _____ Scott Bivings _____ Date: _____

Reviewed By: _____ Robert Varner _____ Date: 10/1/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 20

Project No. 140241

Mix Date Wednesday, July 02, 2014

Mix Time: 8:21 AM

7 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
5	6.04	28.65	12.35	163020
6	6.09	29.08	12.23	169210
7	6.02	28.46	12.34	
8	6.04	28.61	12.34	
9	6.01	28.32	12.33	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 66446

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

7 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data						40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ		P	G _{long}	G _{tran}	ε _{long}	ε _{tran}		σ	MOE (psi)	MOE (50,000 psi)
7	9820	0.00085	0.00005	0.000004	345		66446	0.00755	0.00095	0.00045	0.000070	2335	4957335.5	4.95E+06	0.17
7	9270	0.00085	0.00005	0.000004	326		66446	0.00770	0.00100	0.00046	0.000074	2335	4896094	4.90E+06	0.17
7	8450	0.00085	0.00010	0.000007	297		66446	0.00805	0.00105	0.00048	0.000078	2335	4725350.6	4.75E+06	0.16
Average	9180	0.00085	0.00007	0.000005	323		66446	0.00777	0.00100	0.00046	0.000074	2335	4859593.4	4.85E+06	0.17
8	9640	0.00085	0.00005	0.000004	337		66446	0.00695	0.00080	0.00042	0.000059	2322	5432526.9	5.45E+06	0.15
8	7970	0.00085	0.00005	0.000004	279		66446	0.00705	0.00080	0.00042	0.000059	2322	5502234.6	5.50E+06	0.15
8	9280	0.00085	0.00005	0.000004	324		66446	0.00685	0.00085	0.00041	0.000063	2322	5557864.1	5.55E+06	0.16
Average	8963	0.00085	0.00005	0.000004	313		66446	0.00695	0.00082	0.00042	0.000060	2322	5497541.9	5.50E+06	0.16
9	9780	0.00085	0.00005	0.000004	345		66446	0.00670	0.00080	0.00040	0.000059	2346	5708045.4	5.70E+06	0.16
9	10660	0.00085	0.00000	0.000000	376		66446	0.00665	0.00070	0.00040	0.000052	2346	5667731.2	5.65E+06	0.15
9	9740	0.00085	0.00005	0.000004	344		66446	0.00675	0.00075	0.00040	0.000056	2346	5663778.8	5.65E+06	0.15
Average	10060	0.00085	0.00003	0.000002	355		66446	0.00670	0.00075	0.00040	0.000056	2346	5679851.8	5.70E+06	0.15
Overall Average	9401	0.00085	0.00005	0.000004	330		66446	0.00714	0.00086	0.00043	0.000063	2334	5345662.3	5.35E+06	0.16

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 20 _____

Project No. 140241

Mix Date Wednesday, July 02, 2014

Mix Time: 8:21 AM

14 DAY CYLINDER DATA

Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
11	6.02	28.46	12.37	203230
12	6.02	28.42	12.48	211640
13	6.03	28.56	12.45	
14	6.02	28.42	12.43	
15	6.03	28.56	12.45	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

40% of Ultimate Load (lbs.) 82974

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

14 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
13	9610	0.00085	0.00000	0.000000	336	82974	0.00845	0.00095	0.00051	0.000070	2905	5643620.6	5.65E+06	0.15
13	10200	0.00085	0.00000	0.000000	357	82974	0.00835	0.00100	0.00050	0.000074	2905	5672741.7	5.65E+06	0.16
13	9900	0.00085	0.00015	0.000011	347	82974	0.00845	0.00110	0.00051	0.000081	2905	5621311.9	5.60E+06	0.15
Average	9903	0.00085	0.00005	0.000004	347	82974	0.00842	0.00102	0.00050	0.000075	2905	5645891.4	5.65E+06	0.16
14	10970	0.00085	0.00000	0.000000	386	82974	0.00815	0.00080	0.00049	0.000059	2920	5794611.5	5.80E+06	0.14
14	10790	0.00085	0.00000	0.000000	380	82974	0.00815	0.00080	0.00049	0.000059	2920	5809097.2	5.80E+06	0.14
14	10260	0.00085	0.00005	0.000004	361	82974	0.00860	0.00085	0.00051	0.000063	2920	5512567.4	5.50E+06	0.13
Average	10673	0.00085	0.00002	0.000001	376	82974	0.00830	0.00082	0.00050	0.000061	2920	5705425.4	5.70E+06	0.13
15	9990	0.00085	0.00000	0.000000	350	82974	0.00810	0.00095	0.00048	0.000070	2905	5884919.2	5.90E+06	0.16
15	10430	0.00085	0.00005	0.000004	365	82974	0.00870	0.00105	0.00052	0.000078	2905	5403124.9	5.40E+06	0.16
15	10740	0.00085	0.00010	0.000007	376	82974	0.00795	0.00115	0.00048	0.000085	2905	5947260.2	5.95E+06	0.18
Average	10387	0.00085	0.00005	0.000004	364	82974	0.00825	0.00105	0.00049	0.000078	2905	5745101.4	5.75E+06	0.17
Overall Average	10321	0.00085	0.00004	0.000003	362	82974	0.00832	0.00096	0.00050	0.000071	2910	5698806.1	5.70E+06	0.15

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Vamer

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 20 _____

Project No. 140241

Mix Date Wednesday, July 02, 2014

Mix Time: 8:21 AM

28 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
17	6.03	28.51	12.30	228810
18	6.03	28.51	12.43	228340
19	6.06	28.84	12.27	
20	6.03	28.51	12.28	
21	6.02	28.46	12.30	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	<u>4.95</u>
Longitudinal gage to yoke supports (0.01 in.)	<u>5.40</u>
Longitudinal Gage length (0.01 in.)	<u>8.00</u>

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	<u>3.91</u>
Transverse gage to mid yoke supports (0.01 in.)	<u>4.85</u>

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) 91430

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) 0.00084

28 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
19	12900	0.00085	0.00005	0.000004	447	91430	0.00875	0.00095	0.00052	0.000070	3170	5755583.9	5.75E+06	0.14
19	15980	0.00085	0.00010	0.000007	554	91430	0.00835	0.00100	0.00050	0.000074	3170	5824235.8	5.80E+06	0.15
19	15570	0.00085	0.00015	0.000011	540	91430	0.00830	0.00105	0.00050	0.000077	3170	5895114.5	5.90E+06	0.15
Average	14817	0.00085	0.00010	0.000007	514	91430	0.00847	0.00100	0.00051	0.000074	3170	5824978.1	5.80E+06	0.15
20	11780	0.00085	0.00010	0.000007	413	91430	0.00800	0.00110	0.00048	0.000081	3207	6523492.5	6.50E+06	0.17
20	11520	0.00085	0.00005	0.000004	404	91430	0.00795	0.00095	0.00048	0.000070	3207	6590788.7	6.60E+06	0.16
20	11220	0.00085	0.00000	0.000000	394	91430	0.00795	0.00090	0.00048	0.000067	3207	6615532	6.60E+06	0.16
Average	11507	0.00085	0.00005	0.000004	404	91430	0.00797	0.00098	0.00048	0.000073	3207	6576604.4	6.60E+06	0.16
21	11760	0.00085	0.00005	0.000004	413	91430	0.01000	0.00110	0.00060	0.000082	3213	5109956.6	5.10E+06	0.14
21	10580	0.00085	0.00000	0.000000	372	91430	0.01010	0.00105	0.00060	0.000078	3213	5129662.2	5.15E+06	0.14
21	10040	0.00085	0.00010	0.000007	353	91430	0.01050	0.00115	0.00063	0.000085	3213	4950176.8	4.95E+06	0.13
Average	10793	0.00085	0.00005	0.000004	379	91430	0.01020	0.00110	0.00061	0.000082	3213	5063265.2	5.05E+06	0.14
Overall Average	12372	0.00085	0.00007	0.000005	432	91430	0.00888	0.00103	0.00053	0.000076	3197	5821615.9	5.80E+06	0.15

Reported By: Scott Bivings

Date: _____

Reviewed By: Robert Varner

Date: 8/29/2014

Draft Report

BURNS COOLEY DENNIS, INC.
CONSTRUCTION MATERIALS ENGINEERING AND TESTING SERVICES
ASTM C 469 Modulus of Elasticity and Poisson's Ratio

278 COMMERCE PARK DRIVE
 RIDGELAND, MS 39157

PHONE: (601) 856-2332
 FAX: (601) 856-3552

Mix ID _____ Mix 20 _____

Project No. _____ 140241 _____

Mix Date _____ Wednesday, July 02, 2014 _____

Mix Time: _____ 8:21 AM _____

90 DAY CYLINDER DATA				
Specimen Number	Average Dia. (0.01 in.)	Area (in. ²)	Length Cap (0.01 in.)	Ultimate Load
23	6.05	28.75	12.33	247160
24	6.04	28.61	12.24	227180
25	6.05	28.7	12.33	
26	6.03	28.56	12.35	
27	6.02	28.46	12.26	

Compressometer Calibration

Pivot rod to yoke supports (0.01 in.)	4.95
Longitudinal gage to yoke supports (0.01 in.)	5.40
Longitudinal Gage length (0.01 in.)	8.00

Extensometer Calibration

Hinge to mid yoke supports (0.01 in.)	3.91
Transverse gage to mid yoke supports (0.01 in.)	4.85

Variable Definitions:

- Machine applied load (lbs.), **P**
- Longitudinal gage reading, **G_{long}**
- Longitudinal Strain, **ε_{long}**
- Transverse gage reading, **G_{tran}**
- Transverse Strain, **ε_{tran}**
- Compressive Stress, **σ**

40% of Ultimate Load (lbs.) _____ 94868 _____

Longitudinal Gage Reading at Longitudinal Strain of 50 Millionths psi (in.) _____ 0.00084 _____

90 DAY MODULUS OF ELASTICITY AND POISSON'S RATIO

Specimen Number	50 millionths Data					40 % Ultimate Load Data						Results		
	P	G _{long}	G _{tran}	ε _{tran}	σ	P	G _{long}	G _{tran}	ε _{long}	ε _{tran}	σ	MOE (psi)	MOE (50,000 psi)	Poisson's Ratio (μ)
25	12670	0.00085	0.00000	0.000000	441	94868	0.00755	0.00105	0.00045	0.000077	3306	7135865.9	7.15E+06	0.19
25	11950	0.00085	0.00005	0.000004	416	94868	0.00755	0.00105	0.00045	0.000077	3306	7198371.3	7.20E+06	0.18
25	12010	0.00085	0.00015	0.000011	418	94868	0.00760	0.00115	0.00045	0.000085	3306	7139987.3	7.15E+06	0.18
Average	12210	0.00085	0.00007	0.000005	425	94868	0.00757	0.00108	0.00045	0.000080	3306	7158074.8	7.15E+06	0.19
26	11490	0.00085	0.00010	0.000007	402	94868	0.00885	0.00110	0.00053	0.000081	3322	6093808.1	6.10E+06	0.15
26	11520	0.00085	0.00000	0.000000	403	94868	0.00885	0.00110	0.00053	0.000081	3322	6091615.5	6.10E+06	0.17
26	11400	0.00085	0.00000	0.000000	399	94868	0.00895	0.00100	0.00054	0.000074	3322	6025199.1	6.05E+06	0.15
Average	11470	0.00085	0.00003	0.000002	402	94868	0.00888	0.00107	0.00053	0.000079	3322	6070207.6	6.05E+06	0.16
27	12160	0.00085	0.00000	0.000000	427	94868	0.00915	0.00085	0.00055	0.000063	3333	5847183.7	5.85E+06	0.13
27	11810	0.00085	0.00000	0.000000	415	94868	0.00910	0.00080	0.00054	0.000059	3333	5907456.2	5.90E+06	0.12
27	10800	0.00085	0.00005	0.000004	379	94868	0.00915	0.00085	0.00055	0.000063	3333	5943331.2	5.95E+06	0.12
Average	11590	0.00085	0.00002	0.000001	407	94868	0.00913	0.00083	0.00055	0.000062	3333	5899323.7	5.90E+06	0.12
Overall Average	11757	0.00085	0.00004	0.000003	411	94868	0.00853	0.00099	0.00051	0.000074	3320	6375868.7	6.40E+06	0.16

Reported By: _____ Scott Bivings _____

Date: _____

Reviewed By: _____ Robert Varner _____

Date: _____ 10/1/2014 _____

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

BUS: (601) 856-2332
FAX: (601) 856-3552

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BCD JOB NO. 140241
Mix Number Mix 20 Set No: 20
Mix Date Wednesday, July 02, 2014
Mix Time 8:21 AM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
77	10.0000	0.8135	0.8135	11.59800	1.6270	9.9710
78	10.0000	0.8115	0.8115	11.59450	1.6230	9.9715
79	10.0000	0.8140	0.8140	11.61300	1.6280	9.9850
80	10.0000	0.8120	0.8140	11.61500	1.6260	9.9890

SHRINKAGE TESTING - AASHTO T 160

Reference Bar Length (in.)		INITIAL READINGS												
		Specimen 77	Reference Bar 77	Δ Length 77	Specimen 78	Reference Bar 78	Δ Length 78	Specimen 79	Reference Bar 79	Δ Length 79	Specimen 80	Reference Bar 80	Δ Length 80	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
1	Thursday, July 03, 2014	0.0679	0.0977	-0.0298	0.0653	0.0976	-0.0323	0.0850	0.0976	-0.0126	0.0854	0.0976	-0.0122	-0.0217
Moisture Cure for 7 Days		LENGTH CHANGE CALCULATIONS												
		Specimen 77	Reference Bar 77	Δ Length 77	Specimen 78	Reference Bar 78	Δ Length 78	Specimen 79	Reference Bar 79	Δ Length 79	Specimen 80	Reference Bar 80	Δ Length 80	Average
7	Wednesday, July 09, 2014	0.0680	0.0976	0.0020	0.0657	0.0976	0.0040	0.0852	0.0976	0.0020	0.0857	0.0976	0.0030	0.0027
12	Monday, July 14, 2014	0.0674	0.0975	-0.0030	0.0650	0.0975	-0.0020	0.0846	0.0975	-0.0030	0.0851	0.0976	-0.0030	-0.0028
14	Wednesday, July 16, 2014	0.0675	0.0976	-0.0030	0.0651	0.0976	-0.0020	0.0846	0.0976	-0.0040	0.0851	0.0976	-0.0030	-0.0030
21	Wednesday, July 23, 2014	0.0673	0.0976	-0.0050	0.0649	0.0976	-0.0040	0.0844	0.0976	-0.0060	0.0849	0.0976	-0.0050	-0.0050
35	Wednesday, August 06, 2014	0.0670	0.0975	-0.0070	0.0646	0.0975	-0.0060	0.0841	0.0975	-0.0080	0.0847	0.0975	-0.0060	-0.0068
63	Wednesday, September 03, 2014	0.0666	0.0975	-0.0110	0.0642	0.0975	-0.0100	0.0838	0.0975	-0.0110	0.0842	0.0975	-0.0110	-0.0108
119	Wednesday, October 29, 2014	0.0661	0.0975	-0.0160	0.0637	0.0975	-0.0150	0.0832	0.0975	-0.0170	0.0837	0.0975	-0.0160	-0.0160
231	Wednesday, February 18, 2015	0.0653	0.0974	-0.0230	0.0629	0.0974	-0.0220	0.0825	0.0974	-0.0230	0.0829	0.0974	-0.0230	-0.0228
455	Wednesday, September 30, 2015	0.0644	0.0972	-0.0300	0.0620	0.0972	-0.0290	0.0816	0.0972	-0.0300	0.0821	0.0972	-0.0290	-0.0295
42	Calculated 35 Day Shrinkage			-0.0089			-0.0079			-0.0099			-0.0089	-0.0089
Note: Lowest Reading Value Recorded (Minimum)														
Reported by: <u>Scott Bivings</u> Reviewed by: <u>Robert Varner 10/12/2015</u>														

Draft Report

BURNS COOLEY DENNIS, INC.
GEOTECHNICAL & MATERIALS CONSULTANTS

278 COMMERCE PARK DRIVE
RIDGELAND, MS 39157

BUS: (601) 856-2332
FAX: (601) 856-3552

BCD JOB NO. 140241

Mix Number Mix 20 Set No: 20
Mix Date Wednesday, July 02, 2014
Mix Time 8:21 AM

Measurements Required Before Making Specimens						
Specimen	Standard Bar Distance	Length Stud 1 (0.0001 in.)	Length Stud 2 (0.0001 in.)	Measured Length of Specimen	Combined Stud Length	Net Distance betw
77	10.0000	0.8085	0.8085	11.63950	1.6170	10.0225
78	10.0000	0.8085	0.8070	11.62900	1.6155	10.0135
79	10.0000	0.8070	0.8090	11.71650	1.6160	10.1005
80	10.0000	0.8020	0.8085	11.60850	1.6105	9.9980

REVERSIBLE SHRINKAGE TESTING

Reference Bar Length (in.)		INITIAL READINGS												
	10	Specimen 77	Reference Bar 77	Δ Length 77	Specimen 78	Reference Bar 78	Δ Length 78	Specimen 79	Reference Bar 79	Δ Length 79	Specimen 80	Reference Bar 80	Δ Length 80	Average
Specimen Age	Test date	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	(.0001 in.)	(.0001 in.)	Inches	Inches
819	Wednesday, September 28, 2016	0.0634	0.0970	-0.0380	0.0611	0.0970	-0.0360	0.0811	0.0970	-0.0330	0.0811	0.0970	-0.0370	-0.0360
Reintroduce to Waterbath		LENGTH CHANGE CALCULATIONS												
		Specimen 77	Reference Bar 77	Δ Length 77	Specimen 78	Reference Bar 78	Δ Length 78	Specimen 79	Reference Bar 79	Δ Length 79	Specimen 80	Reference Bar 80	Δ Length 80	Average
		(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.001%)	(.0001 in.)	(.0001 in.)	(0.0001%)	(.0001%)
820	Thursday, September 29, 2016	0.0644	0.0971	-0.0290	0.0623	0.0971	-0.0250	0.0820	0.0971	-0.0250	0.0822	0.0971	-0.0270	-0.0265
822	Saturday, October 01, 2016	0.0655	0.0971	-0.0180	0.0630	0.0971	-0.0180	0.0827	0.0971	-0.0180	0.0831	0.0971	-0.0180	-0.0180
826	Wednesday, October 05, 2016	0.0655	0.0970	-0.0170	0.0630	0.0970	-0.0170	0.0830	0.0970	-0.0140	0.0833	0.0970	-0.0150	-0.0158
833	Wednesday, October 12, 2016	0.0655	0.0971	-0.0180	0.0630	0.0971	-0.0180	0.0832	0.0971	-0.0130	0.0831	0.0971	-0.0180	-0.0168
847	Wednesday, October 26, 2016	0.0657	0.0968	-0.0130	0.0634	0.0968	-0.0110	0.0833	0.0968	-0.0090	0.0834	0.0968	-0.0120	-0.0113
854	Wednesday, November 02, 2016	0.0658	0.0968	-0.0120	0.0634	0.0968	-0.0110	0.0831	0.0968	-0.0110	0.0835	0.0968	-0.0110	-0.0113
875	Wednesday, November 23, 2016	0.0659	0.0967	-0.0100	0.0637	0.0967	-0.0070	0.0834	0.0967	-0.0070	0.0837	0.0967	-0.0080	-0.0080
911	Thursday, December 29, 2016	0.0662	0.0968	-0.0080	0.0640	0.0968	-0.0050	0.0836	0.0968	-0.0060	0.0839	0.0968	-0.0070	-0.0065

Note: Lowest Reading Value Recorded (Minimum)

Reported by: Scott Bivings

Reviewed by: Robert Varmer 12/29/2016