IMPLEMENTATION OF PERFORMANCE ENGINEERED MIXTURES, AASHTO PP 84-20: I-35W NEAR LAKE STREET, HENNEPIN COUNTY, MINNESOTA

FINAL REPORT

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EXECUTIVE SUMMARY

The Minnesota Department of Transportation (MnDOT), as a participant in the Federal Highway Administration Pooled Fund TPF-5(368), "Performance Engineered Concrete Paving Mixtures," specified the use of Performance Engineered Mixture (PEM) designs for two paving projects constructed in Minnesota: the Trunk Highway TH-60 in Watonwan County (MnDOT S.P. 8309-52), for which a report has been prepared in April 2020, and the I-35W in Hennepin County near Lake Street in the City of Minneapolis (MnDOT S.P. 2782-327). The latter is the subject of this report.

The project, located on I-35W in Hennepin County, comprised of approximately 4.929 miles of mainline, with concrete pavements ranging from 8 to 12 inches in depth. The mixtures for the PEM initiative were poured between April and May 2020 on 10-inch thick concrete pavement. Super Air Meter (SAM) testing, aggregate gradation monitoring, flexural strength testing, strength monitoring through maturity, and concrete surface resistivity testing, among other testing, were carried out through the construction period.

In summary, the following observations of the Authors on the PEM implementation can be made. First, maturity faced some challenges since the materials for the mixtures in the field were not the same as the trial mixtures, but in general terms, it was a very useful tool and will continue to be used. While MnDOT has not established if formation factor (FF) will be incorporated in the specifications, if FF is incorporated, it is likely to be used only for mixture qualification, not for quality control/assurance.

Finally, the use of SAM also presented some difficulties as 46% of the tests performed in the field were deemed as "not run properly". Additional training and experience should help reduce the number of "not run properly" test that occur. Future plot projects using the SAM will help MnDOT determine how best to use the SAM in the future.

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

The Federal Highway Administration Pooled Fund TPF-5(368), "Performance Engineered Concrete Paving Mixtures," is a collaborative effort among many state transportation agencies to deploy performance engineered mixtures in highway paving projects. As a participant in this study, the Minnesota Department of Transportation (MnDOT) has worked to implement Performance Engineered Mixture (PEM) designs in paving projects constructed in Minnesota and fulfilling Work *Task 5* of TPF-5(368). This report presents the results obtained in MnDOT 2782-327, a non-reinforced 10-inch, doweled pavement on I-35W in Hennepin County near Lake Street in the City of Minneapolis, Minnesota (Figure 1).

Figure 1. Project location

1.2 SCOPE AND OBJECTIVES

This portion of the TPF-5(368) Task 5 effort focused on the following objectives:

- On-site training and support for contractor use of the Super Air Meter (SAM)
- Collect and compile all contractor construction QA/QC test data related to PEM
- Complete PEM Pooled Fund Administrator data collection spreadsheet

In addition, the fulfillment of the Task 5 objectives includes the production of this post-construction report summarizing the project and data collection.

1.3 OVERVIEW OF REPORT

This report provides general information on tests performed and a summary of test results related to the use of PEM for the concrete pavement on I-35W in Hennepin County. Appendices to the report include documents of the MnDOT mixture design development, laboratory test results (as described in section 2.2.1), and field test results, including the TPF-5(368) Task 4 (see section 2.2.2) documentation.

CHAPTER 2: PROJECT INFORMATION

The project was located along I-35W near Lake Street in Minneapolis, MN. The project area is illustrated in Figure 2. The project construction operations overview is shown in Figure 3.

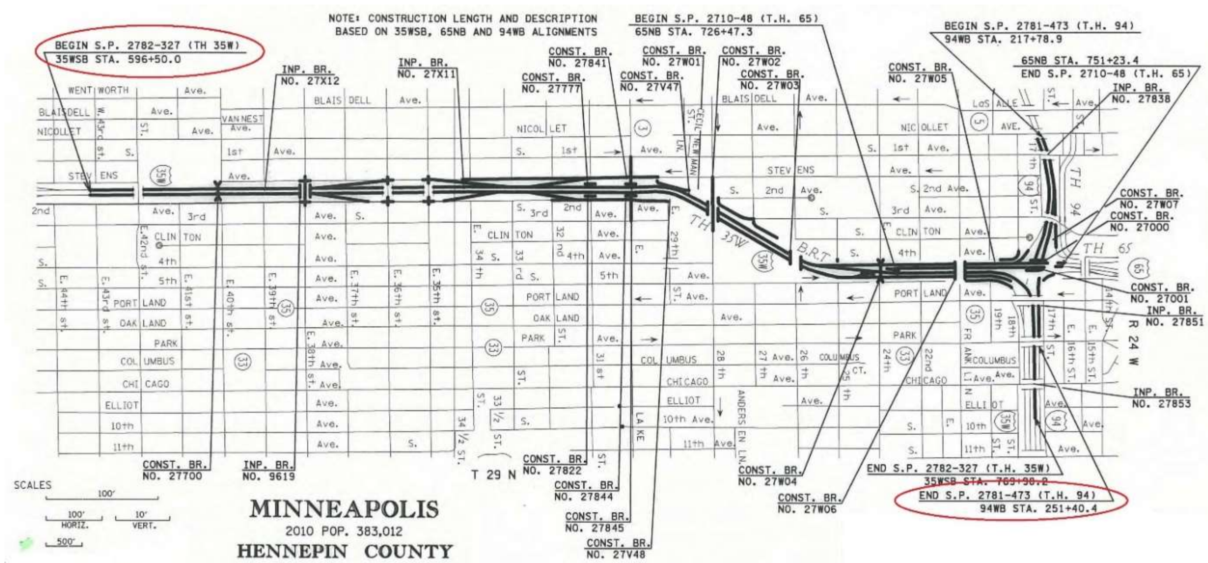


Figure 2. Location of paving project along I-35W near Lake Street in Minneapolis, MN

2.1 GENERAL INFORMATION ON THE PAVING PROJECT

The general information relating to the paving project include the following items.

- The contractor for this project was Shafer Contracting Company, from MN.
- The results presented in this report are referent to the paving that occurred between April 21 and May 5 of 2020.
- The typical pavement consisted of a 15-foot square panel of 10.0-inch non-reinforced concrete over a 4.0-inch aggregate base (CV) class 5Q (Figure 4 and Figure 5).
- Transverse joints depths were ¼ of the pavement thickness with 1.25-inch diameter high performance dowel bars.
- The longitudinal joints along the pavement were unsealed paved construction joints. The longitudinal joints at shoulders were unsealed construction joints, with keyway and tie bars to tie the concrete curbs and gutters to the concrete shoulders (Figure 5).The ties were No. 4, 30-inch long tie bars, every 3-foot.

2.2 MNDOT SPECIFICATION AND POOLED FUND TPF-5(368) ADDITIONAL TESTING

MnDOT Specification 2301 [1] for Contractor mixture designs is mainly prescriptive. It includes a maximum w/cm ratio, a minimum cementitious content, aggregate gradation requirements, minimum aggregate size, a maximum content of supplementary cementitious, and an acceptable slump range. In the project described in this report (MnDOT SP 2782-327), this specification was modified to include the tasks of the Federal Highway Administration Pooled Fund TPF-5(368). The following subsections describe tasks that were added to the MnDOT specification.

2.2.1 Laboratory Testing

Tasks 1 and 2 – This task refers exclusively to preparing and testing trial batches of the concrete mixture proportions. The contractor was asked to provide the test results of the trial batches for the following:

- Third Point Flexural Strength at 1, 3, 7 and 28 days (sets of 3) - AASHTO T 97[2],
- Compressive Strength at 1, 3, 7 and 28 days (sets of 3) - AASHTO T22 [3],
- Unit Weight – AASHTO T 121M/T 121 [4],
- Slump Test – AASHTO T 119M/T 119 [5]– at <5 minutes, 15 minutes, and 30 minutes after the completion of mixing,
- Box Test (AASHTO TP 137 [6]) and Modified V-Kelly Test (AASHTO TP 129 [7]) at <5 minutes, 15 minutes, and 30 minutes after the completion of mixing,
- Air Content and SAM number – AASHTO TP 118 [8] – at <5 minutes, 15 minutes, and 30 minutes after the completion of mixing as determined by Super Air Meter,
- Hardened Air at 7 days – ASTM C457/C457M [9],
- Surface Resistivity – AASHTO T 358 [10]– measured on 28-day compressive strength cylinders,
- Aggregate Voids – ASTM C29/C29M [11],
- Maturity Method – ASTM C1074 [12], [13],
- Sealed Resistivity – AASHTO TP 119 [14] – measured on 28-day compressive strength cylinders, and
- Aggregate gradation – AASHTO T 27 [15] and preparation of the tarantula curve.

2.2.2 Field Testing

Task 2 - In this task, the contractor was asked to develop the Maturity-Strength Relationship for the trial batches – per MnDOT Specification 2461.G.6.a, "Development of Maturity-Strength Relationship." [13] If changes in the concrete mixture occur and a new maturity curve is required, the Contractor is allowed to develop the new maturity curve in the laboratory or the field. The contractor was also asked to perform the following tests during construction using the SAM and cast cylinders:

- Air Content and SAM number - AASHTO TP 118 [8]:
    - Before consolidation (before paver) – 1 per 1500 yd3 and 1 from the first 10 loads of each day,
    - After consolidation (after paver) – 1 per ½ day of slip form paving and 1 SAM at the same location where a "before consolidation" SAM was determined.
- Cast two cylinders (4 by 8 in. or 6 by 12 in.) per day for Hardened Air content – ASTM C457/C457M "Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete [9]: One cylinder from where the "before SAM consolidation"

was determined (i.e., before the paver) and one cylinder from where the "after SAM consolidation" was determined (i.e., after the paver).

- Cast one cylinder (4 by 8 in. or 6 by 12 in.) if the SAM number is greater than or equal to 0.30. Sample the concrete from the same location.

Task 3 – The contractor was asked to provide detailed descriptions of the actions to monitor the quality constituent materials, construction process, and the final product including test methods and frequencies of those tests.

Task 4 – The contractor was asked to provide the following documentation:

- Summary of the Job Mix Formula (JMF) Moving Average (Appendices B2.1: Aggregates: JMF Worksheets and B2.2: Aggregates: Moving Average),
- Individual composite gradations against the tarantula curve (Appendices B2.3: Aggregates: QA test reports and B2.4: Aggregates: Tarantula Curves),
- Contractor plastic air content and SAM number tests (Appendices B3.4: Concrete: Fresh Air Content and B3.5: Concrete: SAM),
- Aggregate Moisture Content (%) (Appendix B2.5: Aggregates: Moisture Content),
- W/C Ratio (Appendix B3.1: Concrete: Water/ Cementitious Ratio),
- Unit Weight (Appendix B3.3: Concrete: Unit Weight),
- Water Content (Appendix B3.2: Concrete: Ingredients Summary),
- Flexural Strength (Appendix B4.3: Concrete: Flexural Strength),
- Maturity (Appendix B4.2: Concrete: Strength-Maturity Data),
- Batch tickets (Appendix C), and
- Reports, records, and diaries developed during construction activities.

Figure 3. Overview of paving operations.

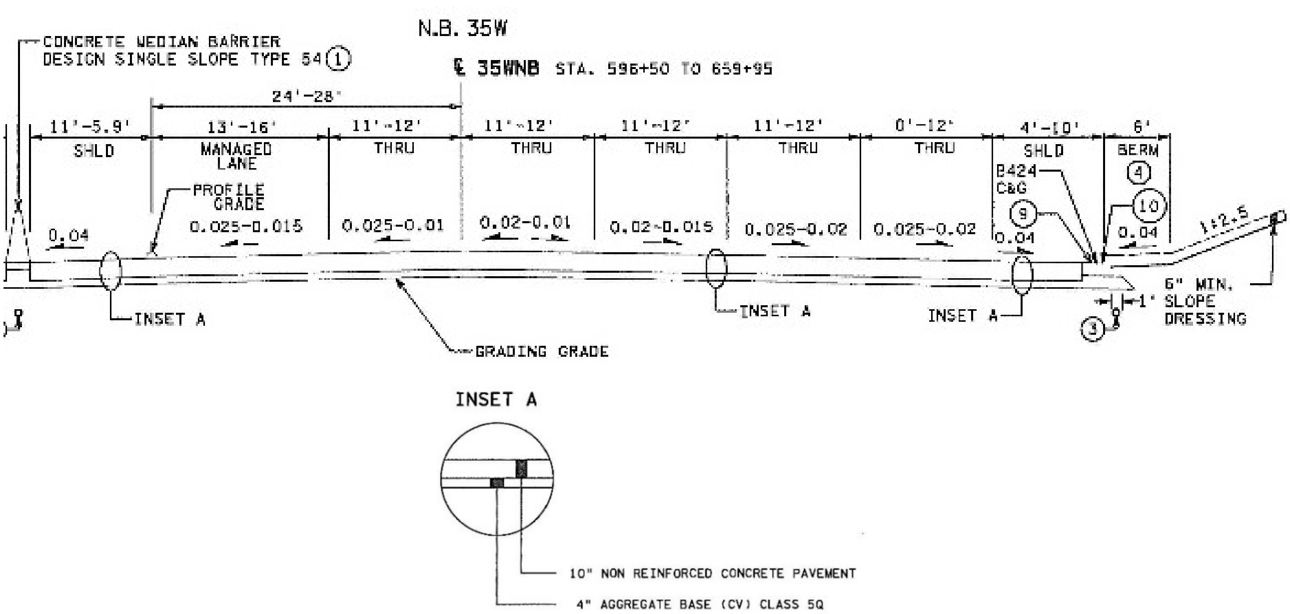


Figure 4. Typical concrete pavement section.

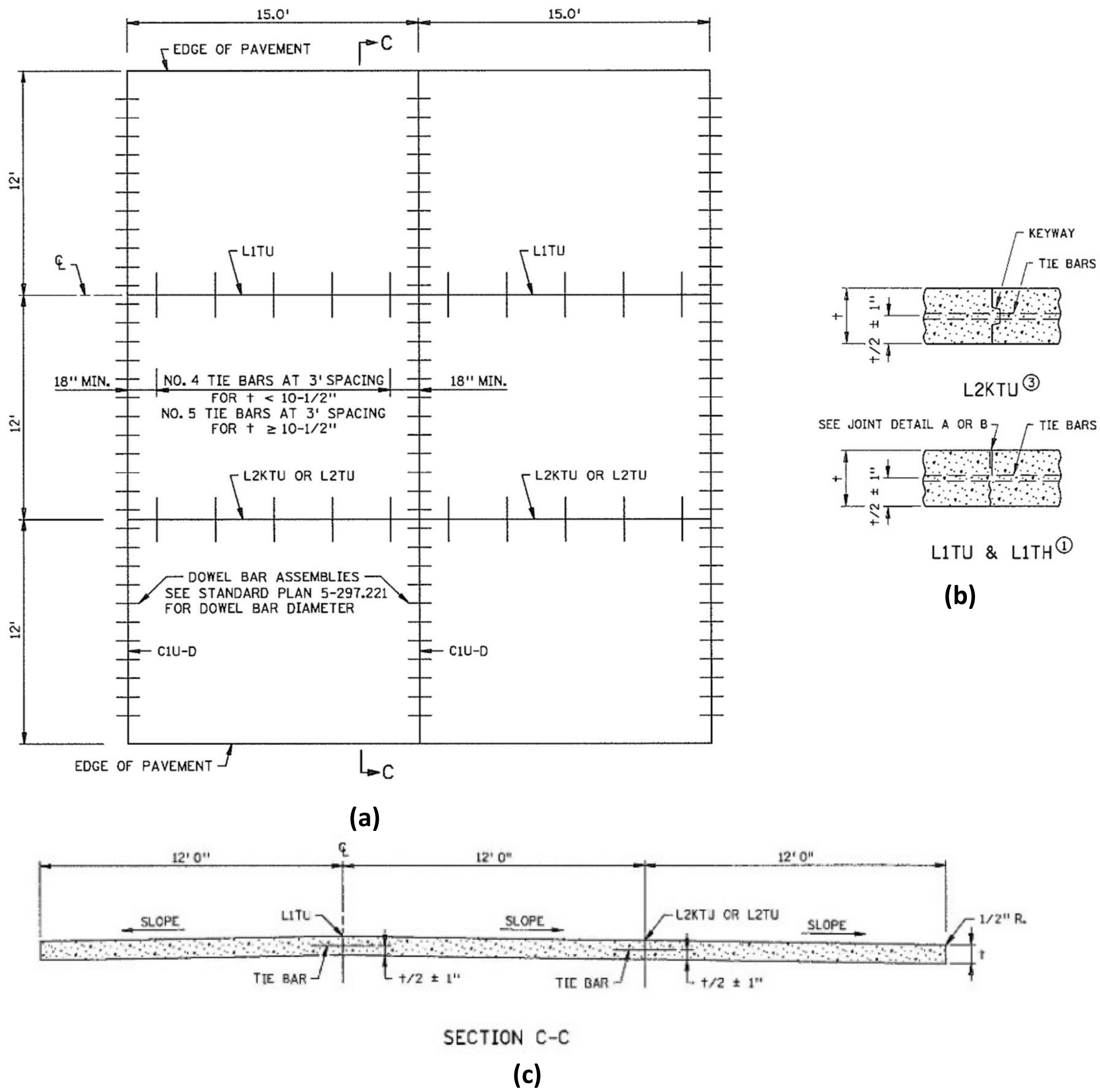


Figure 5. Typical concrete panels. (a) configuration of the panels, transverse, and longitudinal joints, (b) details of longitudinal joints, and (c) typical cross section of the panels.

CHAPTER 3: TESTS PERFORMED

In addition to the more traditional concrete tests to characterize fresh and hardened concrete properties in the laboratory and field, MnDOT, the paving contractor (Shafer Contracting Company), and subcontractors to MnDOT (American Engineering Testing) conducted additional tests as indicators of the concrete paving mixtures performance. The tests were selected based on the Federal Highway Administration Pooled Fund TPF-5(368) and AASHTO PP 84 [16]. Following is a summary of these tests.

3.1 AGGREGATE TESTS

3.1.1 Gradation – Job Mix Formula and Tarantula Curve

The Job Mix Formula (JMF) contains proportions of each aggregate fraction and the individual gradations for each aggregate fraction (as per AASHTO T 27 [15]), as well as the composite gradation of the combined aggregates. See section 3 of MNDOT 2301 Specifications [1].

3.1.2 Unit Weight

The unit weight of the aggregates was determined following a modified version of ASTM C29/C29M [11], proposed by Taylor et al. [17]. In this methodology, the unit weight of the aggregates is not obtained on individual aggregates, but rather, on the blend of all aggregates, at the proportions they will be used in the mixture.

3.2 FRESH CONCRETE AIR PARAMETERS - SUPER AIR METER (SAM)

The Super Air Meter (SAM) method (AASHTO TP 118 [8]) assesses the volume of air and gives an idea of the air void system using a measure known as the SAM number. The SAM number is used as an indicator of appropriate air spacing. In addition, the spreadsheet provided for the SAM calculation, establishes some criteria to determine whether the test result is considered “Likely Correct” or “Run Incorrect” [18].

3.3 WATER-CEMENTITIOUS RATIO OF PLASTIC CONCRETE

AASHTO T 318 [19] is used to determine the w/cm of the concrete delivered to the job site by drying the freshly mixed concrete in a microwave oven.

3.4 CONCRETE WORKABILITY

3.4.1 Vibrating Kelly ball (VKelly)

The vibrating Kelly ball test, AASHTO TP 129 [7], evaluates the consistency of fresh concrete by measuring the depth of penetration of a metal mass into plastic concrete under the force of gravity and quantitatively assessing the responsiveness to vibration of dry concrete mixtures, as is desired of a mixture suitable for slipform paving.

3.4.2 Box test

The box test, AASHTO TP 137 [6], assesses the workability of a given concrete paving mixture and its ability of being properly placed, consolidated, and finished. The field box test was performed on the mixture according to the procedure outlined in AASHTO TP 137 [6]. Box test results include (A) a qualitative measure to estimate the surface percent voids, and (B) slump edge.

3.5 ESTIMATION OF STRENGTH BY THE MATURITY METHOD

In pavement construction, a strength-maturity relationship is developed when the in-place concrete strength is required to be estimated, normally with the intention to open the pavement for traffic. MnDOT specification 2461.3.G.6 [1], which was based on ASTM C1074 [12], describes how the strength-maturity relationship shall be developed. Additional information specific to concrete pavements are presented in MnDOT specification 2301.3.O [13].

3.6 FORMATION FACTOR

Formation Factor (F) is not a test method, but a durability performance measure and is calculated as the ratio between the concrete electrical resistivity and the concrete pore solution resistivity. Formation Factor is used in AASHTO PP 84 [16] as a criterion for transport properties in mixture proportioning and qualification, and as the basis to obtain a freeze-thaw durability criterion, known as the time for critical saturation.

3.6.1 Surface Resistivity (SR)

The most widely used is AASHTO T 358 - Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration [10]. AASHTO T 358 [10] obtains an "apparent" surface resistivity as it does not include the specimen geometry correction factor, so it yields different resistivity results for different sizes of cylinders.

CHAPTER 4: CHAPTER 4 LABORATORY TRIAL BATCHING RESULTS

4.1 INITIAL TRIAL MIXTURE PROPORTION AND FRESH TEST RESULTS

4.1.1 Mixture Proportion

In April 2019, a mixture was prepared, cured, and tested at the AET laboratories.

- Table 1 presents the mixture proportions and Figure 6 shows the combined aggregate gradation, as well as the acceptable range, by means of a tarantula curve. Fresh properties PEM-specific tests were performed immediately after mixing, at 15 minutes after mixing, and at 30 minutes after mixing.
- Table 2 and Figure 7 present the fresh properties test results. Overall, the fresh properties did not change significantly over the first 30 minutes. This table also shows the MnDOT 2301 and AASHTO PP 84 requirements. Additional information on mixture proportions and fresh test results can be found in Appendix A.

Table 1. Mixture Proportions of Trial Batches

Item	Amount per yd^3
	3A21-6
Type I/II Portland Cement, Holcim St. Genevieve (lb)	400
Class C Fly Ash, Lafarge Portage (lb)	170
Coarse Aggregate, Empire #67, Pit #19129 (lb)	1,038
Coarse Aggregate, Empire #4, Pit #19129 (lb)	661
Fine Aggregate, Empire Sand, Pit #19129 (lb))	1,191
Fine Aggregate, CIA, Pit #19129 (lb)	249
Water (lb)	199
Air Entrainer, GRT Polychem SA (oz/cwt)	0.53
Water Reducer, GRT Polychem 400 NC (oz/cwt)	8.42
Water to Cementitious Ratio	0.35

Table 2. Fresh Properties of Trial Batches and MnDOT Specification [1] and AASHTO PP 84 [16] Requirements.

		Initial	15 Minutes	30 Minutes	Requirements
Unit Weight (lb/ft^3)		148.2	148.4	148.4	N.R.
Slump (in)		2.50	2.50	2.25	½-3*
Air Content (%)		7.0	6.8	6.8	5.5-9.0*
SAM Number		0.23	0.24	0.24	≤ 0.30*
Box Test	**Ratings**	1,1,2,2	1,1,2,2	1,1,2,2	≤2**
	Edge Slump (in)	0	0	0	N.R.
VKelly Index (in/√s)		0.711	0.711	0.621	0.6 - 1.2 **

** MnDOT 2301 Specification Requirement; ** AASHTO PP 84 requirement; N.R. - No Requirement*

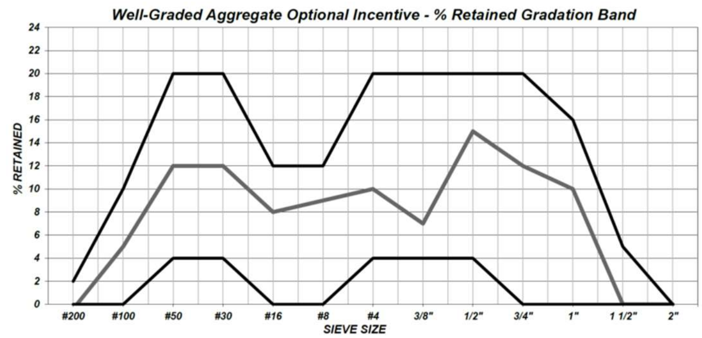


Figure 6. Composite gradation of the combined aggregates (Job Mix Formula) for 3A21-6, and acceptable range – Tarantula Curve.

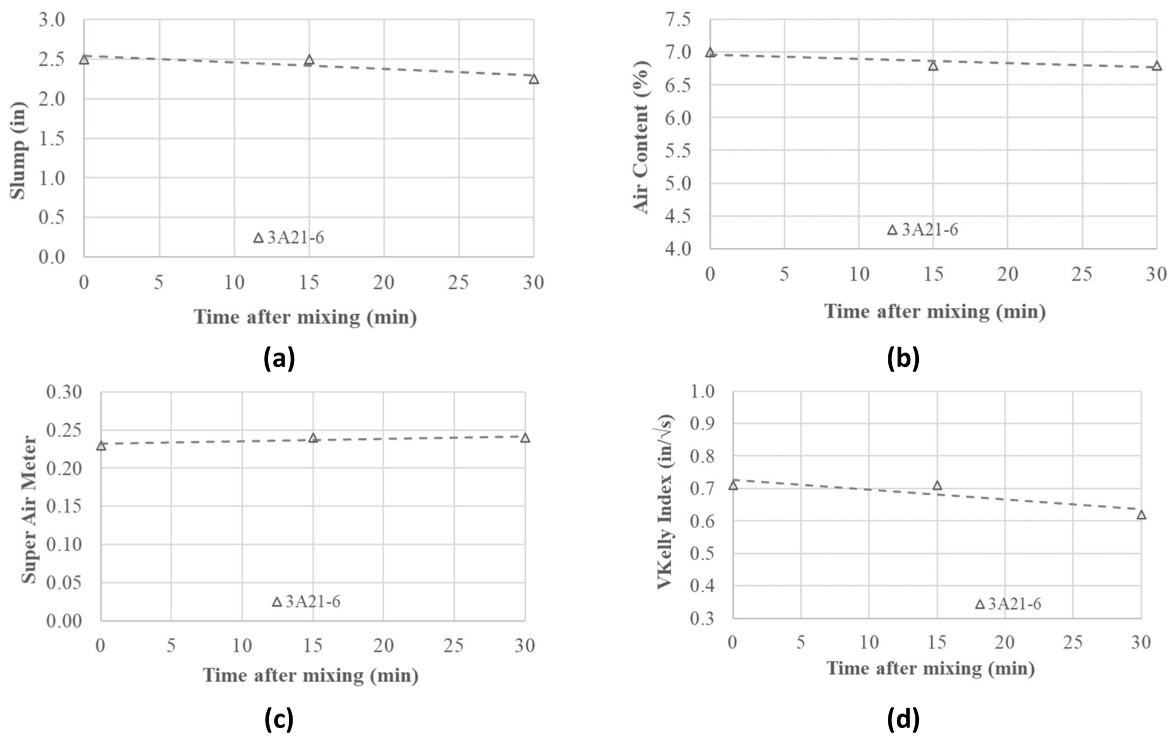


Figure 7. Fresh properties over the first 30 minutes after mixing the concrete: (a) Slump, (b) Total fresh air content, (c) SAM, and (d) VKelly.

4.2 HARDENED PROPERTIES TEST RESULTS

A summary of the trial batch test results is presented in the following sub-sections. For detailed information and results refer to Appendix A.

4.2.1 Maturity

The strength-temperature relationship can be established using either compressive or flexural strength. Since it was envisioned that flexural strength would be used to estimate the strength during construction, only the flexural-temperature curves for mixture 3A21-6 (Figure 8) are shown below. For information on the compressive strength curve development and results, refer to Appendix A.

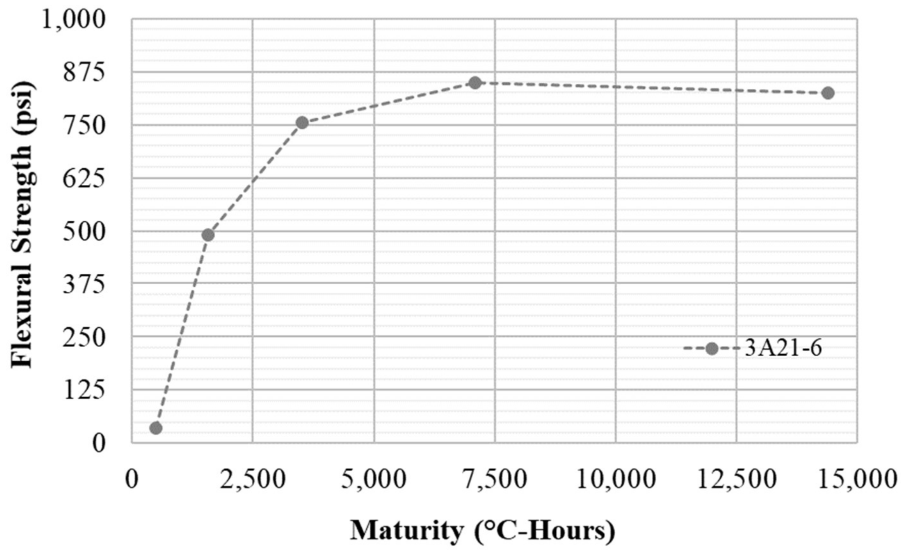


Figure 8. Flexural strength-maturity relationship of mix 3A21-6.

4.2.2 Strength and Hardened Air

Table 3 presents the flexural and compressive strengths, as well as the hardened air void system test results. This table also shows the MnDOT 2301 requirements [1]. The hardened total air content was lower than the measured fresh air content (Table 2) and lower than the specified range of 5.5-9.0%. However, their spacing factor was considered adequate (≤ 0.008 in.).

Table 3. Strength and Air Void System of Trial Batches.

Age	AASHTO T 97 [2] – Flexural Strength	AASHTO T 22 [3] – Compressive Strength
1-day (psi)	35	2,350
2-day (psi)	445	5,090
3-day (psi)	490	6,270
7-day (psi)	755	7,260
14-day (psi)	850	7,740
28-day (psi)	825	8,680
ASTM C457 [9] – Hardened Air		
Total air (%)	4.3	
Specific Surface (in^2/in^3)	550	
Spacing Factor (in)	0.008	

4.2.3 Resistivity and Formation Factor

Table 4 presents the electrical resistivity results obtained according to AASHTO T 358 [10] on 6 by 12 in. cylinders. The surface resistivity is presented in two different ways: as per AASHTO T 358 [10] and after the application of the geometry correction factor, which takes into account the specimen size.

Resistivity was determined in two sets of specimens: in one set, after demolding, specimens were immersed in calcium hydroxide saturated, simulated pore solution, as prescribed in AASHTO TP 119 [14] Option A, where they remained until testing was completed, while in the second set, specimens were removed from the molds only for testing and inserted back in the molds until testing was completed, herein referred as sealed specimens. These two curing/conditioning procedures are defined in the "Conditioning" section of AASHTO TP 119 [14], as "Option A" and "Option B", respectively. Conditioning option B method was nicknamed by the industry as the "Bucket Test", however, it does not represent a test, only a conditioning method.

The importance of correcting the values obtained according to AASHTO T 358 [10] for the geometry of the specimen is clear in Figure 10a where the effective surface resistivity is about 70 % of that of the values reported according to AASHTO T 358 [10]. Special care must be exercised so that the two values are not used interchangeably. Only the effective surface resistivity is an indication of the material property and is comparable to the bulk resistivity (AASHTO TP 119 [14]), consequently, only the effective surface resistivity shall be used to calculate the formation factor.

Figure 10a also shows that, for the mixtures tested and cured in pore solution, both the AASHTO T 358 [10] surface resistivity and the effective surface resistivity doubled from 28 days to 91 days. Figure 10b presents a zoom of the first 20 days of testing. It is interesting to highlight that the first measurement was taken at 1 day, when the cylinders were demolded. Then the resistivity decreases from day 1 to day 3, because the cylinders are immersed in calcium hydroxide saturated, simulated pore solution, causing the degree of saturation of the cylinders to increase and, consequently, their resistivity to decrease.

Figure 10c compares the resistivity for two different curing conditions: immersion in calcium hydroxide saturated, simulated pore solution, and sealed. The effect of the curing on the resistivity is very clear: the sealed specimens present a much lower degree of saturation, consequently a much higher resistivity. The magnitude of the effect of the curing on the resistivity depends on the mixture, and its permeability. At 91 days, the ratio between the sealed resistivity and the resistivity of immersed specimens was found to be 1.9 for mix 3A21-6.

Formation factor was calculated for the cylinders immersed in calcium hydroxide saturated, simulated pore solution, by dividing the effective surface resistivity found in Table 4 by the pore solution resistivity, believed to be the same as the solution used to condition the specimens, i.e., 0.0127 kΩ·cm. Formation factor (F_{app}) is presented in Table 5 and Figure 9.

According to AASHTO PP84 [16], for concrete subjected to freezing and thawing and deicer application the formation factor shall be greater than or equal to 1,000 at 91 days. The trial batch for the mixture 3A21-6 complied with that requirement.

Table 4. Concrete Electrical Surface Resistivity reported as per AASHTO T 358 [10] and Corrected for Specimen Size (Effective Surface Resistivity)

	Mix 3A21-6	
Age	**Surface Resistivity[1]**	**Effective Surface Resistivity[2]**
Specimens Immersed in Calcium Hydroxide Saturated Pore Solution (Option A of AASHTO TP 119 [14])		
1-day (kΩ.cm)	6.7	4.7
3-day (kΩ.cm)	6.1	4.3
5-day (kΩ.cm)	7.3	5.1
7-day (kΩ.cm)	7.9	5.5
14-day (kΩ.cm)	9	6.3
28-day (kΩ.cm)	11.2	7.9
56-day (kΩ.cm)	12.1	8.5
91-day (kΩ.cm)	21.8	15.3
Specimens in Sealed Condition (Option B of AASHTO TP 119 [14])		
2-day (kΩ.cm)[3]	7	4.9
28-day (kΩ.cm)	20.3	14.2
91-day (kΩ.cm)	41.1	28.8

[1] Surface Resistivity reported as per AASHTO T 358 [10] (no geometry correction factor applied); [2] Effective Surface Resistivity reported geometry correction factor applied to the T 358 results. For 6 by 12 in cylinders, results of AASHTO T 358 [10] are multiplied by 0.699; [3] Measurement at age of 2 day, instead of 1 day

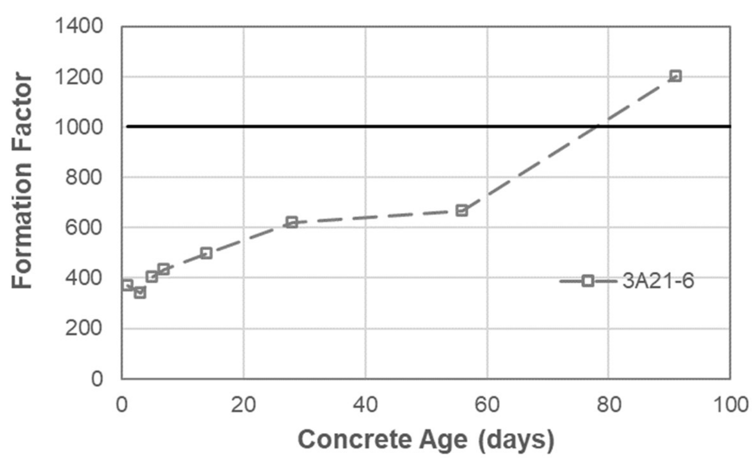
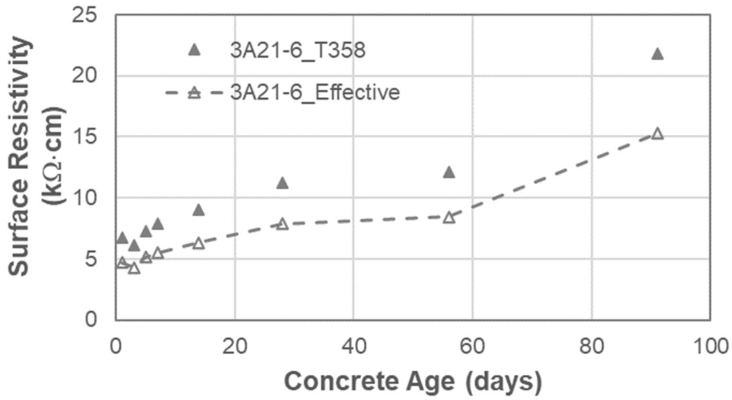


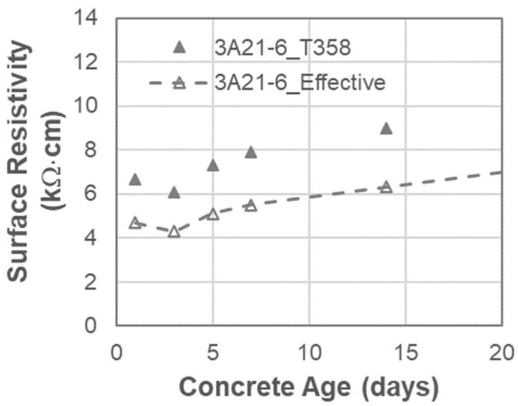
Figure 9. Formation factor (F_{app}) of the trial mixtures.

Table 5. Calculated formation factor (F_{app}).

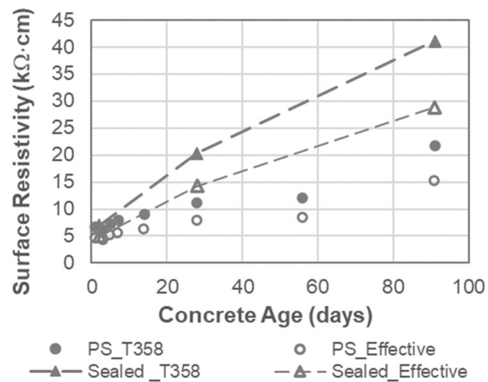
	Formation Factor (F_{app})							
Age (days)	1 d	3 d	5 d	7 d	14 d	28 d	56 d	91 d
Mix 3A21-6	369	339	403	433	498	620	666	1201



(a)



(b)



(c)

Figure 10. Surface resistivity reported as per AASHTO T 358 [10] and as effective surface resistivity. (a) cylinders from mix 3A21-6 immersed in simulated pore solution, (b) zoom-in of (a) for the first 20 days, (c) cylinders from mix 3A21-6 immersed in simulated pore solution or sealed.

CHAPTER 5: FIELD TESTING

5.1 FINAL CONCRETE PAVING MIXTURE PROPORTIONS

Prior to construction, the Class C fly ash, Lafarge Portage, used in the trial batches, became unavailable and had to be replaced by a different source of Class C fly ash, Lafarge Oak Creek Power Plant at Oak Creek, WI. As a result, mixture 3A21-6 was revised and is shown in Table 6 as 3A21-43. The composite gradation of combined aggregates for mix 3A21-43, as well as the acceptable range, is shown in Figure 11.

Table 6. Mixture 3A21-43 Proportions Summary

Item	Amount per yd^3
	3A21-43
Type I/II Portland Cement, Holcim St. Genevieve (lb/yd^3)	400
Class C Fly Ash, Oak Creek (lb/yd^3)	170
Class C Fly Ash (%)	30
Total cementitious content (lb/yd3)	570
Coarse Aggregate, Empire #67, Pit #19129 (lb/yd^3)	1,080
Coarse Aggregate, Empire #4, Pit #19129 (lb/yd^3)	679
Fine Aggregate, Empire Sand, Pit #19129 (lb/yd^3)	1,322
Water (lb/yd^3)	222
Air Entrainer, GRT Polychem SA (oz/cwt)	0.5 to 3
Water Reducer, GRT Polychem Paver Plus (oz/cwt)	0 to 8
Water to Cementitious Ratio	0.39
Paste content (%)	24.4

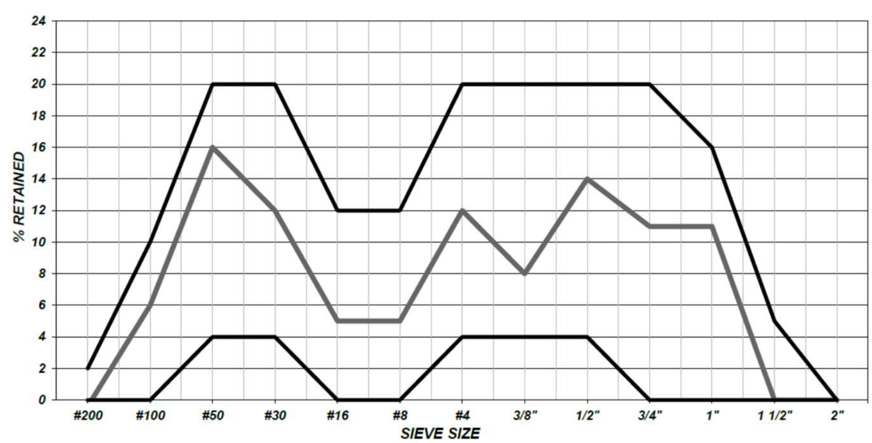


Figure 11. Composite gradation of the combined aggregates (Job Mix Formula) for mix MnDOT 3A21-43 and acceptable range – Tarantula Curve.

5.2 AGGREGATES

The JMF data provided by the contractor related to aggregates, as requested in *Task 4* of the Pooled Fund TPF-5(368), for the mixtures cast between 04/21/20 and 05/07/20 are summarized below. The JMF moving average summary is shown in Figure 12. They were obtained from a total of 108 samples of aggregates, i.e., 36 samples of each aggregate fraction (CA#1, CA#2 and FA#1). All JMF fell within the tarantula curve. Daily information on the aggregate gradation and moisture content can be found in Appendices B2.1: Aggregates: JMF Worksheets, B2.3: Aggregates: QA test reports, B2.4: Aggregates: Tarantula Curves, and B2.5: Aggregates: Moisture Content.

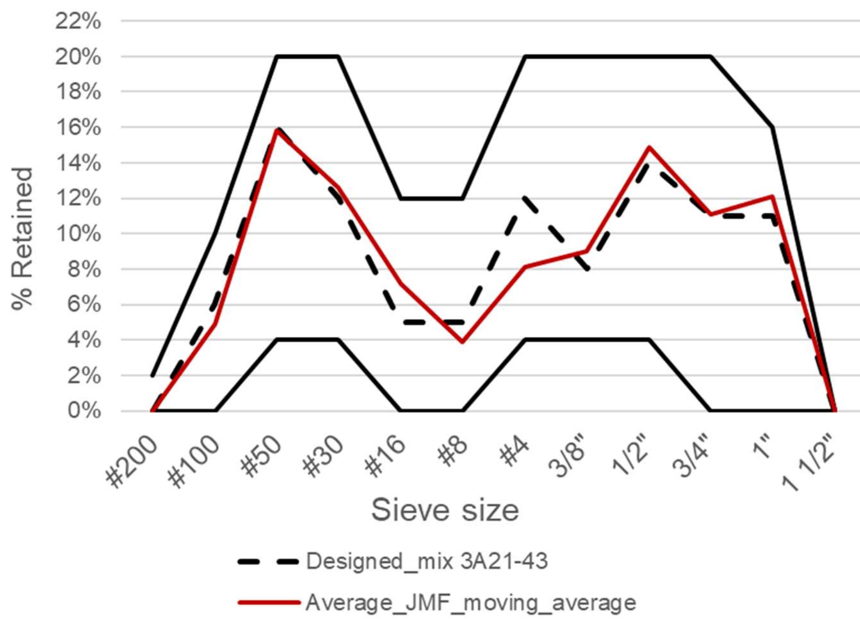


Figure 12. Average JMF moving average and designed JMF.

5.3 FRESH PROPERTIES

5.3.1 Water/ Cementitious Ratio

As part of the *Task 4* of TPF-5(368), the contractor provided the Agency the aggregate moisture content, the average calculated w/cm, and the measured w/cm (according to AASHTO T 318 [19], the microwave test).

The calculated average w/cm was determined using the aggregate moisture contents of a randomly selected concrete batch, and taking into account the average aggregate moisture content and cementitious content of 10 total batches surrounding the selected concrete batch. A total of 37 calculated average w/cm are reported in Figure 13. The average of these 37 calculated average w/cm was found to be 0.35, with a maximum w/cm of 0.39 and a minimum of 0.29. In addition, at least once a day on the selected batch, the w/cm was measured according to AASHTO T 318 [19] using a microwave. Figure 13 also shows the results obtained from 19 microwave tests. The average measured w/cm results from the microwave tests was of 0.34, a maximum of 0.37 and a minimum of 0.31. No measurement was above the maximum allowed of 0.40. Individual test results can be found in Appendix B3.1: Concrete: Water/ Cementitious Ratio.

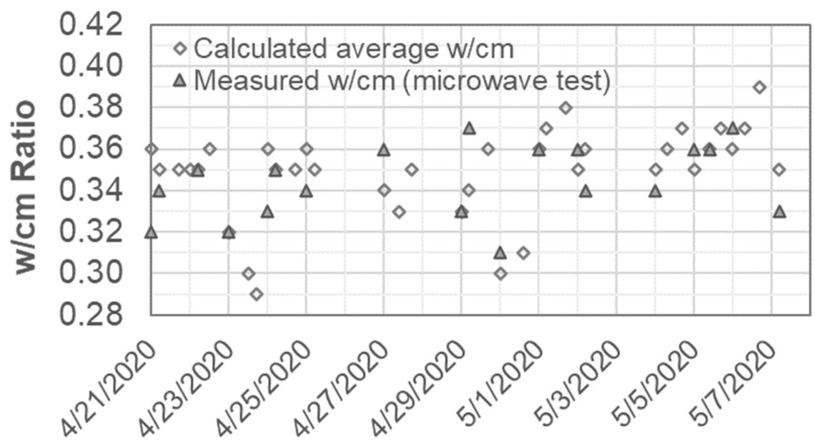


Figure 13. Calculated average w/cm and w/cm, measured according to AASHTO T 318 [19].

5.3.2 Unit Weight

The unit weight of concrete was determined on 37 batches. The results are presented in Figure 14. The concrete unit weight varied from 141 to 147 lb/ft^3, with an average of 145 lb/ft^3. Individual test results can be found in Appendix B3.3: Concrete: Unit Weight.

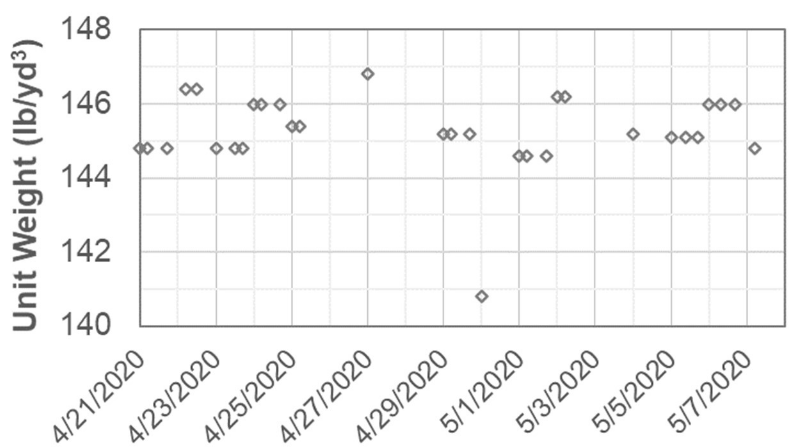


Figure 14. Concrete unit weight of batches between 4/21/20 and 5/7/20.

5.3.3 Fresh Air Content

Total fresh air content was measured, according to AASHTO T 152 [20]. The individual data is presented in B3.4: Concrete: Fresh Air Content. The average total fresh air content between 4/21/20 and 5/5/20 was 8.0%, with a standard deviation of 0.85%. The lowest total air was 6.2% measured on 4/24 and 4/27. For the period reported herein, all the data is within the specification range of 5.5-9.0%. Individual test results can be found in Appendix B3.4: Concrete: Fresh Air Content.

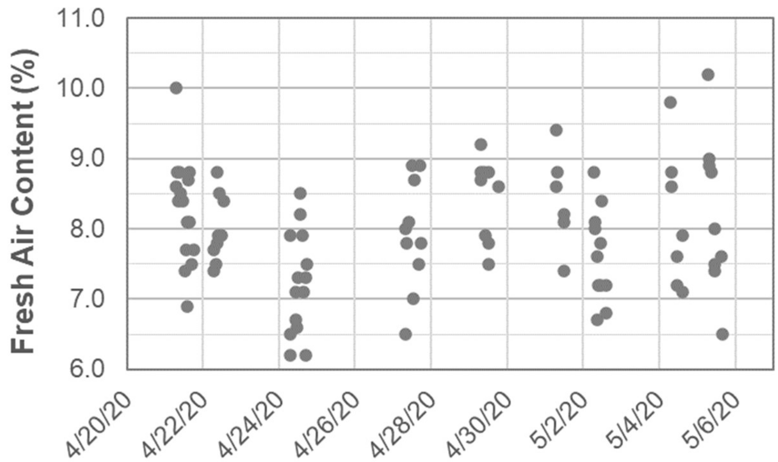


Figure 15. Total fresh air content over the period between 4/21/20 and 5/5/20.

5.3.4 Super Air Meter

SAM tests were conducted before and after the paver. A total of 36 SAM tests were performed, 21 of the SAM tests considered "Likely Correct" if the SAM at 14.5 psi, 30 psi, and 45 psi were above 0 and if the reliability factor (indicated as "SAM's Chance" in the worksheets) was above or equal to 0.5. The reliability factor is a parameter that is automatically calculated in the SAM worksheets provided for the study – more detail on the reliability factor is provided in Hall et al [18]. The SAM results that were "Likely Correct" are summarized in Table 7 . Figure 16 shows the "Likely Correct" results. The air content in these tables represent the total air measured with SAM. Individual test results can be found in Appendix B3.5: Concrete: SAM.

Two cylinders were cast per day, 1 before and 1 after the paver for the evaluation of the hardened air. An additional cylinder was cast for the evaluation of hardened air if SAM was greater than or equal to 0.30. A limited number of these cylinders (9 total) were tested for the determination of the air-void system in hardened concrete, according to ASTM C457/C457M [9]. The results were then compared to the SAM for the same sample. From the nine cylinders, eight of them correspond to pairs representing before and after the paver (Table 8 and Figure 18).

Table 8 shows that the fresh air content is, in all cases but one, higher than the total air measured according to ASTM C457/C457M [9]. It also shows that both the ASTM C457/C457M [9] total air content and entrained air is higher before the paver, comparing to after the paver, as expected. The spacing factors before and after the paver were very low and no considerable difference was found between before and after the paver. The same way, the specific surface differences between before and after the paver were not considerable significant.

The often-quoted rule of thumb of a good air void system are spacing factor ≤ 0.008 in. and specific surface ≥ 600 in^2/in^3. All of the nine cylinders presented very good air void systems, with spacing factors between 0.002 and 0.004 in. and specific surfaces above 920 in^2/in^3, no threshold for these parameters are shown in Figure 18 b and c, however, a threshold for SAM of 0.25 is shown. The areas in red distinguish cylinders that passed the thresholds for surface area or specific surface but had a measured SAM above 0.25.

A complete ASTM C457/C457M [9] report can be found in Appendix B4.1: Concrete: Hardened Air.

Table 7. Summary of SAM results - Before and After Paver

Date	Location	Air Content (%) – Measured with SAM		SAM (at pressure 45 psi)	
		Before Paver	After Paver	Before Paver	After Paver
4/21/2020	635+00	8.7	8.1	0.33	0.47
4/21/2020	638+50	8.1	-	0.11	-
4/22/2020	633+75	8.1	-	0.14	-
4/24/2020	609+25	7.3	6.2	0.13	0.08
4/25/2020	602+00	-	6.6	-	0.21
4/27/2020	76+69	8.9	-	0.18	-
4/27/2020	596+65	8.9	-	0.13	-
4/29/2020	612+85	8.9	-	0.09	-
5/1/2020	750+00	-	7.4	-	0.15
5/2/2020	728+75	7.6	6.7	0.18	0.18
5/2/2020	746+50	7.2	6.8	0.13	0.18
5/4/2020	26+25	7.6	-	0.31	-
5/4/2020	74+80	7.9	-	0.19	-
5/5/2020	740+75	8	7.4	0.16	0.24
5/5/2020	728+15	7.6	6.5	0.25	0.22

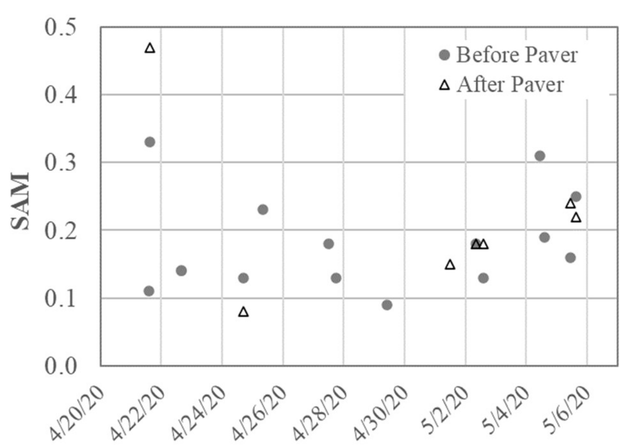


Figure 16. SAM number before and after the paver.

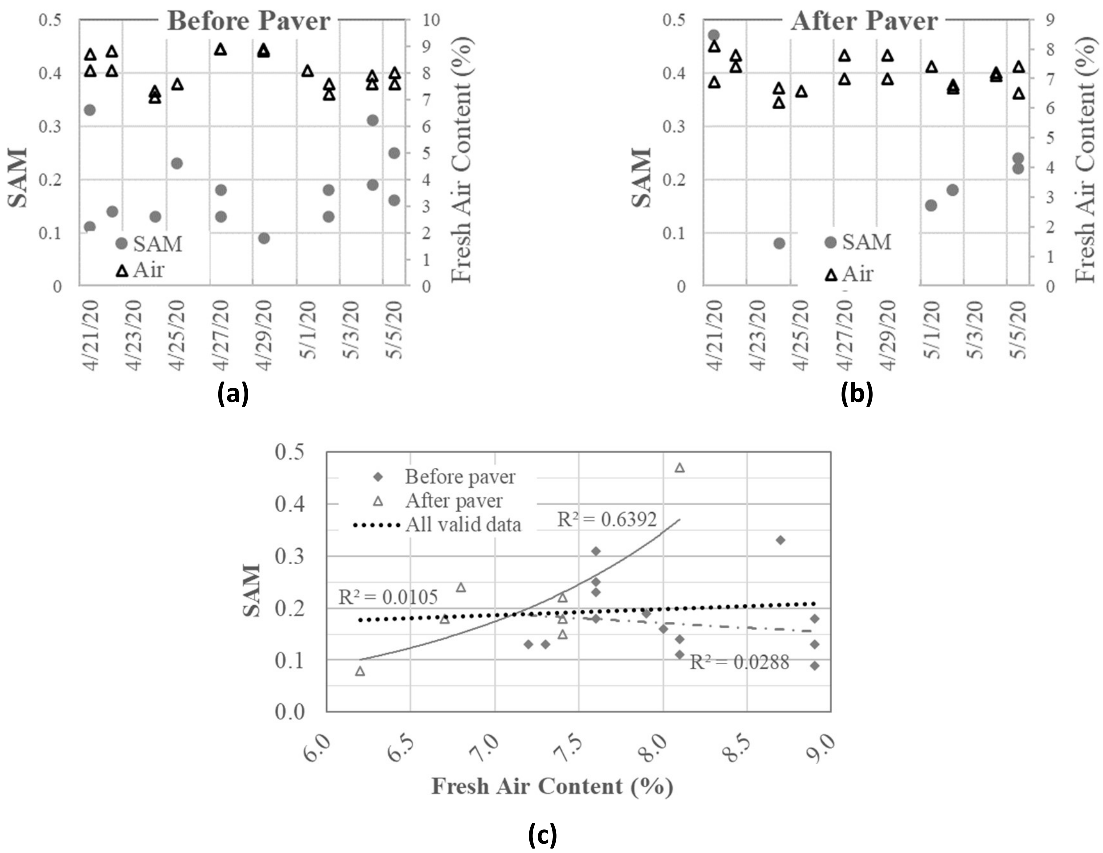


Figure 17. Comparison between SAM and fresh air content: (a) before paver, (b) after paver, and (c) correlation between SAM and total fresh air content for all "Likely Correct" SAM tests. All valid data best fit line (R^2 = 0.0105) includes before and after paver. The other two best fit lines consider before and after paver separately.

Table 8. Summary SAM results and Hardened Concrete Air Voids System.

Casting Date		4/24	4/25		5/2		5/2		5/4	
Station		609+25	602+00		728+75		746+50		26+25	
Relation to Paver		After	Before	After	Before	After	Before	After	Before	After
Fresh Conc.	SAM	0.08	0.23	0.21	0.18	0.18	0.13	0.18	0.31	0.18
	Total Air Content, %	6.2	7.6	6.6	7.6	6.7	7.2	6.8	7.6	7.2
Hardened Concrete	C457 at Age, days	200	199		192		192		190	
	Total Air Content, %	6.3	5.6	5.4	6.4	4.5	5.5	4.9	6.2	6.8
	Entrained Air, %	4.9	4.7	4.1	5.3	3.9	4.6	4.1	4.7	5.2
	Entrapped Air, %	1.4	0.9	1.3	1.1	0.6	0.9	0.8	1.5	1.6
	Specific Surface, in^2/in^3	1090	1090	920	1010	1080	1160	1060	1050	1090
	Spacing Factor, in.	0.003	0.003	0.004	0.003	0.004	0.003	0.003	0.002	0.002

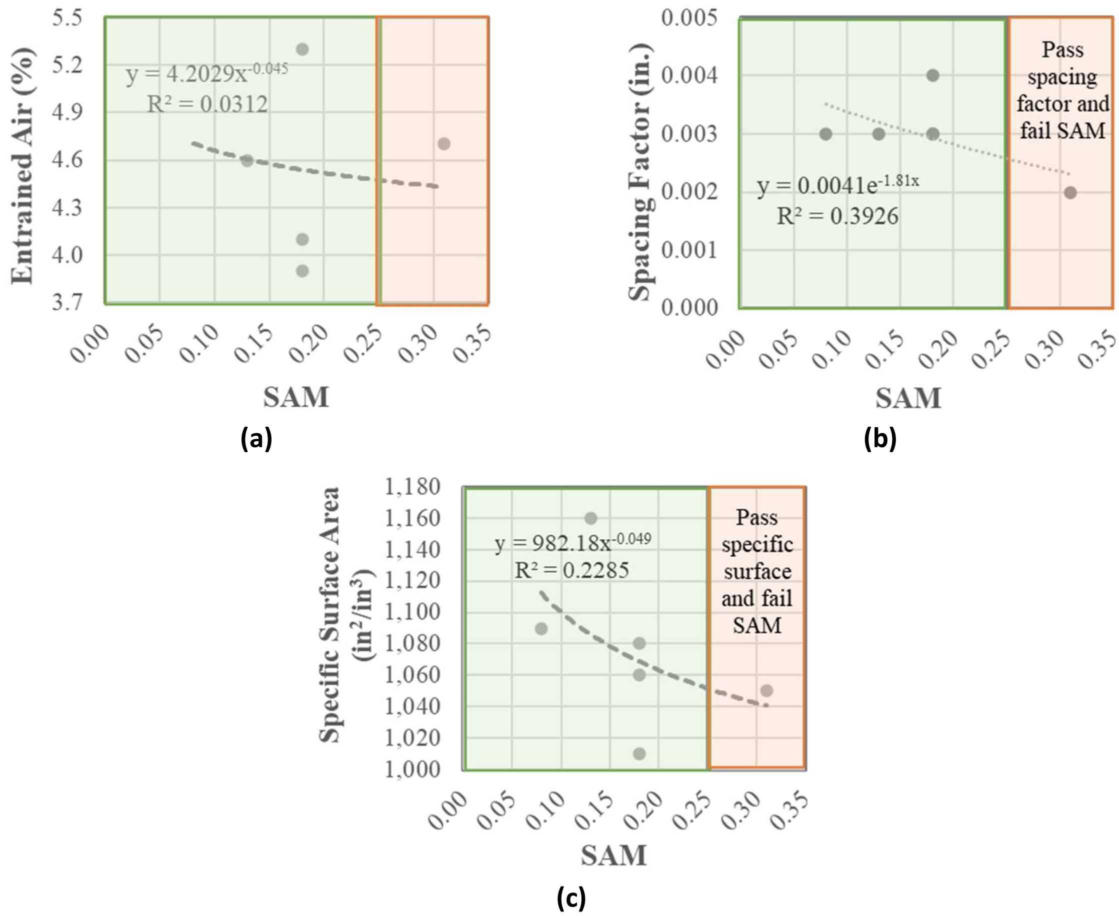


Figure 18. Correlation between SAM and hardened concrete air void system: (a) entrained air, (b) spacing factor, and (c) specific surface. Green and Red areas delimit the passing-fail the threshold SAM and the hardened air void parameter.

5.4 MECHANICAL PROPERTIES

5.4.1 Maturity Tests

For this project the maturity-strength relationship curve was initially developed in the laboratory (see section 2.3.1) according to ASTM C1074 and was expected to be used in the field to estimate the strength. For such, the relationship developed in the laboratory was supposed to be validated in the field on the first day of paving and be within 10% of the limits in the laboratory.

The specification for this project also calls for the development of a new maturity-strength curve if mixture proportions change by more than 5% by mass, if the w/cm increases by more than 0.02 or if the source of materials change.

Since the original mixtures tested in the laboratory could not be used due to a change in the fly ash, new maturity curves, based on the third point flexural strength, were developed for the field mixtures. Figure 19 shows the curve developed for mixture 3A21-43, using specimens cast in the field on 4/20/20. The measured air content of the mixture was 6.4% and the w/cm was 0.37. From this curve, it was determined the required TTF for opening, equivalent to 350 psi, to be 960 C·hours. For the same mixture, the required TTF for the opening strength of 460 psi was determined as 1549 C·hours. For the estimation of strength in the field, sensors were embedded at approximately mid-depth of the pavement and not less than 12 in. from the edge.

Based on the data shown in Figure 19, a maturity-third point flexural strength relationship was developed and used to estimate the concrete flexural strength and determine the time to open for traffic.

Table 9 presents the maturity over time for batches poured in different days, as well as the estimated flexural strength. Some observations can be made based on Table 9. The maturity (TTF) at a certain age for the data used to develop the maturity-third point flexural strength relationship (Figure 19) is significantly lower than the TTF of the other batches in Table 9. This is because the temperatures on 04/20/20 and subsequent days were significantly lower than the temperatures when the other batches were cast. Consequently, the other batches developed strength faster than the 04/20/20 batch.

Second, the batch for station 72+20, poured on 04/05/20, seems to develop strength much faster than the batches for the other stations in Table 9, because the temperatures on 04/05/20 were much higher than the when the other stations were cast. For that reason, station 72+20 was excluded from the observations that follow and the calculated modulus of rupture average and coefficient of variation (COV) presented in the same table. Starting at 1 day, maturity results of different batches were very consistent and comparable. Once concrete reached 1.5 d, the coefficient of variation was only 7%. This shows that those batches developed strength at the same rate.

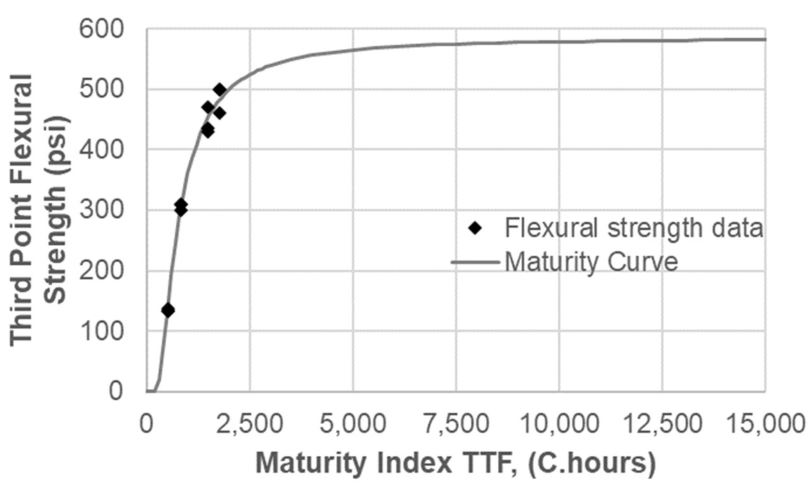


Figure 19. Maturity curve for mixture 3A21-43.

Table 9 Maturity test results in the field and estimated modulus of rupture (MR) based on the maturity- third point flexural strength relationship curve presented in Figure 19.

Station	Date	Time (days)	0.5 d	1 d	1.5 d	2 d	2.5 d	3 d	3.5 d
Figure 19[1]	4/20/20	Maturity (C·h)	-	565	830	-	1475	1760	-
		MR[2] (psi)	-	134	307	-	445	487	-
596+75	4/27/20	Maturity (C·h)	330	691	1014	1312	1622	1944	2293
		MR[3] (psi)	32	242	364	428	469	496	516
598+50	4/22/20	Maturity (C·h)	307	602	958	1257	1598	1890	2243
		MR[3] (psi)	22	194	348	419	466	492	513
606+50	4/24/20	Maturity (C·h)	334	738	1144	1505	1863	2218	2602
		MR[3] (psi)	33	265	396	456	490	512	528
739+50	5/5/20	Maturity (C·h)	301	691	1045	-	-	-	-
		MR[3] (psi)	20	242	373	-	-	-	-
746+75	5/2/20	Maturity (C·h)	383	800	1223	1553	1922	2004	-
		MR[3] (psi)	59	292	412	461	494	500	-
72+20	5/4/20	Maturity (C·h)	509	1065	1634	1698	-	-	-
		MR[3] (psi)	138	378	470	476	-	-	-
Average MR[4] (psi)			33	247	379	441	480	500	519
COV MR[4] (%)			47%	15%	7%	5%	3%	2%	2%

[1] Batch used to establish the maturity-flexural strength relationship in Figure 19, and used to estimate the flexural strength of the other batches in this table.; [2] Measured third-point flexural strength (or modulus of rupture); [3] MR stands for the estimated third-point flexural strength (or modulus of rupture), based on the relationship maturity-flexural strength obtained in Figure 19; [4] Does not include station 72+20, neither the data presented in Figure 19. COV stands for coefficient of variation.

5.4.2 Flexural Strength

The flexural strength of 11 batches of the same mixture, cast at different dates was obtained. Specimens were cast and cured according to AASHTO T 23[21], and tested, according to AASHTO T 97 [2] in the field. Figure 20 shows the flexural strength obtained at 2 or 3 days of age. For all batches represented in Figure 20, concrete surpassed the minimum strength of 350 psi for opening traffic at 2 or 3 days. However, the 2-day strengths were lower than those obtained in the trial batches (Table 3), possibly, not only because of the variations in the mixtures, but also due to the lower curing temperatures for the first 24 hours in the field. Figure 21 combines the results from the different batches to show the evolution of flexural strength over time. The variability among batches is also evident in Figure 21, as the coefficient of determination (R^2) of the best fit curve is only 0.57.

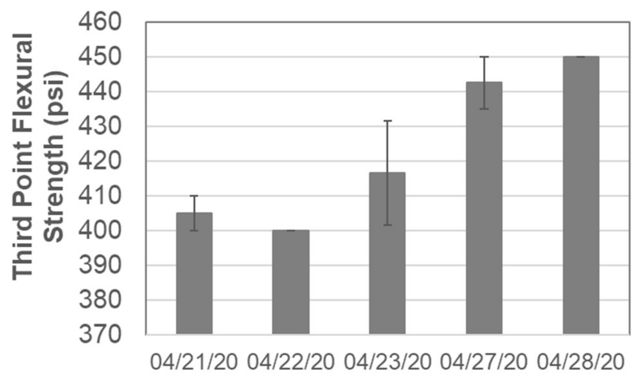


Figure 20. Flexural strength of specimens at 2 or 3 days of age. Dates shown represent the casting dates. Flexural strength represents the average of two beams, with exception of strength of specimens cast on 4/22/20 and 4/27/20, that represent a single beam. Error bars represent the range of strengths obtained.

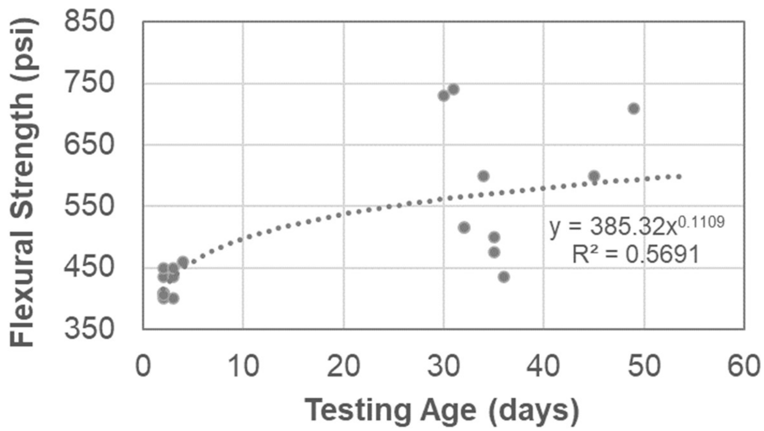


Figure 21. Flexural strength over time for different batches of concrete from mixture 3A21-43.

5.4.3 Pavement Thickness and Compressive Strength

Cores were obtained for thickness verification. On 5/05/2020, four cores were obtained according to AASHTO T 24M/T 24 [22] from four different portions of the project cast on 4/24/2020, so concrete was cored at an age of 11 days. After coring, cores were kept in the field in water tanks for several days and sent to the laboratory to be tested, where they were maintained in a moist room. The cores were tested for pavement thickness using a nine-probe testing device. The thicknesses varied from 10.52 to 11.60 in, with an average of 11.00 in. The cores were also tested for compressive strength according to AASHTO T 22 [3] at the age of 60 days. The compressive strength varied from 5,500 psi to 6,180 psi, with an average of 5,800 psi.

5.5 DURABILITY RELATED PROPERTIES

5.5.1 Concrete Surface Resistivity

On 9/22/20, two 4 by 8 in. cylinders were cast in the field to be tested for electrical resistivity. These cylinders were not cast in the same period as the rest of the field testing in this report due to the pandemic, however they were from the same mix design 3A21-43. After demolding, surface resistivity testing was carried out according to AASHTO T 358 [10]. The cylinders were then immersed in calcium hydroxide saturated, simulated pore solution, as prescribed in AASHTO TP 119 [14], and consisting of 7.6 g/L NaOH (0.19 M);10.64 g/L KOH (0.19 M); 2 g/L $Ca(OH)_2$ and tested on a regular basis until 90 days of age, according to AASHTO T 358 [10], with exception of the specimens' conditioning that followed AASHTO TP 119 [14] Option A. Bulk resistivity, according to AASHTO TP 119 [14], was also determined at ages 56 and 90 days.

In Figure 22, two different surface resistivity values are presented: those obtained according to AASHTO T 358 [10], and referred as T 358 SR, and the effective SR, (referred as effective SR), which were obtained by diving the results obtained according to T 358 by the geometry factor (in case of a 4 by 8 inch cylinder is 1.95). Figure 22 also presents the results obtained according to AASHTO TP 119 [14].

Figure 22 shows that T 358 SR is almost twice the value of the effective SR, since effective SR is calculated by multiplying T 358 SR by the geometry factor and, as a result, both show the same trends. Although concrete resistivity is expected to increase over time, surface resistivity decreased from 56 to 90 days. Possible causes for unexpected results could not be determined, however, one can observe a very high variability among the eight surface resistivity readings on each cylinder, especially on one of them, which overall presented a lower resistivity than the other cylinder. It does not seem to be related to any issue with a particular cylinder since the difference in bulk resistivity of the two cylinders was not considerable. In addition, the bulk resistivity followed the expected trend of increase with age.

In addition, SR was obtained for three 3.95 by 8 in. cylinders that were cored on 5/05/20 (see 4.4.3). They were maintained in the field in water tanks and stored in a moist room once they arrived in the laboratory. Two cores were 60 days old at the time of testing and resulted in effective surface resistivities of 9.8 and 10.0 kΩ·cm, while the core tested at the age of 604 days, presented an effective surface resistivity of 16.0 kΩ·cm. Due to the curing conditions, significant leaching of alkalis may have occurred, potentially increasing the resistivity for these cylinders. However, that is not observed in Figure 22.

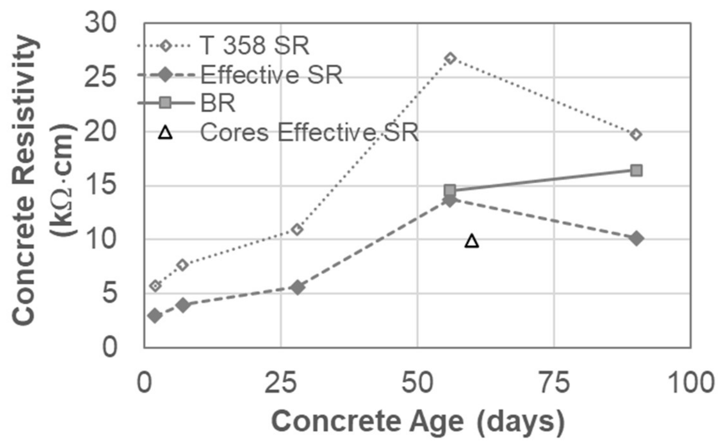


Figure 22. Concrete resistivity over time: T 358 SR – surface resistivity reported as per T 358, Effective SR – T 358 SR corrected for the cylinder's geometry, and BR – bulk resistivity determined as per TP 119. All specimens conditioned according Option A, with exception for the cores.

5.5.2 Formation Factor

Figure 23 shows the Formation Factor (F_{app}). Since F_{app} was calculated from resistivity values (effective surface resistivity and bulk resistivity), the results at 90 days from effective surface resistivity do not seem to be reasonable, because there is a significant decrease from 56 to 90 days. Resistivity, and consequently F_{app}, are expected to increase over time, as it is observed with the F_{app} calculated from the bulk resistivity. The F_{app} at 56 days from effective surface resistivity was very similar to the one obtained from bulk resistivity, so at 90 days, the same trend should have been observed, and it would have surpassed the requirement of a minimum 1,000 at 91 days for concretes exposed to freezing-thawing and deicing salts (AASHTO PP 84 [16]).

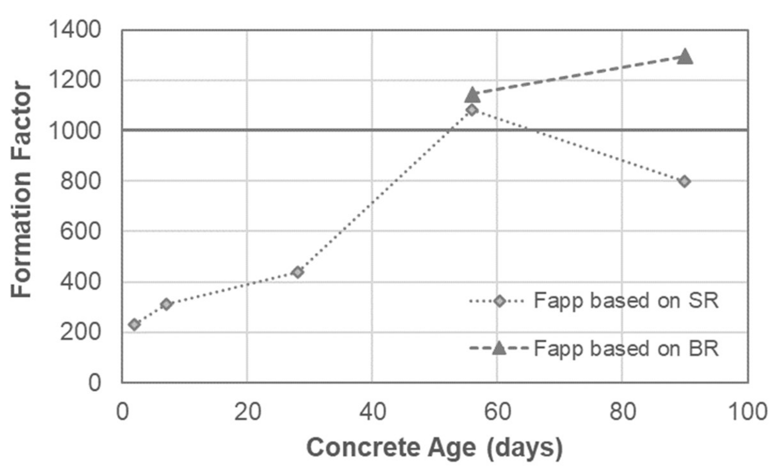


Figure 23. Formation factor (F_{app}) based on effective surface resistivity and bulk resistivity.

CHAPTER 6: CONCLUSIONS AND DISCUSSION

The implementation of PEM on this project was an opportunity to familiarize MnDOT and contractor personnel with PEM testing, and especially the SAM. The initial mixtures batched and tested in the laboratory had to be modified due to changes in materials. Consequently, the results obtained in the laboratory could not be directly compared to those obtained in the field and the maturity-strength curve had to be developed again. Unless otherwise stated, the remarks below refer to the field results.

6.1 GENERAL OBSERVATIONS

For the period showcased in this report:

- All the JMF's fell within the tarantula curve.
- The average w/cm measured using a microwave was 0.34, with a maximum of 0.37, complying with the specification. The microwave results compared well with the w/cm calculated from the batch materials.
- The concrete unit weight varied from 141 to 147 lb/ft3, with an average of 145 lb/ft3.
- The fresh air content, measured according to AASHTO T 152 [20], presented an average of 8.0 %. All 92 tests performed complied with the specification range of 5.5-9.0%.
- Eleven batches of concrete had their flexural strength determined. All of them achieved the minimum opening strength of 350 psi on day 2 or 3.

6.2 SUPER AIR METER

MnDOT required the contractor to perform the SAM testing for this project. The contractor was trained to use the SAM. Based on the results obtained in the field, the following observations can be made:

- A total of 36 SAM tests were carried out, from which 58 % were considered "Likely Correct".
- The SAM average for the "Likely Correct" tests was 0.19, with 85 % of the SAM below 0.25, i.e., considered freeze-thaw resistant.
- The air content after the paver decreased from 0.4 % to 1.1 %, in comparison with before the paver.
- A total of 9 cylinders were tested to determine the hardened air void systems according to ASTM C457/C457M [9]. All of the cylinders presented very good air void systems, with spacing factors between 0.002 and 0.004 in. and specific surfaces above 920 in2/in3. In one of the nine cylinders, the SAM number was greater than 0.25.
- With more experience and training, MnDOT believes that the SAM can be utilized for mixture qualification and/or quality control/quality assurance to provide real-time results regarding freeze thaw durability of the concrete pavement.

6.3 MATURITY AND STRENGTH

The maturity-strength curve is a powerful tool to estimate in-place strength. The fact that the source of the fly ash had to be modified created an extra step to the process because the curve developed in the laboratory couldn't be used and a new one had to be developed in the field. Once the new curve was established, maturity testing provided a very good real time estimate of strength for opening to traffic.

6.4 RESISTIVITY TESTS AND FORMATION FACTOR

Results were reported for surface resistivity, as per AASHTO T 358 [10] or as "effective" surface resistivity (a geometry factor was applied to the T 358 results). In addition, for particular ages, bulk resistivity was also determined for the field cylinders. This report showed the importance of properly referring to the type of results being displayed. Surface resistivity (reported as per AASHTO T 358 [10]) are about double of the "effective" surface resistivity, for 4 by 8 in. cylinders (as observed with the field cylinders), and about 40 % higher, for 6 by 12 in. cylinders (as observed with the trial batches).

In addition, the importance of cylinder conditioning was also presented. For the trial batches, two different conditionings were used: calcium hydroxide saturated, simulated pore solution (Option A of AASHTO TP 119 [14]) and sealed curing (Option B of AASHTO TP 119 [14]). The ratio of the resistivity of cylinders conditioned in calcium hydroxide saturated, simulated pore solution and the resistivity of the sealed cylinders varied, depending on the mixture microstructure, from 0.46 to 0.60.

In the field, only two cylinders were cast, and they were conditioned in calcium hydroxide saturated, simulated pore solution (Option A of AASHTO TP 119 [14]. An anomaly was observed on the surface resistivity results between the ages of 56 and 91 days, because the surface resistivity decreased with time. However, bulk resistivity confirmed the expected trend of resistivity increase with time. Bulk resistivity values are expected to be comparable to those of the "effective" surface resistivity. At age 56 days, bulk resistivity and effective surface resistivity were comparable, however, since an anomaly was observed with the 91 days surface resistivity results, the 91 days resistivities were not comparable.

Formation factor was calculated from the "effective" surface resistivity and bulk resistivity results. AASHTO PP 84 [16] presents a requirement of a minimum formation factor of 1,000 for concretes exposed to freezing-thawing. The formation factor at 91 days calculated from the bulk resistivity results complied with this requirement.

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[17] P. Taylor, E. Yurdakul, X. Wang, and X. Wang, “Concrete Pavement Mixture Design and Analysis (MDA): An Innovative Approach To Proportioning Concrete Mixtures. Report TPF-5(205),” *Natl. Concr. Pavement Technol. Cent.*, 2015.

[18] H. Hall *et al.*, “Improving Specifications to Resist Frost Damage in Modern Concrete Mixtures, Part 2." Report, FHWA Pooled Fund Study TPF-5-297, Federal Highway Administration, 2019.

[19] AASHTO T 318-15 (2019), “Standard Method of Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.” American Association of State Highway and Transportation Officials, Washington D.C.

[20] AASHTO T 152-19, “Standard Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method.” American Association of State Highway and Transportation Officials, Washington, D.C., 2019.

[21] AASHTO T 23-18, “Standard Method of Test for Making and Curing Concrete Test Specimens in the Field,” vol. 1. American Association of State Highway and Transportation Officials, Washington, D.C., pp. 1–9, 2020.

[22] AASHTO T 24M/T 24-15 (2019), “Standard Method of Test for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.” American Association of State Highway and Transportation Officials, Washington D.C.

APPENDIX A

MnDOT 3A21-43 Mix Design Summary

July 30, 2019

Mr. Greg Pelkey
Shafer Contracting Co., Inc
30405 Regal Avenue
Shafer, MN 55074

Re: MnDOT TH35W & Lake Street, SP 2782-327
MnDOT Work Task #1 – Materials Performance Test Results
AET Project No. 29-20213

Dear Mr. Pelkey,

Attached are the final test results for the referenced project. Three mix designs that you provided and identified as 3A21-3, 3A21-6, and 3A41-9 were used to cast various concrete test specimens at American Engineering Testing, Inc. (AET) between April 24 and April 26, 2019 in accordance with the required test matrix identified as MnDOT Task #1. You submitted and identified all materials for the concrete mix. Materials were delivered to AET in early April 2019.

Basic and additional required plastic properties were obtained after mixing.

The requested testing was conducted in accordance with the following standard test methods:

- ASTM C192/C192M – 16a, "Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory" Plastic Tests: Air Content, SAM Number, Slump, Unit Weight
- Box Test
- Vibrating V-Kelly Ball Test
- AASHTO T 22-17, "Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens"
- AASHTO T 97-18, "Standard Method of Test for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)"
- AASHTO T 358-19, "Standard Method of Test for Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration
- AASHTO TP 119-19, "Modified Standard Method of Test for Electrical Resistivity of a Concrete Cylinder Tested in a Uniaxial Resistance Test" (Bucket Test)
- ASTM C29/C29M – 17a, "Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate

- ASTM C457/C457M – 16, "Standard Test Method for Microscopical Determination of Parameters of the Air Void System in Hardened Concrete"
- ASTM C136/136M – 14, "Standard Test Method for Sieve Analysis of Fine and Coarse Aggregate"
- ASTM C1074 – 17, "Standard Practice for Estimating Concrete Strength by the Maturity Method"

Any remaining test samples will be retained for a period of 30 days from the date of this report. Unless we are informed otherwise, the specimens will then be discarded. The results represent specifically the samples tested and the methods specified.

Please contact us should you have any questions or need additional information.

American Engineering Testing, Inc.

Patrick Barnhouse

Patrick Barnhouse, PE
Engineer II, Concrete Materials Laboratory
Phone: 651-999-1772
pbarnhouse@amengtest.com

Dan Vruno

Daniel M. Vruno, PE
Principal Engineer
MN Reg. No. 42037
Phone: 651-659-1334
dvruno@amengtest.com

AET Project No:	29-20213	**AET Project Mgr.:**	D. Vruno
Project:	MnDOT Work Task #1	**AET Engineer:**	P. Barnhouse
Client:	Shafer Contracting Co., Inc.	**Approved:**	W. Morrison
Contact:	Mr. Greg Pelkey	**Date:**	July 30, 2019

Mix Design and Fresh Property Summary

	3A21-3	**3A21-6**	**3A41-9**
Type I/II Portland Cement, Holcim St. Genevieve (lb/yd^3)	390	400	420
Class C Fly Ash, Lafarge Portage (lb/yd^3)	180	170	180
Coarse Aggregate, Empire #67, Pit #19129 (lb/yd^3)	1,038	1,038	1,020
Coarse Aggregate, Empire #4, Pit #19129 (lb/yd^3)	660	661	649
Fine Aggregate, Empire Sand, Pit #19129 (lb/yd^3)	1,191	1,191	1,170
Fine Aggregate, CIA, Pit #19129 (lb/yd^3)	249	249	244
Water (lb/yd^3)	199	199	210
Air Entrainer, GRT Polychem SA (oz/cwt)	0.53	0.53	0.53
Water Reducer, GRT Polychem 400 NC (oz/cwt)	8.42	8.42	8.83
Water to Cementitious Ratio	0.35	0.35	0.35

Notes:

1. All test specimens were fabricated at AET between April 24 and April 26, 2019.
2. Aggregate weights provided are for the oven dry condition.

AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
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· GEOTECHNICAL
· MATERIALS
· FORENSICS

AET Project No:	29-20213	**AET Project Mgr.:**	D. Vruno
Project:	MnDOT Work Task #1	**AET Engineer:**	P. Barnhouse
Client:	Shafer Contracting Co., Inc.	**Approved:**	W. Morrison
Contact:	Mr. Greg Pelkey	**Date:**	July 30, 2019

Mix Design and Fresh Property Summary

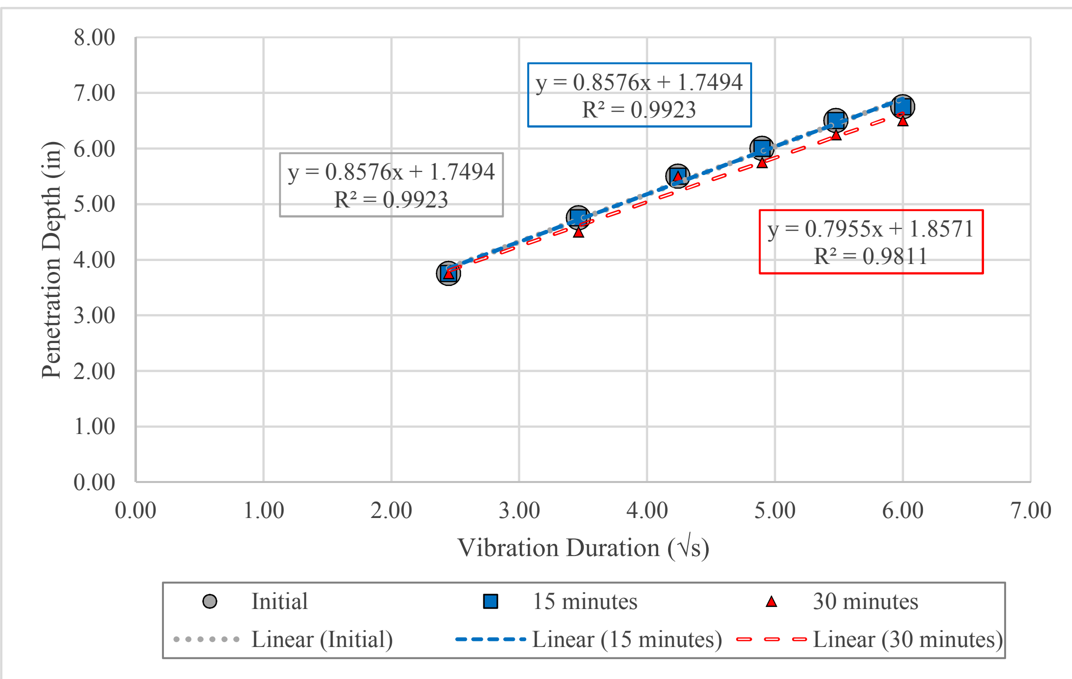
	3A21-3	**3A21-6**	**3A41-9**
Initial			
Unit Weight (lb/ft^3)	148.8	148.2	143.6
Slump (in)	2.50	2.50	2.75
Air Content (%)	6.1	7.0	6.3
Super Air Meter (SAM) Number	0.21	0.23	0.16
Box Test Ratings/Edge Slump (in)	1,1,1,2 / 0	1,1,2,2 / 0	2,2,2,1 / 0
VKelly Index (in/√s)	0.858	0.711	0.390
15 Minutes			
Unit Weight (lb/ft^3)	148.6	148.4	142.8
Slump (in)	2.25	2.50	2.50
Air Content (%)	5.9	6.8	6.0
Super Air Meter (SAM) Number	0.24	0.24	0.19
Box Test Ratings/Edge Slump (in)	1,1,1,2 / 0	1,1,2,2 / 0	2,2,2,1 / 0
VKelly Index (in/√s)	0.858	0.711	0.418
30 Minutes			
Unit Weight (lb/ft^3)	148.0	148.4	143.2
Slump (in)	2.00	2.25	2.25
Air Content (%)	5.8	6.8	5.8
Super Air Meter (SAM) Number	0.25	0.24	0.21
Box Test Ratings/Edge Slump (in)	2,1,1,2 / 0	1,1,2,2 / 0	1,2,2,2 / 0.25
VKelly Index (in/√s)	0.796	0.621	0.475

Notes:
1. All test specimens were fabricated at AET between April 24 and April 26, 2019.
2. Aggregate weights provided are for the oven dry condition.

Project No: 29-20213 **AET Project Mgr.:** D. Vruno
Project: MnDOT Work Task #1 **AET Engineer:** P. Barnhouse
Client: Shafer Contracting Co., Inc. **Approved:** W. Morrison
Contact: Mr. Greg Pelkey **Date:** June 7, 2019

Fresh Property Data Sheet
Mix ID - 3A21-3
VKelly Ball Test Results

Initial			15 minutes			30 minutes		
Time (s)	Depth (in)		Time (s)	Depth (in)		Time (s)	Depth (in)	
Initial	1.25		Initial	1.00		Initial	1.00	
At Rest	1.75		At Rest	1.50		At Rest	1.50	
6	3.75		6	3.75		6	3.75	
12	4.75		12	4.75		12	4.50	
18	5.50		18	5.50		18	5.50	
24	6.00		24	6.00		24	5.75	
30	6.50		30	6.50		30	6.25	
36	6.75		36	6.75		36	6.5	
VKelly Index (in/√s)		0.858	VKelly Index (in/√s)		0.858	VKelly Index (in/√s)		0.796

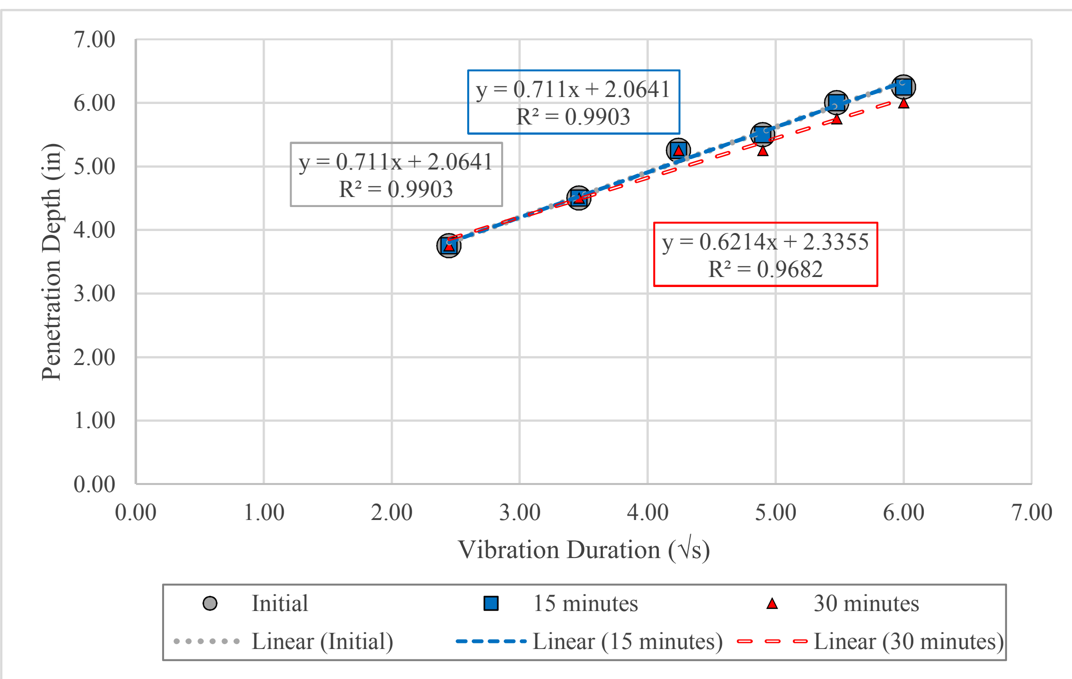


Project No: 29-20213
Project: MnDOT Work Task #1
Client: Shafer Contracting Co., Inc.
Contact: Mr. Greg Pelkey

AET Project Mgr.: D. Vruno
AET Engineer: P. Barnhouse
Approved: W. Morrison
Date: June 7, 2019

Fresh Property Data Sheet
Mix ID - 3A21-6
VKelly Ball Test Results

Initial			15 minutes			30 minutes		
Time (s)	Depth (in)		Time (s)	Depth (in)		Time (s)	Depth (in)	
Initial	1.50		Initial	1.50		Initial	1.50	
At Rest	2.00		At Rest	2.00		At Rest	2.00	
6	3.75		6	3.75		6	3.75	
12	4.50		12	4.50		12	4.50	
18	5.25		18	5.25		18	5.25	
24	5.50		24	5.50		24	5.25	
30	6.00		30	6.00		30	5.75	
36	6.25		36	6.25		36	6.00	
VKelly Index (in/√s)		0.711	VKelly Index (in/√s)		0.711	VKelly Index (in/√s)		0.621



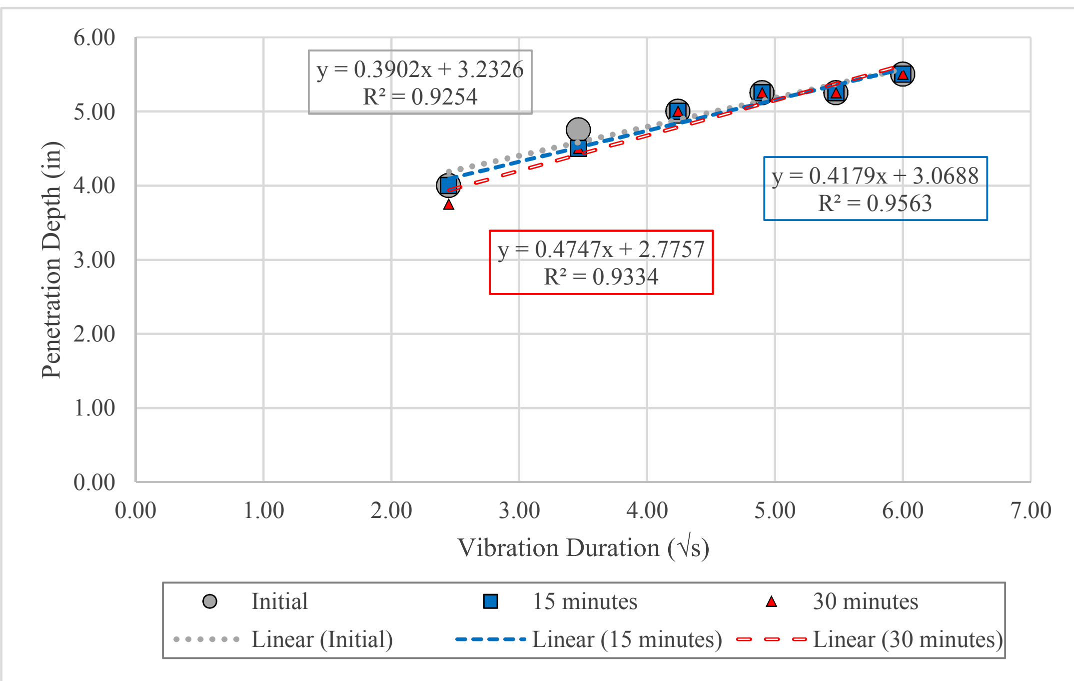
Project No: 29-20213 **AET Project Mgr.:** D. Vruno
Project: MnDOT Work Task #1 **AET Engineer:** P. Barnhouse
Client: Shafer Contracting Co., Inc. **Approved:** W. Morrison
Contact: Mr. Greg Pelkey **Date:** June 7, 2019

Fresh Property Data Sheet

Mix ID - 3A41-9

VKelly Ball Test Results

Initial			15 minutes			30 minutes		
Time (s)	Depth (in)		Time (s)	Depth (in)		Time (s)	Depth (in)	
Initial	2.25		Initial	2.00		Initial	1.75	
At Rest	2.50		At Rest	2.50		At Rest	2.25	
6	4.00		6	4.00		6	3.75	
12	4.75		12	4.50		12	4.50	
18	5.00		18	5.00		18	5.00	
24	5.25		24	5.25		24	5.25	
30	5.25		30	5.25		30	5.25	
36	5.50		36	5.50		36	5.50	
VKelly Index (in/√s)		0.390	VKelly Index (in/√s)		0.418	VKelly Index (in/√s)		0.475



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CONSULTANTS
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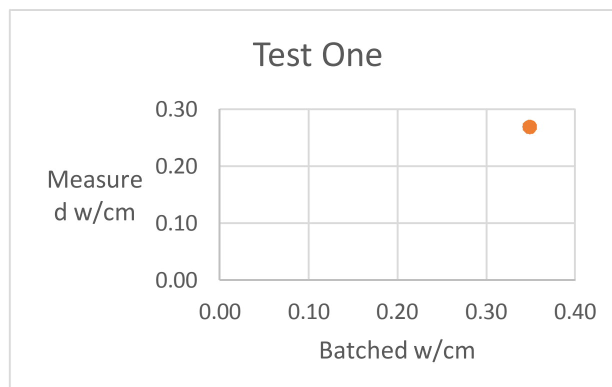
· MATERIALS
· FORENSICS

AET Project No.:	29-20213	AET Project Mgr.:	D. Vruno
Project:	Work Task #1	Approved:	W. Morrison
Client:	Shafer	Date:	June 7, 2019
Contact:	Mr. Greg Pelkey	Mix ID:	3A21-3

Specific Gravities		Absorptions		Batch Masses	
Cement SG	3.15	CAI	1.2	Cement	57.8
Fly Ash SG	2.72	CAII	1.2	Fly Ash	26.7
CAI	2.67	CAIII		CAI	156.9
CAII	2.67	FAI	0.5	CAII	100.9
CAIII		FAII	1.4	CAIII	
FAI	2.66			FAI	185.3
FAII	2.64			FAII	38.2
				Water	29.5
				Batched Volume (ft^3)	4
				Batched Concrete Air Volume	

Air Volume		Total Water Absorbed		Binder and Absorbed Water Cylinder	
Cylinder Density (g/ft^3)	67737.6	CAI Abs	1.88	Volume Ratio	0.014665896
Total Batched Mass	595.3	CAII Abs	1.21	Cylinder Binder	1.239268187
Absolute Volume Batched (Air Free)	3.8	CAIII Abs		Cylinder Abs Water	0.066801688
Air Content (%)	6.1	FAI Abs	0.93		
		FAII Abs	0.53		
		Total Absorbed Water	4.55		

Absolute Volume Batched	4.06
Batched Density	146.49
Water Loss Mass (lbs)	0.40



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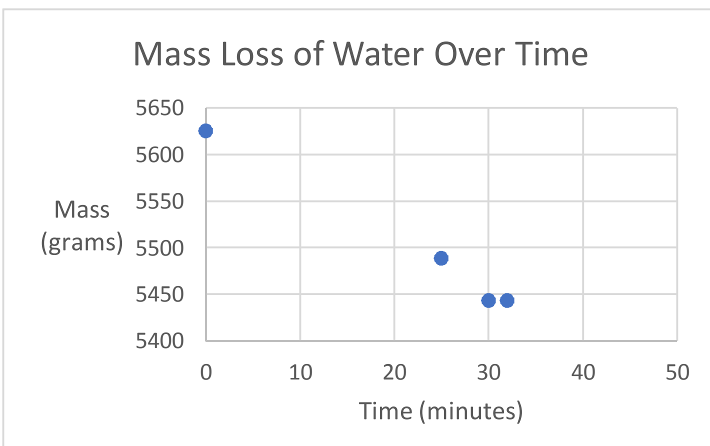
AET Project No.:	29-20213	AET Project Mgr.:	D. Vruno
Project:	Work Task #1	Approved:	W. Morrison
Client:	Shafer	Date:	June 7, 2019
Contact:	Mr. Greg Pelkey	Mix ID:	3A21-3

Phoenix Masses			lbs	Mass loss of water over time	
Tare Cylinder (g)	108.9		0.24	Mass (g)	Time (min)
Mass Cylinder Filled (g)	4173.1		9.2	5625	0
Mass Cylinder Emptied (g)	136.1		0.3	5488.5	25
Volume Cylinder (ft^3)	0.06			5443.1	30
				5443.1	32
Mass of Pan Fresh Concrete (g)	5624.64		12.4		
Mass of Pan Dried Concrete (g)	5443.2		12		
Cylinder Volume Tested (g/ft^3)	0.06	(lbs/ft^3)	0.06		

w/cm Calculations	
Measure w/cm	0.27
Batched w/cm	0.35



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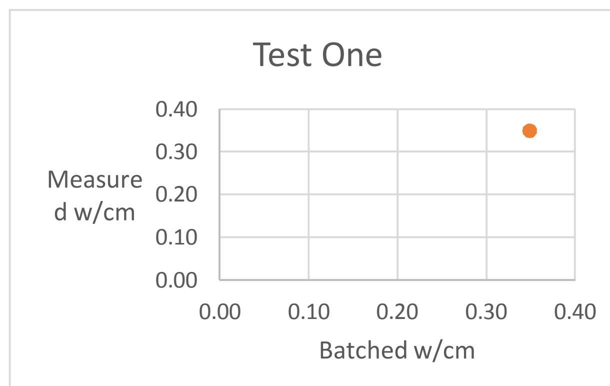
AET Project No.:	29-20213	AET Project Mgr.:	D. Vruno
Project:	Work Task #1	Approved:	W. Morrison
Client:	Shafer	Date:	June 7, 2019
Contact:	Mr. Greg Pelkey	Mix ID:	3A21-6

Specific Gravities		Absorptions		Batch Masses	
Cement SG	3.15	CAI	1.2	Cement	59.3
Fly Ash SG	2.72	CAII	1.2	Fly Ash	25.2
CAI	2.67	CAIII		CAI	156.9
CAII	2.67	FAI	0.5	CAII	101.1
CAIII		FAII	1.4	CAIII	
FAI	2.66			FAI	185.3
FAII	2.64			FAII	38.2
				Water	29.5
				Batched Volume (ft^3)	4
				Batched Concrete Air Volume	

Air Volume		Total Water Absorbed		Binder and Absorbed Water Cylinder	
Cylinder Density (g/ft^3)	66981.6	CAI Abs	1.88	Volume Ratio	0.014647201
Total Batched Mass	595.5	CAII Abs	1.21	Cylinder Binder	1.237688525
Absolute Volume Batched (Air Free)	3.8	CAIII Abs		Cylinder Abs Water	0.066751691
Air Content (%)	6.8	FAI Abs	0.93		
		FAII Abs	0.53		
		Total Absorbed Water	4.56		

Absolute Volume Batched	4.09
Batched Density	145.54
Water Loss Mass (lbs)	0.50



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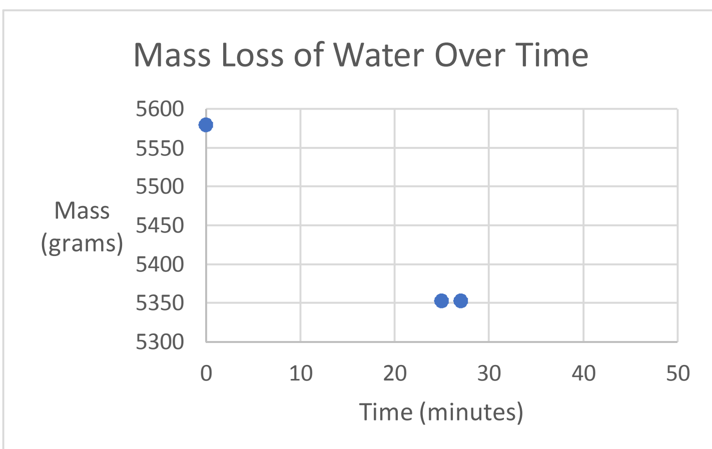
AET Project No.:	29-20213	AET Project Mgr.:	D. Vruno
Project:	Work Task #1	Approved:	W. Morrison
Client:	Shafer	Date:	June 7, 2019
Contact:	Mr. Greg Pelkey	Mix ID:	3A21-6

Phoenix Masses			lbs
Tare Cylinder (g)	113.4		0.25
Mass Cylinder Filled (g)	4132.3		9.11
Mass Cylinder Emptied (g)	117.9		0.26
Volume Cylinder (ft^3)	0.06		
Mass of Pan Fresh Concrete (g)	5579.28		12.3
Mass of Pan Dried Concrete (g)	5352.48		11.8
Cylinder Volume Tested (g/ft^3)	0.06	(lbs/ft^3)	0.06

Mass loss of water over time

Mass (g)	Time (min)
5579	0
5352	25
5352	27

w/cm Calculations	
Measure w/cm	0.35
Batched w/cm	0.35



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CONSULTANTS
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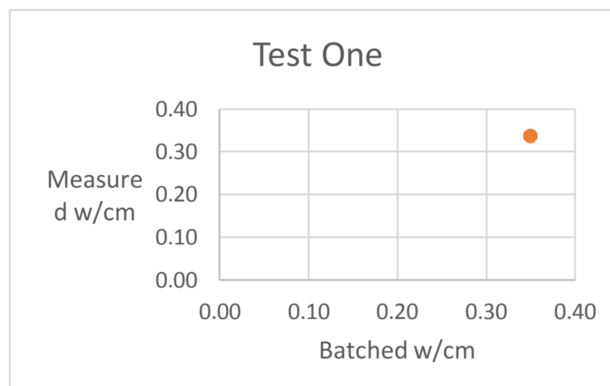
AET Project No.:	29-20213	AET Project Mgr.:	D. Vruno
Project:	Work Task #1	Approved:	W. Morrison
Client:	Shafer	Date:	June 7, 2019
Contact:	Mr. Greg Pelkey	Mix ID:	3A41-9

Specific Gravities		Absorptions		Batch Masses	
Cement SG	3.15	CAI	1.2	Cement	248.9
Fly Ash SG	2.72	CAII	1.2	Fly Ash	106.7
CAI	2.67	CAIII		CAI	616.6
CAII	2.67	FAI	0.5	CAII	397
CAIII		FAII	1.4	CAIII	
FAI	2.66			FAI	728.2
FAII	2.64			FAII	149.6
				Water	124.4
				Batched Volume (ft^3)	16
				Batched Concrete Air Volume	

Air Volume		Total Water Absorbed		Binder and Absorbed Water Cylinder	
Cylinder Density (g/ft^3)	66376.8	CAI Abs	7.40	Volume Ratio	0.003692633
Total Batched Mass	2371.4	CAII Abs	4.76	Cylinder Binder	1.313100465
Absolute Volume Batched (Air Free)	15.3	CAIII Abs		Cylinder Abs Water	0.06609297
Air Content (%)	5.9	FAI Abs	3.64		
		FAII Abs	2.09		
		Total Absorbed Water	17.90		

Absolute Volume Batched	16.21
Batched Density	146.28
Water Loss Mass (lbs)	0.51



AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
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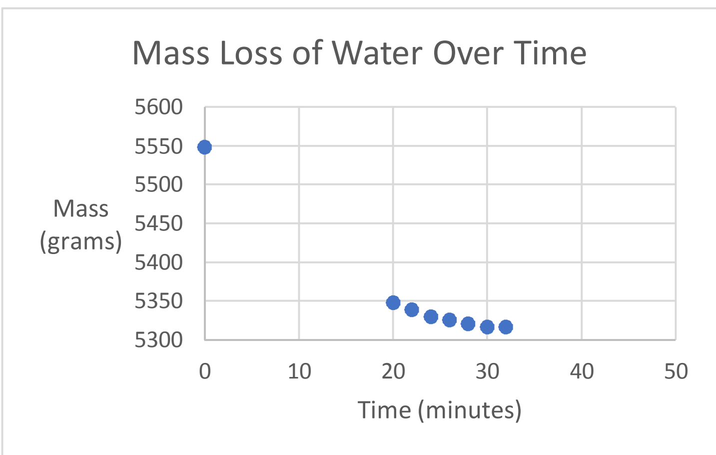
AET Project No.:	29-20213	AET Project Mgr.:	D. Vruno
Project:	Work Task #1	Approved:	W. Morrison
Client:	Shafer	Date:	June 7, 2019
Contact:	Mr. Greg Pelkey	Mix ID:	3A41-9

Phoenix Masses			lbs	Mass loss of water over time	
				Mass (g)	Time (min)
Tare Cylinder (g)	108.9		0.24	5548	0
Mass Cylinder Filled (g)	4091.5		9.02	5348	20
Mass Cylinder Emptied (g)	117.9		0.26	5339	22
Volume Cylinder (ft^3)	0.06			5330	24
Mass of Pan Fresh Concrete (g)	5547.528		12.23	5325	26
Mass of Pan Dried Concrete (g)	5316.192		11.72	5321	28
				5316	30
Cylinder Volume Tested (g/ft^3)	0.06	(lbs/ft^3)	0.06	5316	32

w/cm Calculations	
Measure w/cm	0.34
Batched w/cm	0.35



AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
· ENVIRONMENTAL
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· FORENSICS

AET Project No:	29-20213	**AET Project Mgr.:**	D. Vruno
Project:	MnDOT Work Task #1	**AET Engineer:**	P. Barnhouse
Client:	Shafer Contracting Co., Inc.	**Approved:**	W. Morrison
Contact:	Mr. Greg Pelkey	**Report Date:**	June 7, 2019

Test Result Summary of Hardened Properties

Concrete Mix 3A21-3

ASTM C78, Flexural Strength

	Specimen 1	Specimen 2	Specimen 3	Average	Specification
1 day, psi	225	250	255	**245**	
2 days, psi	560	460	610	**545**	
3 days, psi	460	475	445	**460**	
7 days, psi	720	680	605	**670**	
14 days, psi	690	695	595	**660**	
28 days, psi	635	600	600	**610**	

ASTM C39, Compressive Strength

	Specimen 1	Specimen 2	Specimen 3	Average
1 day, psi	2,750	840	1,000	**1,530**
2 days, psi	4,700	4,290	3,280	**4,090**
3 days, psi	4,800	5,900	5,840	**5,510**
7 days, psi	6,610	6,850	6,680	**6,710**
14 days, psi	6,710	6,530	6,270	**6,500**
28 days, psi	8,090	8,330	7,750	**8,060**

ASTM C457, Air Void Analysis

Total Air Voids, %	Specific Surface, in^2/in^3	Spacing Factor, in
5.7	1050	0.005

Notes:

1. The test results represent the specimens tested and the methods specified.
2. All test specimens were fabricated at AET on April 24, 2019.

AET Project No:	29-20213	**AET Project Mgr.:**	D. Vruno
Project:	MnDOT Work Task #1	**AET Engineer:**	P. Barnhouse
Client:	Shafer Contracting Co., Inc.	**Approved:**	W. Morrison
Contact:	Mr. Greg Pelkey	**Report Date:**	June 7, 2019

Test Result Summary of Hardened Properties

Concrete Mix 3A21-6

ASTM C78, Flexural Strength

	Specimen 1	Specimen 2	Specimen 3	**Average**	**Specification**
1 day, psi	20	35	50	**35**	
2 days, psi	410	435	485	**445**	
3 days, psi	460	510	495	**490**	
7 days, psi	745	795	720	**755**	
14 days, psi	860	815	880	**850**	
28 days, psi	845	825	810	**825**	

ASTM C39, Compressive Strength

	Specimen 1	Specimen 2	Specimen 3	**Average**
1 day, psi	1,860	2,500	2,680	**2,350**
2 days, psi	4,690	5,290	5,290	**5,090**
3 days, psi	6,410	5,900	6,510	**6,270**
7 days, psi	7,190	7,310	7,270	**7,260**
14 days, psi	7,960	7,770	7,490	**7,740**
28 days, psi	8,400	8,840	8,800	**8,680**

ASTM C457, Air Void Analysis

Total Air Voids, %	Specific Surface, in^2/in^3	Spacing Factor, in
4.3	550	0.008

Notes:

1. The test results represent the specimens tested and the methods specified.
2. All test specimens were fabricated at AET on April 24, 2019.

AET Project No:	29-20213	**AET Project Mgr.:**	D. Vruno
Project:	MnDOT Work Task #1	**AET Engineer:**	P. Barnhouse
Client:	Shafer Contracting Co., Inc.	**Approved:**	W. Morrison
Contact:	Mr. Greg Pelkey	**Report Date:**	June 7, 2019

Test Result Summary of Hardened Properties

Concrete Mix 3A41-9

ASTM C78, Flexural Strength

	Specimen 1	Specimen 2	Specimen 3	**Average**	**Specification**
1 day, psi	420	425	410	**420**	
2 days, psi	495	450	525	**490**	
3 days, psi	605	555	565	**575**	
7 days, psi	690	675	720	**695**	
14 days, psi	600	675	680	**650**	
28 days, psi	735	625	715	**690**	

ASTM C39, Compressive Strength

	Specimen 1	Specimen 2	Specimen 3	**Average**
1 day, psi	2,300	2,380	2,270	**2,320**
2 days, psi	3,630	3,710	3,840	**3,730**
3 days, psi	4,220	4,170	4,140	**4,180**
7 days, psi	4,550	5,350	4,930	**4,940**
14 days, psi	5,360	4,950	5,230	**5,180**
28 days, psi	5,590	5,760	6,200	**5,850**

ASTM C457, Air Void Analysis

Total Air Voids, %	Specific Surface, in^2/in^3	Spacing Factor, in
4.3	1090	0.004

Notes:

1. The test results represent the specimens tested and the methods specified.
2. All test specimens were fabricated at AET on April 26, 2019.

AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
- ENVIRONMENTAL
- GEOTECHNICAL
- MATERIALS
- FORENSICS

AET Project No: 29-20213
Project: Work Task #1
Client: Shafer

AET Project Mgr.: D. Vruno
AET Engineer: P. Barnhouse
Cast Date: April 24, 2019

AASHTO T 358 Surface Resistivity
Specimens immersed in a calcium hydroxide saturated, simulated pore solution, as in AASHTO TP 119
Mix 3A21-3

Day 1 **4/25/19**

	Submerged 1	Submerged 2
Mass (g)	13,336.5	13,399.5

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	6.9	8.4	9.0	9.1	8.1	8.3	8.3	9.5
Sample 2	8.9	8.2	7.4	7.3	9.2	9.5	7.8	7.6

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	8.5	5.76	**5.83**
Sample 2	8.2	5.91	

Day 3 **4/27/19**

	Submerged 1	Submerged 2
Mass (g)	13,403.0	13,463.0

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	7.6	6.2	7.4	7.4	7.7	6.5	8	7.6
Sample 2	6.3	6.8	7.2	7.3	8.2	7.4	7	7

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	7.3	5.10	**5.10**
Sample 2	7.2	5.10	

AET Project No: 29-20213 | **AET Project Mgr.:** D. Vruno
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Client: Shafer | **Cast Date:** April 24, 2019

AASHTO T 358 Surface Resistivity
Specimens immersed in a calcium hydroxide saturated, simulated pore solution, as in AASHTO TP 119
Mix 3A21-3

Day 5 **4/29/19**

	Submerged 1	Submerged 2
Mass (g)	13,410.8	13,470.5

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	8.0	8.7	9.4	8.6	9.3	8.6	9.5	8.5
Sample 2	8.9	8.2	8.3	8.6	9.7	9.0	9.4	9.1

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	8.8	6.22	**6.20**
Sample 2	8.9	6.17	

Day 7 **5/1/19**

	Submerged 1	Submerged 2
Mass (g)	13,413.9	13,474.4

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	9.8	9.2	10.9	9.1	10.3	10.0	10.7	9.8
Sample 2	9.9	9.8	9.4	9.9	10.6	10.6	10.0	9.8

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	10.0	6.99	**6.98**
Sample 2	10.0	6.98	

AET Project No: 29-20213 **AET Project Mgr.:** D. Vruno
Project: Work Task #1 **AET Engineer:** P. Barnhouse
Client: Shafer **Cast Date:** April 24, 2019

AASHTO T 358 Surface Resistivity
Specimens immersed in a calcium hydroxide saturated, simulated pore solution, as in AASHTO TP 119
Mix 3A21-3

Day 14 **5/8/19**

	Submerged 1	Submerged 2
Mass (g)	13,424.1	13,483.0

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	9.6	9.8	10.7	10.2	11.5	10.9	11.6	10.4
Sample 2	11.2	11.0	10.9	10.7	11.6	11.1	11.1	10.8

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	10.6	7.73	**7.57**
Sample 2	11.1	7.40	

Day 28 **5/22/19**

	Submerged 1	Submerged 2
Mass (g)	13,430.4	13,494.0

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	10.1	11.0	11.7	11.8	12.9	13.1	13.1	13.0
Sample 2	11.5	11.1	10.3	11.6	11.2	11.8	11.2	11.6

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	12.1	7.89	**8.17**
Sample 2	11.3	8.45	

AET Project No: 29-20213
Project: Work Task #1
Client: Shafer

AET Project Mgr.: D. Vruno
AET Engineer: P. Barnhouse
Cast Date: April 24, 2019

AASHTO T 358 Surface Resistivity
Specimens immersed in a calcium hydroxide saturated, simulated pore solution, as in AASHTO TP 119
Mix 3A21-3

Day 56 **6/19/19**

	Submerged 1	Submerged 2
Mass (g)	13,445.0	13,503.6

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	13.5	14.3	14.1	13.2	17.9	15.2	16.3	14.9
Sample 2	15.6	13.2	13.2	12.7	14.3	15.0	14.4	15.1

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	14.9	9.92	**10.18**
Sample 2	14.2	10.44	

Day 91 **7/24/19**

	Submerged 1	Submerged 2
Mass (g)	13,449.6	13,506.7

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	16.2	15.2	18.5	18.1	17.5	19.1	20.1	19.8
Sample 2	26.9	38.3	24.8	27.1	22.9	25.9	29.7	27.2

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	18.1	12.63	**12.63**
Sample 2	27.9	12.63	

AET Project No: 29-20213 **AET Project Mgr.:** D. Vruno
Project: Work Task #1 **AET Engineer:** P. Barnhouse
Client: Shafer **Cast Date:** April 24, 2019

AASHTO T 358 Surface Resistivity
Specimens immersed in a calcium hydroxide saturated, simulated pore solution, as in AASHTO TP 119
Mix 3A21-6

Day 1 **4/25/19**

	Submerged 1	Submerged 2
Mass (g)	13,662.4	13,641.4

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	6.1	7.2	6.4	7.0	6.2	7.1	6.4	7.4
Sample 2	6.5	6.3	7.4	6.9	6.5	6.3	7.2	6.3

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	6.7	4.67	**4.69**
Sample 2	6.7	4.70	

Day 3 **4/27/19**

	Submerged 1	Submerged 2
Mass (g)	13,685.0	13,662.8

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	5.8	6.1	5.7	5.8	6	6.2	6	7.1
Sample 2	5.8	5.9	6.4	5.9	6.3	6.3	6.9	6

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	6.1	4.33	**4.29**
Sample 2	6.2	4.26	

AET Project No: 29-20213 **AET Project Mgr.:** D. Vruno
Project: Work Task #1 **AET Engineer:** P. Barnhouse
Client: Shafer **Cast Date:** April 24, 2019

AASHTO T 358 Surface Resistivity
Specimens immersed in a calcium hydroxide saturated, simulated pore solution, as in AASHTO TP 119
Mix 3A21-6

Day 5 **4/29/19**

	Submerged 1	Submerged 2
Mass (g)	13,697.0	13,672.3

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	6.5	7.0	7.0	7.4	7.0	7.2	7.1	7.9
Sample 2	7.2	7.4	7.7	7.0	7.7	7.9	7.6	7.4

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	7.1	5.24	**5.11**
Sample 2	7.5	4.99	

Day 7 **5/1/19**

	Submerged 1	Submerged 2
Mass (g)	13,701.5	13,677.0

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	6.2	7.3	6.8	8.0	7.2	8.8	7.5	7.8
Sample 2	8.1	8.5	7.9	7.8	8.3	8.9	8.4	8.2

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	7.5	5.78	**5.49**
Sample 2	8.3	5.21	

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AASHTO T 358 Surface Resistivity
Specimens immersed in a calcium hydroxide saturated, simulated pore solution, as in AASHTO TP 119
Mix 3A21-6

Day 14 **5/8/19**

	Submerged 1	Submerged 2
Mass (g)	13,710.2	13,686.7

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	7.7	9.0	7.9	9.3	8.3	9.0	8.3	8.9
Sample 2	9.5	9.1	9.4	9.2	9.7	9.9	9.5	9.7

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	8.6	6.64	**6.31**
Sample 2	9.5	5.98	

Day 28 **5/22/19**

	Submerged 1	Submerged 2
Mass (g)	13,718.4	13,695.3

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	10.3	10.4	11.9	11.6	11.5	12.4	12.5	13.3
Sample 2	10.1	10.5	10.3	10.2	11.1	11.1	11.5	11.0

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	11.7	7.50	**7.85**
Sample 2	10.7	8.21	

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AASHTO T 358 Surface Resistivity
Specimens immersed in a calcium hydroxide saturated, simulated pore solution, as in AASHTO TP 119
Mix 3A21-6

Day 56 **6/19/19**

	Submerged 1	Submerged 2
Mass (g)	13,727.4	13,702.8

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	11.0	11.0	11.7	11.8	12.6	12.4	12.3	12.9
Sample 2	13.3	12.0	12.9	10.6	12.5	12.7	12.3	11.2

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	12.0	8.52	**8.44**
Sample 2	12.2	8.37	

Day 91 **7/24/19**

	Submerged 1	Submerged 2
Mass (g)	13,732.7	13,706.3

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	17.9	19	20.6	22.2	19.6	22.5	21.2	21.3
Sample 2	22.8	21.9	21.5	20.3	24.6	24.1	25.5	23.4

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	20.5	16.09	**15.23**
Sample 2	23.0	14.36	

AET Project No: 29-20213
Project: Work Task #1
Client: Shafer

AET Project Mgr.: D. Vruno
AET Engineer: P. Barnhouse
Cast Date: April 26, 2019

AASHTO T 358 Surface Resistivity
Specimens immersed in a calcium hydroxide saturated, simulated pore solution, as in AASHTO TP 119
Mix 3A21-9

Day 1 **4/27/19**

	Submerged 1	Submerged 2
Mass (g)	13,215.4	13,223.2

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	3.7	3.9	3.3	3.1	3.7	3.6	3.2	3.0
Sample 2	3.4	3.6	3.2	3.7	3.3	3.7	3.3	3.6

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	3.4	2.43	**2.42**
Sample 2	3.5	2.40	

Day 3 **4/29/19**

	Submerged 1	Submerged 2
Mass (g)	13,260.7	13,270.1

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	5.4	5.5	5	4.6	5.2	5.3	4.8	4.7
Sample 2	4.7	5.6	4.1	5	5	5.3	4.4	4.7

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	5.1	3.39	**3.47**
Sample 2	4.9	3.54	

American Engineering Testing, Inc.

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- Environmental
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- Materials
- Forensics

AET Project No:	29-20213	**AET Project Mgr.:**	D. Vruno
Project:	Work Task #1	**AET Engineer:**	P. Barnhouse
Client:	Shafer	**Cast Date:**	April 26, 2019

AASHTO T 358 Surface Resistivity
Specimens immersed in a calcium hydroxide saturated, simulated pore solution, as in AASHTO TP 119
Mix 3A21-9

Day 5 **5/1/19**

	Submerged 1	Submerged 2
Mass (g)	13,268.7	13,279.2

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	5.5	6.0	5.5	5.3	5.8	6.0	5.3	5.6
Sample 2	5.7	6.8	5.5	5.8	6.0	6.5	5.4	6.0

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	5.6	4.17	**4.05**
Sample 2	6.0	3.93	

Day 7 **5/3/19**

	Submerged 1	Submerged 2
Mass (g)	13,269.7	13,282.1

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	6.3	7.0	6.7	6.2	7.2	7.3	6.7	6.3
Sample 2	6.1	7.2	6.0	6.4	6.3	7.6	6.4	6.6

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	6.7	4.60	**4.65**
Sample 2	6.6	4.69	

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AASHTO T 358 Surface Resistivity
Specimens immersed in a calcium hydroxide saturated, simulated pore solution, as in AASHTO TP 119
Mix 3A21-9

Day 14 **5/10/19**

	Submerged 1	Submerged 2
Mass (g)	13,282.9	13,296.4

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	7.8	8.2	7.5	7.8	8.6	8.9	8.4	8.2
Sample 2	7.6	7.8	7.1	8.0	8.1	8.9	7.6	8.2

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	8.2	5.53	**5.63**
Sample 2	7.9	5.72	

Day 28 **5/24/19**

	Submerged 1	Submerged 2
Mass (g)	13,289.9	13,302.3

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	9.8	10.2	8.8	9.3	10.5	11.1	10.2	10.1
Sample 2	8.9	9.3	8.0	9.0	8.8	10.1	8.0	9.5

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	10.0	6.26	**6.63**
Sample 2	9.0	6.99	

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AASHTO T 358 Surface Resistivity
Specimens immersed in a calcium hydroxide saturated, simulated pore solution, as in AASHTO TP 119
Mix 3A21-9

Day 56 **6/21/19**

	Submerged 1	Submerged 2
Mass (g)	13,297.4	13,310.2

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	13.2	14.3	12.7	13.2	14.3	15.4	14.2	14.3
Sample 2	11.2	12.3	11.5	11.9	12.9	13.1	12.9	13.9

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	14.0	8.72	**9.24**
Sample 2	12.5	9.76	

Day 91 **7/26/19**

	Submerged 1	Submerged 2
Mass (g)	13,299.6	13,310.9

Submerged	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	14.5	15	15.4	18.9	18.2	18.9	16.9	19.8
Sample 2	21.9	21.1	19	20.5	22.5	19.7	19.2	20.7

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	17.2	14.39	**13.21**
Sample 2	20.6	12.03	

AET Project No: 29-20213 **AET Project Mgr.:** D. Vruno
Project: Work Task #1 **AET Engineer:** P. Barnhouse
Client: Shafer **Cast Date:** April 24, 2019

AASHTO T 358 Surface Resistivity
Sealed Specimens
Mix 3A21-3

Day 1 **4/25/19**

	Sealed 1	Sealed 2
Mass (g)	13,306.4	13,274.7

Sealed	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	7.7	9.0	7.0	7.9	7.8	9.2	7.1	7.9
Sample 2	8.7	7.6	6.7	8.2	8.7	7.6	7.3	8.7

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	8.0	5.56	**5.56**
Sample 2	7.9	5.55	

Day 28 **5/22/19**

	Sealed 1	Sealed 2
Mass (g)	13,306.6	13,274.2

Sealed	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	24.9	23.2	24.1	26.2	25.9	27.2	24.5	23.8
Sample 2	28.5	26	23.1	26.8	28.5	26.1	23.7	25.9

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	25.0	17.47	**17.85**
Sample 2	26.1	18.23	

AET Project No: 29-20213
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AASHTO T 358 Surface Resistivity
Sealed Specimens
Mix 3A21-3

Day 91 **7/24/19**

	Sealed 1	Sealed 2
Mass (g)	13,304.6	13,271.8

Sealed	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	47.8	52.1	44.6	48.8	48.8	49.6	43.6	56.5
Sample 2	50.9	53.1	44.9	44.1	61.9	55.4	45.2	49.5

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	49.0	34.25	**34.83**
Sample 2	50.6	35.40	

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Client: Shafer

AET Project Mgr.: D. Vruno
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Cast Date: April 24, 2019

AASHTO T 358 Surface Resistivity
Sealed Specimens
Mix 3A21-6

Day 1 **4/25/19**

	Sealed 1	Sealed 2
Mass (g)	13,760.6	13,698.8

Sealed	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	6.3	6.3	7.7	7.3	6.1	6.5	7.5	7.5
Sample 2	6.7	7.1	6.4	8.5	6.6	7.2	6.3	8.3

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	6.9	4.83	**4.91**
Sample 2	7.1	4.99	

Day 28 **5/22/19**

	Sealed 1	Sealed 2
Mass (g)	13,755.1	13,695.3

Sealed	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	17.4	17.4	21.8	19.6	17.6	18.2	21.6	18.8
Sample 2	19.6	21.7	19.1	25.7	19.7	22.8	19.1	24.7

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	19.1	13.32	**14.20**
Sample 2	21.6	15.07	

AET Project No: 29-20213
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Client: Shafer

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AET Engineer: P. Barnhouse
Cast Date: April 24, 2019

AASHTO T 358 Surface Resistivity
Sealed Specimens
Mix 3A21-6

Day 91 **7/24/19**

	Sealed 1	Sealed 2
Mass (g)	13,727.4	13,702.8

Sealed	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	41.6	41.6	41.4	38.7	40.8	40.3	40.1	36.2
Sample 2	40.7	45.3	40.9	40.8	40.1	42.5	40.6	45.9

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	40.1	28.03	**28.74**
Sample 2	42.1	29.44	

AET Project No: 29-20213 **AET Project Mgr.:** D. Vruno
Project: Work Task #1 **AET Engineer:** P. Barnhouse
Client: Shafer **Cast Date:** April 26, 2019

AASHTO T 358 Surface Resistivity
Sealed Specimens
Mix 3A21-9

Day 1 **4/27/19**

	Sealed 1	Sealed 2
Mass (g)	13,208.2	13,295.4

Sealed	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	3.6	3.7	3.5	3.6	3.3	3.9	3.4	3.5
Sample 2	4.2	3.4	3.5	3.7	4.0	3.8	3.7	3.7

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	3.6	2.49	**2.56**
Sample 2	3.8	2.62	

Day 28 **5/24/19**

	Sealed 1	Sealed 2
Mass (g)	13,202.5	13,288.2

Sealed	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	15.4	17.3	16	15.8	15.5	17	15.6	15.6
Sample 2	17.3	16.2	16	16.5	16.1	16.4	15.8	16.3

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	16.0	11.21	**11.31**
Sample 2	16.3	11.42	

AET Project No: 29-20213 **AET Project Mgr.:** D. Vruno
Project: Work Task #1 **AET Engineer:** P. Barnhouse
Client: Shafer **Cast Date:** April 26, 2019

AASHTO T 358 Surface Resistivity
Sealed Specimens
Mix 3A21-9

Day 91 **7/26/19**

	Sealed 1	Sealed 2
Mass (g)	13,199.0	13,283.5

Sealed	0°	90°	180°	270°	0°	90°	180°	270°
Sample 1	29.0	31.5	26.8	32.9	29.5	30.3	27.4	32.5
Sample 2	34.3	33.7	33.0	31.8	32.5	36.3	32.5	30.7

	Average Surface Resistivity (kΩ-cm) (reporeted as per T 358)	Effective Surface Resistivity (kΩ-cm)	
Sample 1	30.0	20.97	**22.06**
Sample 2	33.1	23.15	

DETERMINING CONCRETE STRENGTH USING THE MATURITY METHOD

Below are the results of maturity calculations conducted on the concrete mixture identified as 3A21-3. Compressive and flexural strength specimens were cast at the AET laboratory on April 24, 2019, and stored at our laboratory in St. Paul, MN, for strength testing. At the same time, a companion compressive and companion flexural specimen were cast and were used to monitor and record concrete temperature and maturity. All specimens were stored in a 100% relative humidity curing room at 23 °C until testing in accordance with ASTM C39 and ASTM C78. The temperature-time factor (i.e., maturity) was determined from the companion specimens in accordance with the method in ASTM C1074.

- Table 1 presents the temperature-time factor and compressive strengths at various ages for the given mix design.
- Figure 1 illustrates the relationship between estimated maturity and compressive strength through 28 days of curing in our laboratory.
- Table 2 presents the temperature-time factor and flexural strengths at various ages for the given mix design.
- Figure 2 illustrates the relationship between estimated maturity and flexural strength through 28 days of curing in our laboratory.

Table 1. Maturity and compressive strength results from laboratory-cured cylinders (3A21-3)

Age, days	Maturity (°C-Hours)	Compressive Strength (psi)
1	517	1,530
3	1,591	5,510
7	3,544	6,710
14	7,159	6,500
28	14,610	8,060

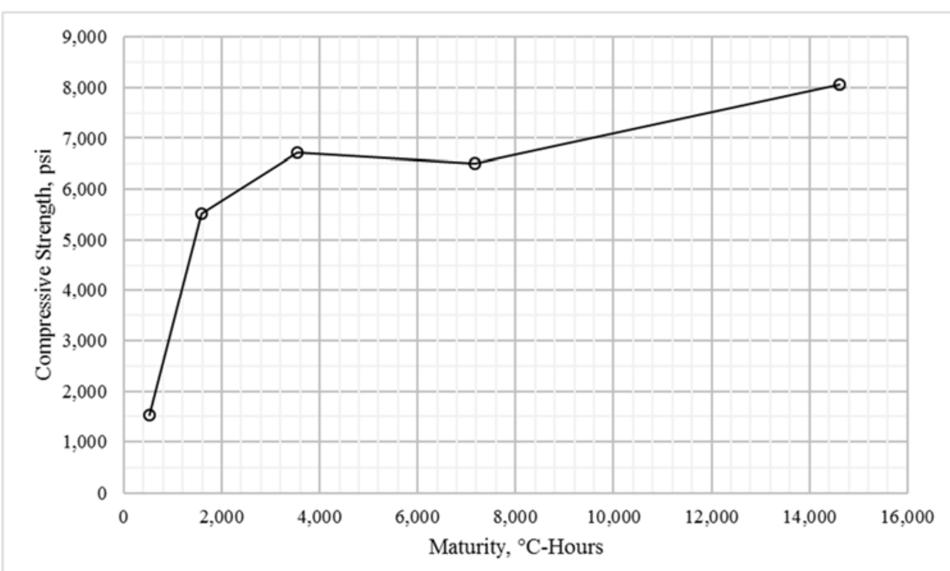


Figure 1. Compressive strength-maturity relationship (3A21-3)

Table 2. Maturity and flexural strength results from laboratory-cured cylinders (3A21-3)

Age, days	Maturity (°C-Hours)	Flexural Strength (psi)
1	501	245
3	1,594	460
7	3,574	670
14	7,229	660
28	14,661	610

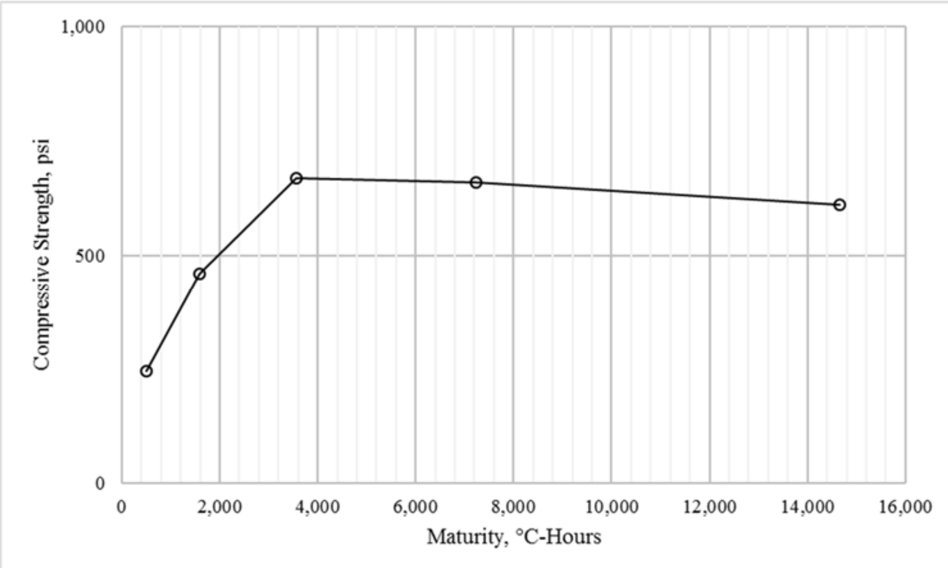


Figure 2. Flexural strength-maturity relationship (3A21-3)

DETERMINING CONCRETE STRENGTH USING THE MATURITY METHOD

Below are the results of maturity calculations conducted on the concrete mixture identified as 3A21-6. Compressive and flexural strength specimens were cast at the AET laboratory on April 24, 2019, and stored at our laboratory in St. Paul, MN, for strength testing. At the same time, a companion compressive and companion flexural specimen were cast and were used to monitor and record concrete temperature and maturity. All specimens were stored in a 100% relative humidity curing room at 23 °C until testing in accordance with ASTM C39 and ASTM C78. The temperature-time factor (i.e., maturity) was determined from the companion specimens in accordance with the method in ASTM C1074.

- Table 1 presents the temperature-time factor and compressive strengths at various ages for the given mix design.
- Figure 1 illustrates the relationship between estimated maturity and compressive strength through 28 days of curing in our laboratory.
- Table 2 presents the temperature-time factor and flexural strengths at various ages for the given mix design.
- Figure 2 illustrates the relationship between estimated maturity and flexural strength through 28 days of curing in our laboratory.

Table 1. Maturity and compressive strength results from laboratory-cured cylinders (3A21-6)

Age, days	Maturity (°C-Hours)	Compressive Strength (psi)
1	523	2,350
3	1,598	6,270
7	3,566	7,260
14	7,205	7,740
28	14,676	8,680

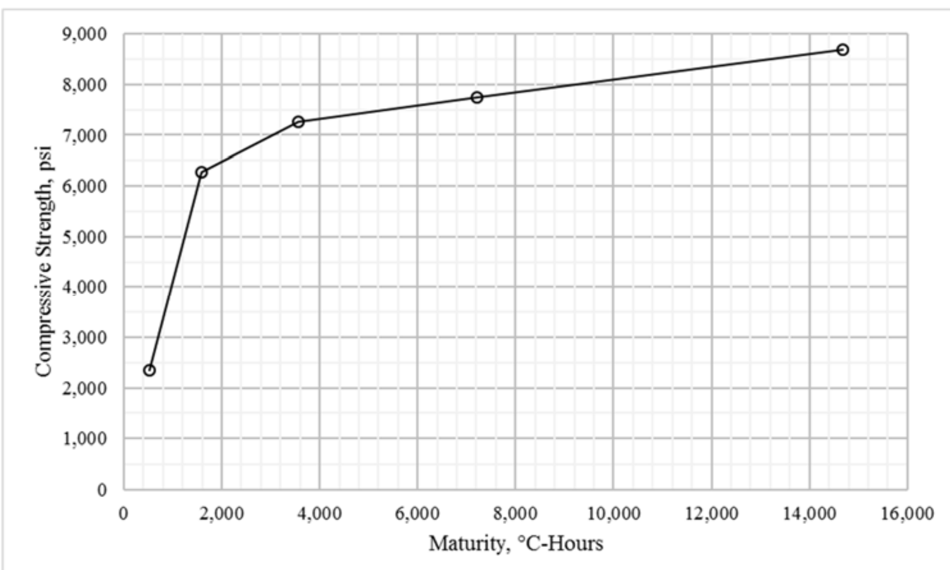


Figure 1. Compressive strength-maturity relationship (3A21-6)

Table 2. Maturity and flexural strength results from laboratory-cured cylinders (3A21-6)

Age, days	Maturity (°C-Hours)	Flexural Strength (psi)
1	500	35
3	1,570	490
7	3,519	755
14	7,089	850
28	14,400	825

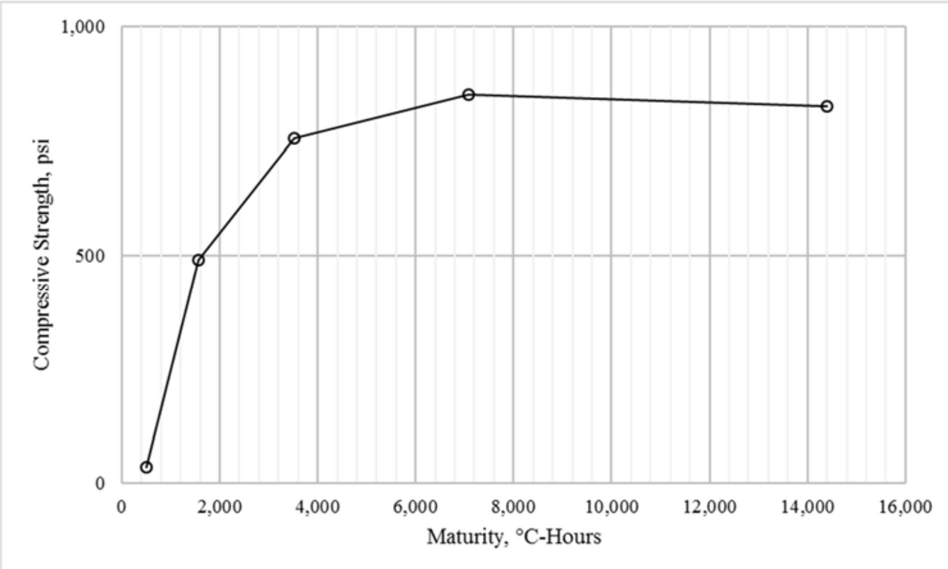


Figure 2. Flexural strength-maturity relationship (3A21-6)

DETERMINING CONCRETE STRENGTH USING THE MATURITY METHOD

Below are the results of maturity calculations conducted on the concrete mixture identified as 3A41-9. Compressive and flexural strength specimens were cast at the AET laboratory on April 26, 2019, and stored at our laboratory in St. Paul, MN, for strength testing. At the same time, a companion compressive and companion flexural specimen were cast and were used to monitor and record concrete temperature and maturity. All specimens were stored in a 100% relative humidity curing room at 23 °C until testing in accordance with ASTM C39 and ASTM C78. The temperature-time factor (i.e., maturity) was determined from the companion specimens in accordance with the method in ASTM C1074.

- Table 1 presents the temperature-time factor and compressive strengths at various ages for the given mix design.
- Figure 1 illustrates the relationship between estimated maturity and compressive strength through 28 days of curing in our laboratory.
- Table 2 presents the temperature-time factor and flexural strengths at various ages for the given mix design.
- Figure 2 illustrates the relationship between estimated maturity and flexural strength through 28 days of curing in our laboratory.

Table 1. Maturity and compressive strength results from laboratory-cured cylinders (3A41-9)

Age, days	Maturity (°C-Hours)	Compressive Strength (psi)
1	542	2,320
3	1,567	4,180
7	3,535	4,940
14	7,236	5,180
28	14,712	5,850

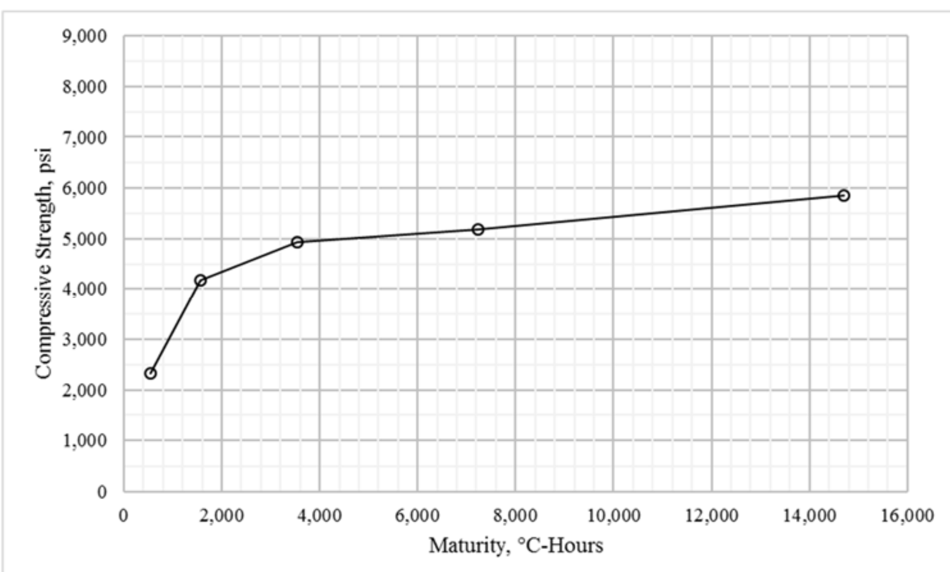


Figure 1. Compressive strength-maturity relationship (3A41-9)

Table 2. Maturity and flexural strength results from laboratory-cured cylinders (3A41-9)

Age, days	Maturity (°C-Hours)	Flexural Strength (psi)
1	580	420
3	1,595	575
7	3,538	695
14	7,158	650
28	14,415	690

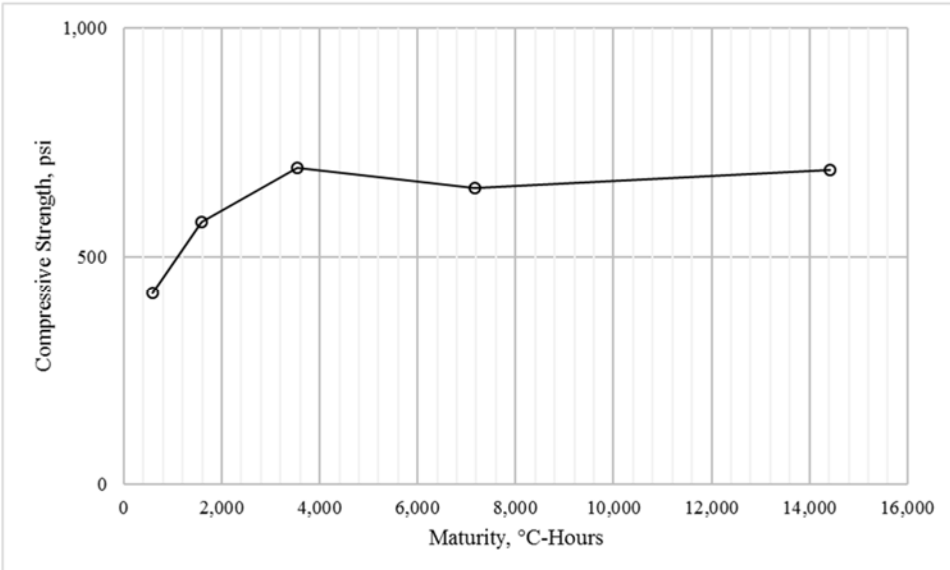


Figure 2. Flexural strength-maturity relationship (3A41-9)

AIR VOID ANALYSIS

PROJECT:

TH35W AND LAKE STREET
MINNEAPOLIS, MN

REPORTED TO:

SHAFER CONTRACTING CO INC
PO BOX 128
SHAFER, MN 55074

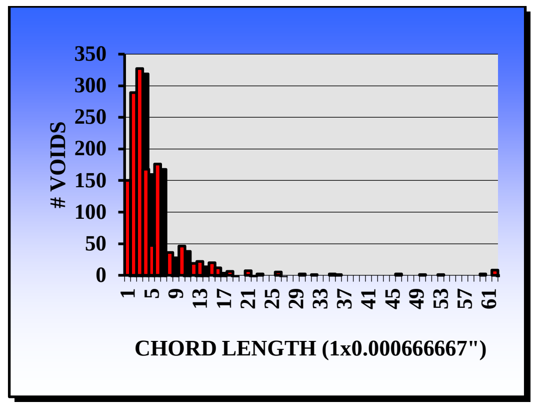
ATTN: GREG PELKY

AET PROJECT NO: 29-20213

DATE: MAY 22, 2019

Sample ID: 3A21-3

Conformance: The concrete contains an air void system which is consistent with current American Concrete Institute (ACI) recommendations for freeze-thaw resistance.



Sample Data

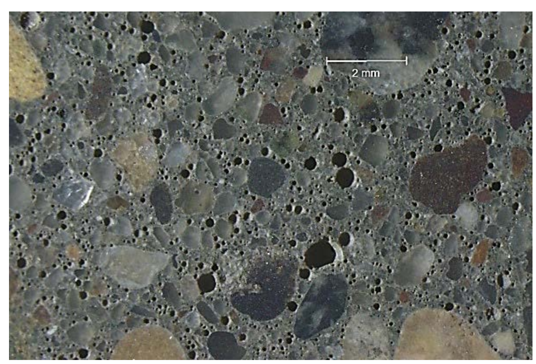
Description: Hardened Concrete Cylinder
Dimensions: 152 mm (6”) diameter x 305 mm (12”) length

Test Data: By ASTM C457, Procedure A

Air Void Content %	5.7
Entrained, % < 0.040"(1mm)	4.7
Entrapped, %> 0.040"(1mm)	1.0
Air Voids/inch	15.0
Specific Surface, in^2/in^3	1050
Spacing Factor, inches	0.005
Paste Content, % estimated	30
Magnification	75x
Traverse Length, inches	90
Test Date	5/13/2019
Test Performed By	W. Reely

Report Prepared By:
American Engineering Testing, Inc.

Blake M. Lemcke, PG
Geologist/Petrographer
MN License #50337



Magnification: 15x
Description: Hardened air void system.

550 Cleveland Avenue North | Saint Paul, MN 55114
Phone (651) 659-9001 | (800) 972-6364 | Fax (651) 659-1379 | www.amengtest.com | AA/EEO

AIR VOID ANALYSIS

PROJECT:

TH35W AND LAKE STREET
MINNEAPOLIS, MN

REPORTED TO:

SHAFER CONTRACTING CO INC
PO BOX 128
SHAFER, MN 55074

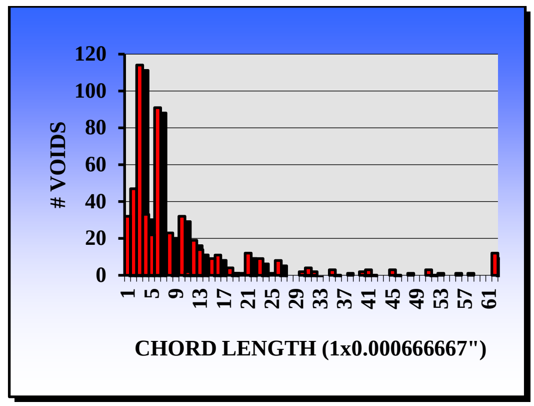
ATTN: GREG PELKY

AET PROJECT NO: 29-20213

DATE: MAY 22, 2019

Sample ID: 3A21-6

Conformance: The concrete contains an air void system which is generally consistent with current American Concrete Institute (ACI) recommendations for freeze-thaw resistance.



Sample Data

Description:	Hardened Concrete Cylinder
Dimensions:	152 mm (6") diameter x 305 mm (12") length

Test Data: By ASTM C457, Procedure A

Air Void Content %	4.3
Entrained, % < 0.040"(1mm)	3.3
Entrapped, %> 0.040"(1mm)	1.0
Air Voids/inch	5.8
Specific Surface, in^2/in^3	550
Spacing Factor, inches	0.008
Paste Content, % estimated	18
Magnification	75x
Traverse Length, inches	90
Test Date	5/13/2019
Test Performed By	W. Reely

Magnification: 15x
Description: Hardened air void system.

Report Prepared By:
American Engineering Testing, Inc.

Blake M. Lemcke, PG
Geologist/Petrographer
MN License #50337

550 Cleveland Avenue North | Saint Paul, MN 55114
Phone (651) 659-9001 | (800) 972-6364 | Fax (651) 659-1379 | www.amengtest.com | AA/EEO

AIR VOID ANALYSIS

PROJECT:

TH35W AND LAKE STREET
MINNEAPOLIS, MN

REPORTED TO:

SHAFER CONTRACTING CO INC
PO BOX 128
SHAFER, MN 55074

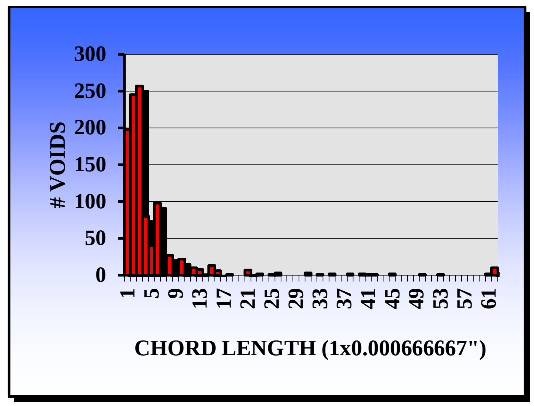
ATTN: GREG PELKY

AET PROJECT NO: 29-20213

DATE: MAY 22, 2019

Sample ID: 3A41-9

Conformance: The concrete contains an air void system which is consistent with current American Concrete Institute (ACI) recommendations for freeze-thaw resistance.



Sample Data

Description: Hardened Concrete Cylinder Section
Dimensions: 152 mm (6”) diameter x 19 mm (3/4”) length

Test Data: By ASTM C457, Procedure A

Air Void Content %	4.3
Entrained, % < 0.040"(1mm)	3.4
Entrapped, %> 0.040"(1mm)	0.9
Air Voids/inch	11.6
Specific Surface, in^2/in^3	1090
Spacing Factor, inches	0.004
Paste Content, % estimated	17
Magnification	75x
Traverse Length, inches	90
Test Date	5/22/2019
Test Performed By	W. Reely

Report Prepared By:
American Engineering Testing, Inc.

Blake M. Lemcke, PG
Geologist/Petrographer
MN License #50337

Magnification: 15x
Description: Hardened air void system.

AMERICAN ENGINEERING TESTING, INC.

American Engineering Testing, Inc.

St. Paul	Albertville
550 Cleveland Ave N	5548 Barthel Ind Dr, Ste 500
St. Paul, MN 55114	Albertville, MN 55301
(651) 659-9001	(763) 428-5573
Toll Free: (800) 972-6364	www.amengtest.com

Material Test Report

Report No: MAT:19-04229-S3
Issue No: 1

Client: SHAFER CONTRACTING CO., INC **CC:**

Project: TH35W and Lake Street

Minneapolis MN

Job No: 29-20213

Date of Issue: 4/26/2019
Reviewed By: Jesse Sich
EIT, MNDOT Tech ID#17564

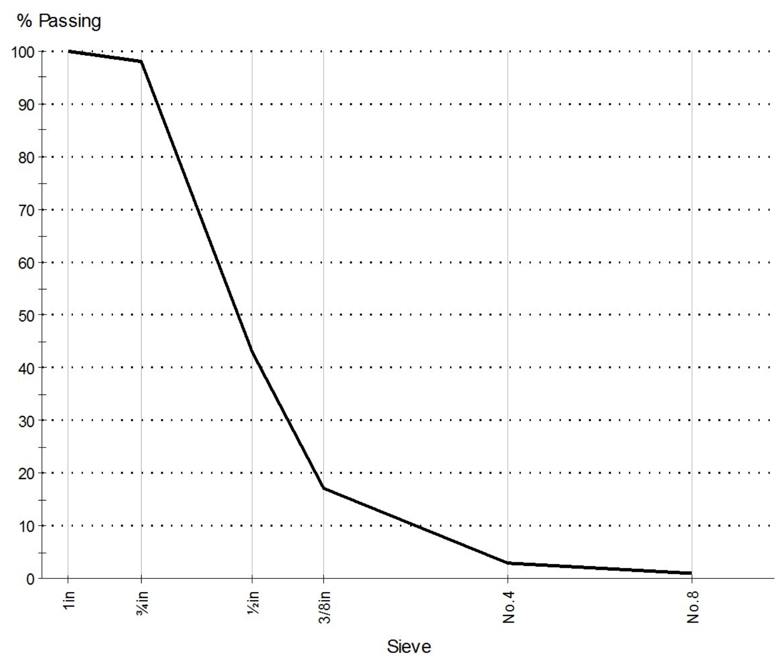
Sample Details

Sample ID	19-04229-S3
Date Sampled	4/25/2019
Source	Aggregate Industries - Empire
Material	Natural Gravel
Specification	C33 5S CA Specs
Sampling Method	ASTM D75
Location	#67
Date Submitted	4/25/2019

Other Test Results

Description	Method	Result	Limits
Bulk Density (lb/ft³)	ASTM C 29	99	
Voids (%)			
Filling Procedure		Shoveling	
Bulk Density (lb/ft³)	ASTM C 29	108	
Voids (%)			
Filling Procedure		Rodding	
Specific Gravity (OD)	ASTM C127	2.67	
Specific Gravity (SSD)		2.70	
Apparent Specific Gravity		2.76	
Absorption (%)		1.3	
Density Determined Without First Drying?		No	

Particle Size Distribution



Method: ASTM C 136

Drying by: Oven
Date Tested: 4/26/2019
Tested By: 20-St. Paul

Sieve Size	% Passing	Limits
1in (25.0mm)	100	
¾in (19.0mm)	98	
½in (12.5mm)	43	
3/8in (9.5mm)	17	
No.4 (4.75mm)	3	
No.8 (2.36mm)	1	

Comments

N/A

American Engineering Testing, Inc.
St. Paul
550 Cleveland Ave N
St. Paul, MN 55114
(651) 659-9001
Toll Free: (800) 972-6364

Albertville
5548 Barthel Ind Dr, Ste 500
Albertville, MN 55301
(763) 428-5573
www.amengtest.com

Material Test Report

Report No: MAT:19-04229-S4
Issue No: 1

Client: SHAFER CONTRACTING CO., INC **CC:**

Project: TH35W and Lake Street

Minneapolis MN

Job No: 29-20213

Date of Issue: 4/26/2019
Reviewed By: Jesse Sich
EIT, MNDOT Tech ID#17564

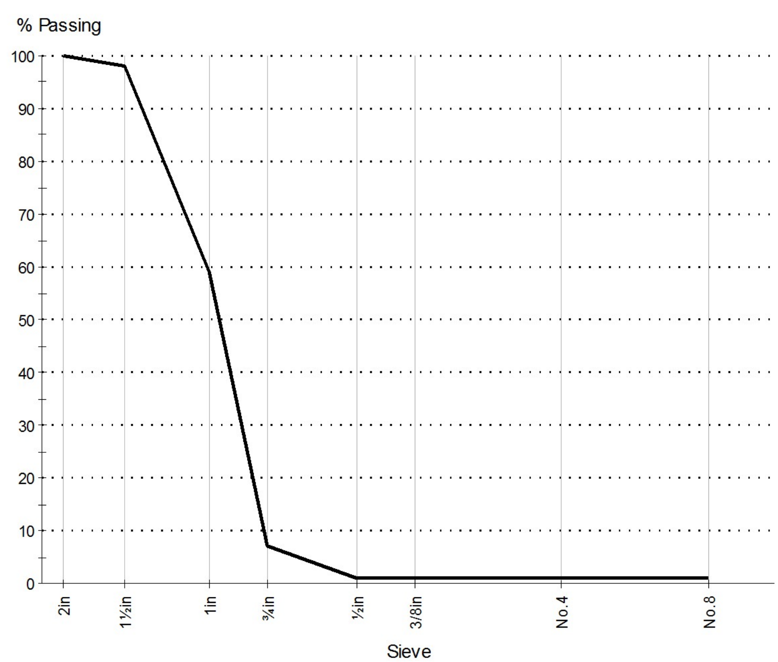
Sample Details

Sample ID	19-04229-S4
Date Sampled	4/25/2019
Source	Aggregate Industries - Empire
Material	Natural Gravel
Specification	C33 5S CA Specs
Sampling Method	ASTM D75
Location	#4
Date Submitted	4/25/2019

Other Test Results

Description	Method	Result	Limits
Bulk Density (lb/ft³)	ASTM C 29	95	
Voids (%)			
Filling Procedure		Shoveling	
Bulk Density (lb/ft³)	ASTM C 29	104	
Voids (%)			
Filling Procedure		Rodding	
Specific Gravity (OD)	ASTM C 127	2.69	
Specific Gravity (SSD)		2.72	
Apparent Specific Gravity		2.76	
Absorption (%)		1.0	
Density Determined Without First Drying?		No	

Particle Size Distribution



Method: ASTM C 136
Drying by: Oven
Date Tested: 4/26/2019
Tested By: 20-St. Paul

Sieve Size	% Passing	Limits
2in (50.0mm)	100	
1½in (37.5mm)	98	
1in (25.0mm)	59	
¾in (19.0mm)	7	
½in (12.5mm)	1	
3/8in (9.5mm)	1	
No.4 (4.75mm)	1	
No.8 (2.36mm)	1	

Comments

N/A

American Engineering Testing, Inc.
St. Paul
550 Cleveland Ave N
St. Paul, MN 55114
(651) 659-9001
Toll Free: (800) 972-6364

Albertville
5548 Barthel Ind Dr, Ste 500
Albertville, MN 55301
(763) 428-5573
www.amengtest.com

Material Test Report

Report No: MAT:19-04229-S2
Issue No: 1

Client: SHAFER CONTRACTING CO., INC

CC:

Project: TH35W and Lake Street

Minneapolis MN

Job No: 29-20213

Date of Issue: 4/26/2019
Reviewed By: Jesse Sich
EIT, MNDOT Tech ID#17564

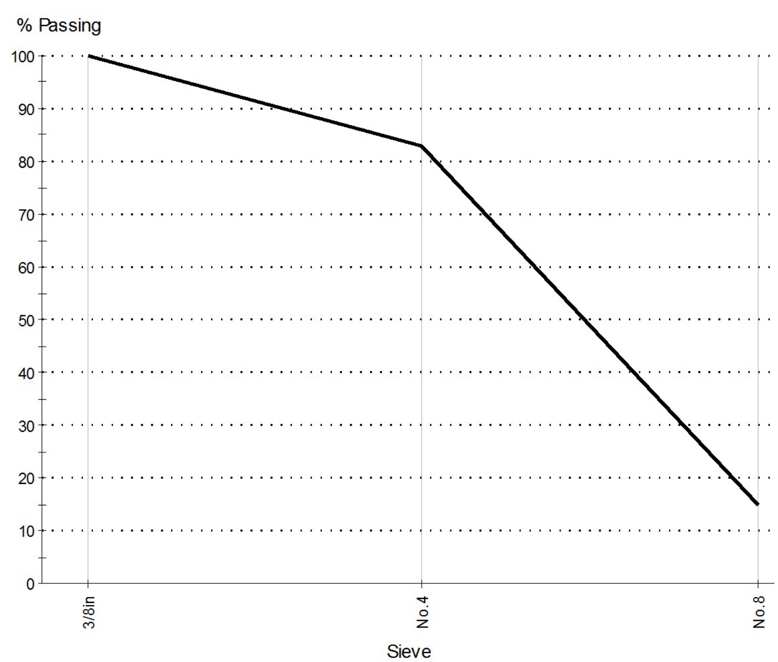
Sample Details

Sample ID	19-04229-S2
Date Sampled	4/25/2019
Source	Aggregate Industries - Empire
Material	Natural Gravel
Specification	C33 5S CA Specs
Sampling Method	ASTM D75
Location	CIA
Date Submitted	4/25/2019

Other Test Results

Description	Method	Result	Limits
Bulk Density (lb/ft³)	ASTM C 29	97	
Voids (%)			
Filling Procedure		Shoveling	
Bulk Density (lb/ft³)	ASTM C 29	106	
Voids (%)			
Filling Procedure		Rodding	
Specific Gravity (OD)	ASTM C 128	2.64	
Specific Gravity (SSD)		2.68	
Apparent Specific Gravity		2.74	
Absorption (%)		1.4	

Particle Size Distribution



Method: ASTM C 136

Drying by: Oven
Date Tested: 4/26/2019
Tested By: Maria Fuerstenberg

Sieve Size	% Passing	Limits
3/8in (9.5mm)	100	
No.4 (4.75mm)	83	
No.8 (2.36mm)	15	

Comments

N/A

American Engineering Testing, Inc.

St. Paul	Albertville
550 Cleveland Ave N	5548 Barthel Ind Dr, Ste 500
St. Paul, MN 55114	Albertville, MN 55301
(651) 659-9001	(763) 428-5573
Toll Free: (800) 972-6364	www.amengtest.com

Material Test Report

Report No: MAT:19-04229-S1
Issue No: 1

Client: SHAFER CONTRACTING CO., INC **CC:**

Project: TH35W and Lake Street

Minneapolis MN

Job No: 29-20213

Date of Issue: 4/26/2019
Reviewed By: Jesse Sich
EIT, MNDOT Tech ID#17564

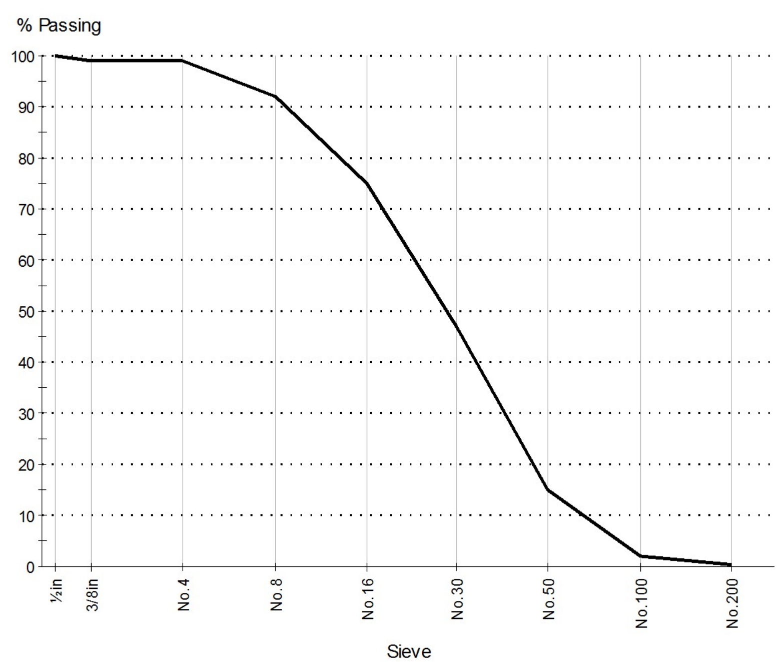
Sample Details

Sample ID	19-04229-S1
Date Sampled	4/25/2019
Source	Aggregate Industries - Empire
Material	Concrete Sand
Specification	C33 FA Spec
Sampling Method	ASTM D75
Location	Sand
Date Submitted	4/25/2019

Other Test Results

Description	Method	Result	Limits
Bulk Density (lb/ft³)	ASTM C 29	103	
Voids (%)			
Filling Procedure		Shoveling	
Bulk Density (lb/ft³)	ASTM C 29	110	
Voids (%)			
Filling Procedure		Rodding	
Fineness Modulus	ASTM C 136, ASTM C 117	2.71	
Specific Gravity (OD)	ASTM C128	2.66	
Specific Gravity (SSD)		2.67	
Apparent Specific Gravity		2.69	
Absorption (%)		0.5	

Particle Size Distribution



Method: ASTM C 136, ASTM C 117
Drying by: Oven
Date Tested: 4/26/2019
Tested By: Maria Fuerstenberg

Sieve Size	% Passing	Limits
½in (12.5mm)	100	
3/8in (9.5mm)	99	
No.4 (4.75mm)	99	
No.8 (2.36mm)	92	
No.16 (1.18mm)	75	
No.30 (600µm)	47	
No.50 (300µm)	15	
No.100 (150µm)	2	
No.200 (75µm)	0.5	

Comments

N/A

APPENDIX B

Field Testing

B1.1: Cement Test Report

CO-Maplewood Mat Lab
1400 Gervais Avenue
Maplewood, MN 55109-5592

DEPARTMENT OF TRANSPORTATION

Lab No: CE20-0115
Authorization Date: 06/25/2020 13:12
Report Date: 06/29/2020

Test Report on Cement Sample

Sample ID:	MnAd\Lars4Dav20200507030644	**Field ID:**	4
Sampled By:	Mark Kosmalski	**Project Number:**	2782-327
Engineer Rep:		**Billed Agency:**	
Requested By:		**Bridge Number:**	
Source:	St. Genevieve at Bloomsdale, MO	**Sampled From:**	Truck, 44
Brand:		**Sample Type:**	
Additional Sources:	Shafer - X425	**Sample Date:**	04/21/2020
Material Type:	3101-Type I/II	**Received Date:**	05/07/2020
Material Description	Type I/II Portland Cement		

Bill of Lading: SSA0074957

	MnDOT Results	Specification Requirements Minimum	Maximum
Compstr 1 Day (PSI)			
Compstr 3 Day (PSI)			
Compstr 7 Day (PSI)	5,390	2,760	
Compstr 28 Day (PSI)			
AutoCl Expan (%)			
Vicat INL Time of Set (minutes)			
Vicat FIN Time of Set (minutes)			
Gilmr INL Time of Set (minutes)			
Gilmr FIN Time of Set (minutes)			
Air Content (%)			
Reported Blaine (cm2/gm)			

ASTM Test Methods: C109,C151,C185,C187,C191,C204, C266

Report on Cement Chemical Tests

	MnDOT Results	Specification Requirements Minimum	Specification Requirements Maximum
Silicon Dioxide (%)	19.93		
Aluminum Oxide (%)	4.60		
Iron Oxide (%)	3.24		
Calcium Oxide (%)	63.54		
Magnesium Oxide (%)	2.69		
Sulfur Trioxide † (%)	3.20		
Loss on Ignition (%)			
Insoluble Residue (%)			
Sodium Oxide (%)	0.10		
Potassium Oxide (%)	0.60		
Equivalent Alkalies (%)	0.49		
Sulfide (%)			
Limestone (%)			
Sulfate as SO3 (%)			
Tricalcium Silicate (%)	62.59		
Dicalcium Silicate (%)	9.92		
Tricalcium Aluminate (%)	6.69		
Tetracalcium Aluminoferrite (%)	9.87		

† **Note:**

Sample Disposition: Meets Requirements

Copies To: Jon Erickson, Mark Kosmalski

Test Results Reviewed By: David Larson, Jason Krogman

CE20-0115

Charge Out:

B1.2: Fly Ash Test Report

CO-Maplewood Mat Lab
1400 Gervais Avenue
Maplewood, MN 55109-5592

DEPARTMENT OF TRANSPORTATION

Lab No: FA20-0159
Authorization Date: 07/21/2020 09:48
Report Date: 07/28/2020

Test Report on Fly Ash Sample

Sample ID:	MnAd\Lars4Dav20200507030227	Field ID:	4
Sampled By:	Mark Kosmalski	Project Number:	2782-327
Engineer Rep:		Billed Agency:	
Requested By:		Bridge Number:	
Source:	Oak Creek Power Plant at Oak Creek, WI	Sampled From:	Truck, 398
Brand:		Sample Type:	
Additional Sources:	Shafer - X425	Sample Date:	04/21/2020
Material Type:	3115-Class C	Received Date:	05/07/2020
Material Description	Class C Fly Ash		

Bill of Lading: 809565439

	MnDOT Results	Specification Requirements Minimum	Maximum
Physical Tests			
Reported SpG (g/cm3)	2.71		
Retained on #325 (%)	7.58		34
Autocl Expan (%)			
Activity Index 7 Day (% of control)	100	75	
Activity Index 28 Day (% of Control)			
Chemical Analysis			
Silicon Dioxide (%)	34.62		
Aluminum Oxide (%)	19.49		
Iron Oxide (%)	6.25		
Sum of 3 (%)	60.4	50	
Calcium Oxide (%)	6.25	50	
Magnesium Oxide (%)	5.53		
Sulfur Trioxide (%)	5.53		
Sodium Oxide (%)	1.65		
Potassium Oxide (%)	0.56		
Avail Sodium Oxide (%)			
Avail Potassium Oxide (%)			
Avail Alkali (%)			
Loss of Ignition (%)	0.4		3.50
Chem Lab Disposition	Pass		
Foam Index			

ASTM Test Methods: C311, C188, C430, C151, C109, C114

Sample Disposition: Meets Requirements

Copies To: Jon Erickson, Mark Kosmalski

Test Results Reviewed By: David Larson, Jason Krogman

B1.3: Type A Additive Test Report

CO-Maplewood Mat Lab
1400 Gervais Avenue
Maplewood, MN 55109-5592

DEPARTMENT OF TRANSPORTATION

Lab No: CO-CX20-0365
Date: 04/29/2020
Report Version: 202004290828

Concrete Additive Test Report

Sample ID:	MnAd\Krog1Jas20200423010215	Field ID:	1
Sampled By:	Mark Kosmalski	Project Number:	2782-327
Engineer Rep:		Billed Agency:	
Requested By:	Jon Erickson	Bridge Number:	
Source:	GRT	Sampled From:	,
Brand:	AGRTPLYPP	Sample Type:	
Additional Sources:	Shafer - X433	Sample Date:	04/21/2020
Material Type:	3113-Type A	Received Date:	04/23/2020
Material Description	Type A - Water Reducing and Mid Range Water Reducing		

	MnDOT Results	Specification Requirements	
		Minimum	Maximum
Total Percent Solids	44.3	42	52
pH			
Specific Gravity	1.190	1.167	1.204
Infra Red Spectrum			

Test Procedures: ASTM - C260, C494, C1017, E1252

Sample Disposition: Meets Requirements

Copies To:

Test Results Reviewed By: Kayla Kuhlman

CO-CX20-0365

Charge Out: 1103

CO-Maplewood Mat Lab
1400 Gervais Avenue
Maplewood, MN 55109-5592

DEPARTMENT OF TRANSPORTATION

Lab No: CO-CX20-0397
Date: 04/29/2020
Report Version: 202004290840

Concrete Additive Test Report

Sample ID:	MnAd\Krog1Jas20200427030841	Field ID:	2
Sampled By:	Mark Kosmalski	Project Number:	2782-327
Engineer Rep:		Billed Agency:	
Requested By:	Jon Erickson	Bridge Number:	
Source:	GRT	Sampled From:	,
Brand:	AGRTPLYPP	Sample Type:	
Additional Sources:	Shafer - X433	Sample Date:	04/25/2020
Material Type:	3113-Type A	Received Date:	04/27/2020
Material Description	Type A - Water Reducing and Mid Range Water Reducing		

	MnDOT Results	Specification Requirements	
		Minimum	Maximum
Total Percent Solids	44.8	42	52
pH			
Specific Gravity	1.192	1.167	1.204
Infra Red Spectrum			

Test Procedures: ASTM - C260, C494, C1017, E1252

Sample Disposition: Meets Requirements

Copies To:

Test Results Reviewed By: Kayla Kuhlman

CO-CX20-0397

Charge Out: 1103

B1.4: Type AEA Additive Test Report

CO-Maplewood Mat Lab
1400 Gervais Avenue
Maplewood, MN 55109-5592

Lab No: CO-CX20-0364
Date: 04/29/2020
Report Version: 202004290828

Concrete Additive Test Report

Sample ID:	MnAd\Krog1Jas20200423125358	Field ID:	3
Sampled By:	Mark Kosmalski	Project Number:	2782-327
Engineer Rep:		Billed Agency:	
Requested By:	Jon Erickson	Bridge Number:	
Source:	GRT	Sampled From:	,
Brand:	GRTPOLYSA	Sample Type:	
Additional Sources:	Shafer - X433	Sample Date:	04/21/2020
Material Type:	3113-Type AEA	Received Date:	04/23/2020
Material Description	Type AEA - Air Entrainment		

	MnDOT Results	Specification Requirements	
		Minimum	Maximum
Total Percent Solids	7.3	3.4	9.4
pH	7.0	5.1	8.1
Specific Gravity	1.020	1.008	1.028
Infra Red Spectrum			

Test Procedures: ASTM - C260, C494, C1017, E1252

Sample Disposition: Meets Requirements

Copies To:

Test Results Reviewed By: Kayla Kuhlman

CO-CX20-0364

Charge Out: 1103

B2.1: Aggregates: JMF Worksheets

(6/4/2019)

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	2:08 PM
Lot #:	1	Test #:		JMF #:	20-018

Aggregate Sources (Pit #):	FA #1:	19129	FA #2:			
	CA #1:	19129	CA #2:	19129	CA #3:	
Contractor only - QA or Verification Test # corresponding to this test:						
Agency only - QC or Verification Companion Test # corresponding to this test:						

Sieve Analysis of Coarse Aggregate

Aggregate Fraction				Comparison Test Results				Comparison Test Results				Comparison Test Results
	Sample Wt.	13.43			Sample Wt.	22.50			Sample Wt.			
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	13.4	100		0.4	22.6	100					
1 1/2" - 1 1/4"	0.0	13.4	100		3.8	22.2	98					
1 1/4" - 1"	0.0	13.4	100		8.3	18.4	81					
1" - 3/4"	0.6	13.4	100		9.2	10.1	45					
3/4" - 5/8"	0.0	12.9	96		0.0	0.9	4					
* 5/8" - 1/2"	5.7	12.9	-	-	0.7	0.9	-	-			-	-
1/2" - 3/8"	3.4	7.2	53		0.1	0.2	1					
3/8" - 1/4"	0.0	3.8	28		0.0	0.1	0					
* 1/4" - #4	3.0	3.8	-	-	0.0	0.1	-	-			-	-
#4 - Btm	0.8	0.8	6		0.1	0.1	0					
Check Total	13.4	± 0.2 lb of Sample Wt			22.6	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction				Comparison Test Results				Comparison Test Results
	Sample Wt.	544.3			Sample Wt.			
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	543.5	100					
3/8" - #4	2.7	543.5	100					
#4 - #6	0.0	540.8	100					
* #6 - #8	34.4	540.8	-	-			-	-
#8 - #16	86.2	506.4	93					
#16 - #30	139.6	420.2	77					
#30 - #50	199.5	280.6	52					
#50 - #100	72.4	81.1	15					
#100 - #200	5.8	8.7	2					
#200 - Btm	1.3	2.9	0.5					
Loss by Washing	1.6							
Check Total	543.5	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample	3037.8	5413.4	
(B) Dry weight of washed sample	3023.9	5406.1	
(C) Loss by washing (A-B)	13.9	7.3	
(D) % Passing #200 (C/A)*100	0.5	0.1	
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	544.3	
(B) Dry weight of washed sample	542.7	
(C) Loss by washing (A-B)	1.6	
(D) % Passing #200 (C/A)*100	0.3	
Comparison Test Results		

Additional Remarks or Comments

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	10			43			88	89	± 5	84	94	12
3/4"	34	1			43			77	78	± 5	73	83	11
1/2"	19	0			43			62	64	± 5	59	69	15
3/8"	10	0			43			53	56	± 5	51	61	9
#4	2	0			43			45	44	± 5	39	49	8
#8					40			40	39	± 4	35	43	5
#16					33			33	34	± 4	30	38	7
#30					22			22	22	± 4	18	26	11
#50					6			6	6	± 3	3	9	16
#100					1			1	0	± 2	0	2	5
#200	0.2	0.0			0.2			0.4	0.4	± 1.6% max	0.0	1.6	0.6

Coarse Sand % Retained
(#8 through #30)
23

Fine Sand % Retained
(#30 through #200)
33

(6/4/2019)

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	4/21/2020	Aggregate Sources (Pit #):	FA #1:	19129	FA #2:	
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	5:04 AM		CA #1:	19129	CA #2:	19129	CA #3:
Lot #:	1	Test #:	1	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:				
						Agency only - QC or Verification Companion Test # corresponding to this test:				

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt. / CA #1 / Mix Prop.	13.2 / 3/4" / 35%		Comparison Test Results	Sample Wt. / CA #2 / Mix Prop.	28.1 / 1-12" / 22%		Comparison Test Results	Sample Wt. / CA #3 / Mix Prop.			Comparison Test Results
Sieve Sizes Pass - Ret.	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	13.2	100		1.4	28.2	100					
1 1/2" - 1 1/4"	0.0	13.2	100		4.7	26.7	95					
1 1/4" - 1"	0.0	13.2	100		12.2	22.0	78					
1" - 3/4"	1.0	13.2	100		8.6	9.9	35					
3/4" - 5/8"	0.0	12.3	93		0.0	1.3	4					
* 5/8" - 1/2"	5.4	12.3	-	-	1.0	1.3	-	-			-	-
1/2" - 3/8"	3.5	6.9	52		0.1	0.3	1					
3/8" - 1/4"	0.0	3.4	26		0.0	0.2	1					
* 1/4" - #4	2.8	3.4	-	-	0.1	0.2	-	-			-	-
#4 - Btm	0.6	0.6	4		0.1	0.1	0					
Check Total	13.2	± 0.2 lb of Sample Wt			28.2	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt. / FA #1 / Mix Prop.	540.4 / Sand / 43%		Comparison Test Results	Sample Wt. / FA #2 / Mix Prop.			Comparison Test Results
Sieve Sizes Pass - Ret.	Weights (g) Ind.	Cum.	% Pass	% Pass	Weights (g) Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	541.3	100					
3/8" - #4	1.4	541.3	100					
#4 - #6	0.0	539.9	100					
* #6 - #8	34.2	539.9	-	-			-	-
#8 - #16	86.9	505.7	93					
#16 - #30	139.7	418.8	77					
#30 - #50	202.2	279.1	52					
#50 - #100	68.5	76.9	14					
#100 - #200	5.6	8.4	2					
#200 - Btm	1.6	2.8	0.5					
Loss by Washing	1.2							
Check Total	541.3	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample	2749.0	5151.8	
(B) Dry weight of washed sample	2724.1	5118.8	
(C) Loss by washing (A-B)	24.9	33.0	
(D) % Passing #200 (C/A)*100	0.9	0.6	
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	540.4	
(B) Dry weight of washed sample	539.2	
(C) Loss by washing (A-B)	1.2	
(D) % Passing #200 (C/A)*100	0.2	
Comparison Test Results		

Additional Remarks or Comments

Mix 3A21-43

Composite Gradation for Job Mix Formula

Aggregate Fraction Mix Prop.	CA #1 3/4" 35%	CA #2 1-12" 22%	CA #3		FA #1 Sand 43%	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	21			43			99	100	± 5	95	100	1
1"	35	8			43			86	89	± 5	84	94	13
3/4"	33	1			43			76	78	± 5	73	83	10
1/2"	18	0			43			61	64	± 5	59	69	15
3/8"	9	0			43			52	56	± 5	51	61	9
#4	1	0			43			44	44	± 5	39	49	8
#8					40			40	39	± 4	35	43	4
#16					33			33	34	± 4	30	38	7
#30					22			22	22	± 4	18	26	11
#50					6			6	6	± 3	3	9	16
#100					1			1	0	± 2	0	2	5
#200	0.3	0.1			0.2			0.7	0.4	± 1.6% max	0.0	1.6	0.3

Coarse Sand % Retained (#8 through #30)

22

Fine Sand % Retained (#30 through #200)

32

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	4/21/2020	Aggregate Sources (Pit #):	FA #1: 19129	FA #2:
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	1:09 PM		CA #1: 19129	CA #2: 19129	CA #3:
Lot #:	1	Test #:	2	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:		
						Agency only - QC or Verification Companion Test # corresponding to this test:		

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	13.6		Comparison Test Results	Sample Wt.	25.3		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	13.6	100		0.0	25.3	100					
1 1/2" - 1 1/4"	0.0	13.6	100		2.6	25.3	100					
1 1/4" - 1"	0.0	13.6	100		10.2	22.7	90					
1" - 3/4"	0.7	13.6	100		11.2	12.5	49					
3/4" - 5/8"	0.0	12.9	95		0.0	1.3	5					
* 5/8" - 1/2"	3.8	12.9	-	-	1.1	1.3	-	-			-	-
1/2" - 3/8"	3.2	9.1	67		0.1	0.2	1					
3/8" - 1/4"	0.0	5.9	43		0.0	0.1	0					
* 1/4" - #4	4.5	5.9	-	-	0.0	0.1	-	-			-	-
#4 - Btm	1.4	1.4	10		0.1	0.1	0					
Check Total	13.6	± 0.2 lb of Sample Wt			25.3	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	537.1		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	536.0	100					
3/8" - #4	2.6	536.0	100					
#4 - #6	0.0	533.4	100					
* #6 - #8	36.0	533.4	-	-			-	-
#8 - #16	84.1	497.4	93					
#16 - #30	138.4	413.3	77					
#30 - #50	198.1	274.9	51					
#50 - #100	68.8	76.8	14					
#100 - #200	5.6	8.0	1					
#200 - Btm	0.8	2.4	0.4					
Loss by Washing	1.6							
Check Total	536.0	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample			
(B) Dry weight of washed sample			
(C) Loss by washing (A-B)			
(D) % Passing #200 (C/A)*100			
Comparison Test Results			
Fine Aggregate	**FA #1**	**FA #2**	
(A) Dry weight of original sample	537.1		
(B) Dry weight of washed sample	535.5		
(C) Loss by washing (A-B)	1.6		
(D) % Passing #200 (C/A)*100	0.3		
Comparison Test Results			

Additional Remarks or Comments

3A21-43

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	11			43			89	89	± 5	84	94	11
3/4"	33	1			43			77	78	± 5	73	83	12
1/2"	23	0			43			67	64	± 5	59	69	10
3/8"	15	0			43			58	56	± 5	51	61	9
#4	4	0			43			47	44	± 5	39	49	11
#8					40			40	39	± 4	35	43	7
#16					33			33	34	± 4	30	38	7
#30					22			22	22	± 4	18	26	11
#50					6			6	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	6
#200					0.2			0.2	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained (#8 through #30)

25

Fine Sand % Retained (#30 through #200)

33

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	4/22/2020	Aggregate Sources (Pit #):	FA #1:	19129	FA #2:	
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	6:15 AM		CA #1:	19129	CA #2:	19129	CA #3:
Lot #:	2	Test #:	3	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:				
						Agency only - QC or Verification Companion Test # corresponding to this test:				

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	14.6		Comparison Test Results	Sample Wt.	26.8		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	14.6	100		1.2	26.9	100					
1 1/2" - 1 1/4"	0.0	14.6	100		3.1	25.7	96					
1 1/4" - 1"	0.0	14.6	100		11.6	22.6	84					
1" - 3/4"	0.7	14.6	100		9.8	11.0	41					
3/4" - 5/8"	0.0	13.9	95		0.0	1.2	4					
* 5/8" - 1/2"	4.1	13.9	-	-	0.9	1.2	-	-			-	-
1/2" - 3/8"	3.7	9.8	67		0.1	0.3	1					
3/8" - 1/4"	0.0	6.1	42		0.0	0.2	1					
* 1/4" - #4	4.7	6.1	-	-	0.1	0.2	-	-			-	-
#4 - Btm	1.4	1.4	10		0.1	0.1	0					
Check Total	14.6	± 0.2 lb of Sample Wt			26.9	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	535.9		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	2.2	536.1	100					
3/8" - #4	4.7	533.9	100					
#4 - #6	0.0	529.2	99					
* #6 - #8	35.3	529.2	-	-			-	-
#8 - #16	86.3	493.9	92					
#16 - #30	140.0	407.6	76					
#30 - #50	190.8	267.6	50					
#50 - #100	67.3	76.8	14					
#100 - #200	5.6	9.5	2					
#200 - Btm	1.2	3.9	0.7					
Loss by Washing	2.7							
Check Total	536.1	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample	2821.6	5241.4	
(B) Dry weight of washed sample	2800.5	5220.9	
(C) Loss by washing (A-B)	21.1	20.5	
(D) % Passing #200 (C/A)*100	0.7	0.4	
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	535.9	
(B) Dry weight of washed sample	533.2	
(C) Loss by washing (A-B)	2.7	
(D) % Passing #200 (C/A)*100	0.5	
Comparison Test Results		

Additional Remarks or Comments

Mix 3A21-43

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	21			43			99	100	± 5	95	100	1
1"	35	9			43			87	89	± 5	84	94	12
3/4"	33	1			43			77	78	± 5	73	83	10
1/2"	23	0			43			67	64	± 5	59	69	10
3/8"	15	0			43			58	56	± 5	51	61	9
#4	4	0			43			46	44	± 5	39	49	12
#8					40			40	39	± 4	35	43	6
#16					33			33	34	± 4	30	38	7
#30					22			22	22	± 4	18	26	11
#50					6			6	6	± 3	3	9	16
#100					1			1	0	± 2	0	2	5
#200	0.2	0.1			0.3			0.6	0.4	± 1.6% max	0.0	1.6	0.4

Coarse Sand % Retained
(#8 through #30)
24

Fine Sand % Retained
(#30 through #200)
32

(6/4/2019)

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	4/22/2020	Aggregate Sources (Pit #):	FA #1: 19129	FA #2:	
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	3:35 PM		CA #1: 19129	CA #2: 19129	CA #3:
Lot #:	2	Test #:	4	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:			
						Agency only - QC or Verification Companion Test # corresponding to this test:			

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	13.6		Comparison Test Results	Sample Wt.	28.0		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	13.6	100		0.5	28.2	100					
1 1/2" - 1 1/4"	0.0	13.6	100		3.5	27.7	98					
1 1/4" - 1"	0.0	13.6	100		11.7	24.2	86					
1" - 3/4"	1.0	13.6	100		10.6	12.5	44					
3/4" - 5/8"	0.0	12.6	92		0.0	1.9	7					
* 5/8" - 1/2"	5.1	12.6	-	-	1.2	1.9	-	-			-	-
1/2" - 3/8"	3.9	7.5	55		0.2	0.7	2					
3/8" - 1/4"	0.0	3.6	26		0.0	0.5	2					
* 1/4" - #4	3.1	3.6	-	-	0.2	0.5	-	-			-	-
#4 - Btm	0.5	0.5	4		0.3	0.3	1					
Check Total	13.6	± 0.2 lb of Sample Wt			28.2	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	539.5		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	538.7	100					
3/8" - #4	1.8	538.7	100					
#4 - #6	0.0	536.9	100					
* #6 - #8	33.6	536.9	-	-			-	-
#8 - #16	87.8	503.3	93					
#16 - #30	142.5	415.5	77					
#30 - #50	194.8	273.0	51					
#50 - #100	68.5	78.2	15					
#100 - #200	5.6	9.7	2					
#200 - Btm	1.1	4.1	0.8					
Loss by Washing	3.0							
Check Total	538.7	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample			
(B) Dry weight of washed sample			
(C) Loss by washing (A-B)			
(D) % Passing #200 (C/A)*100			
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	539.5	
(B) Dry weight of washed sample	536.5	
(C) Loss by washing (A-B)	3.0	
(D) % Passing #200 (C/A)*100	0.6	
Comparison Test Results		

Additional Remarks or Comments

3A21-43 & 3A21-43

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	10			43			88	89	± 5	84	94	12
3/4"	32	2			43			77	78	± 5	73	83	11
1/2"	19	0			43			63	64	± 5	59	69	14
3/8"	9	0			43			53	56	± 5	51	61	10
#4	1	0			43			45	44	± 5	39	49	8
#8					40			40	39	± 4	35	43	5
#16					33			33	34	± 4	30	38	7
#30					22			22	22	± 4	18	26	11
#50					6			6	6	± 3	3	9	16
#100					1			1	0	± 2	0	2	5
#200					0.3			0.3	0.4	± 1.6% max	0.0	1.6	0.7

Coarse Sand % Retained (#8 through #30)

23

Fine Sand % Retained (#30 through #200)

33

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	4/23/2020
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	6:25 AM
Lot #:	3	Test #:	5	JMF #:	20-018

Aggregate Sources (Pit #):	FA #1: 19129	FA #2:			
	CA #1: 19129	CA #2: 19129	CA #3:		

Contractor only - QA or Verification Test # corresponding to this test:

Agency only - QC or Verification Companion Test # corresponding to this test:

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	12.1		Comparison Test Results	Sample Wt.	27.1		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	12.0	100		0.4	27.2	100					
1 1/2" - 1 1/4"	0.0	12.0	100		6.1	26.8	99					
1 1/4" - 1"	0.0	12.0	100		11.3	20.7	76					
1" - 3/4"	1.2	12.0	100		8.5	9.4	34					
3/4" - 5/8"	0.0	10.8	90		0.0	0.9	3					
* 5/8" - 1/2"	5.1	10.8	-	-	0.6	0.9	-	-			-	-
1/2" - 3/8"	3.2	5.7	48		0.1	0.3	1					
3/8" - 1/4"	0.0	2.5	21		0.0	0.2	1					
* 1/4" - #4	2.1	2.5	-	-	0.1	0.2	-	-			-	-
#4 - Btm	0.4	0.4	3		0.1	0.1	0					
Check Total	12.0	± 0.2 lb of Sample Wt			27.2	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	543.2		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	543.3	100					
3/8" - #4	2.3	543.3	100					
#4 - #6	0.0	541.0	100					
* #6 - #8	37.4	541.0	-	-			-	-
#8 - #16	92.7	503.6	93					
#16 - #30	143.3	410.9	76					
#30 - #50	190.1	267.6	49					
#50 - #100	69.6	77.5	14					
#100 - #200	5.9	7.9	1					
#200 - Btm	0.9	2.0	0.4					
Loss by Washing	1.1							
Check Total	543.3	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample	2822.5	5199.8	
(B) Dry weight of washed sample	2808.2	5181.2	
(C) Loss by washing (A-B)	14.3	18.6	
(D) % Passing #200 (C/A)*100	0.5	0.4	
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	543.2	
(B) Dry weight of washed sample	542.1	
(C) Loss by washing (A-B)	1.1	
(D) % Passing #200 (C/A)*100	0.2	
Comparison Test Results		

Additional Remarks or Comments

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	7			43			85	89	± 5	84	94	15
3/4"	32	1			43			75	78	± 5	73	83	10
1/2"	17	0			43			60	64	± 5	59	69	15
3/8"	7	0			43			51	56	± 5	51	61	9
#4	1	0			43			44	44	± 5	39	49	7
#8					40			40	39	± 4	35	43	4
#16					33			33	34	± 4	30	38	7
#30					21			21	22	± 4	18	26	12
#50					6			6	6	± 3	3	9	15
#100					0			0	0	± 2	0	2	6
#200	0.2	0.1			0.2			0.4	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained
(#8 through #30)
23

Fine Sand % Retained
(#30 through #200)
33

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	4/23/2020	Aggregate Sources (Pit #):	FA #1: 19129	FA #2:	
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	2:15 PM		CA #1: 19129	CA #2: 19129	CA #3:
Lot #:	3	Test #:	6	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:			
						Agency only - QC or Verification Companion Test # corresponding to this test:			

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	12.1		Comparison Test Results	Sample Wt.	28.1		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	12.1	100		0.4	28.2	100					
1 1/2" - 1 1/4"	0.0	12.1	100		3.4	27.8	99					
1 1/4" - 1"	0.0	12.1	100		10.1	24.4	87					
1" - 3/4"	1.6	12.1	100		12.7	14.3	51					
3/4" - 5/8"	0.0	10.5	86		0.0	1.6	6					
* 5/8" - 1/2"	5.5	10.5	-	-	1.3	1.6	-	-			-	-
1/2" - 3/8"	2.8	5.0	41		0.1	0.3	1					
3/8" - 1/4"	0.0	2.2	18		0.0	0.2	1					
* 1/4" - #4	1.8	2.2	-	-	0.1	0.2	-	-			-	-
#4 - Btm	0.4	0.4	3		0.1	0.1	0					
Check Total	12.1	± 0.2 lb of Sample Wt			28.2	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	537.7		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	536.8	100					
3/8" - #4	3.1	536.8	100					
#4 - #6	0.0	533.7	99					
* #6 - #8	31.7	533.7	-	-			-	-
#8 - #16	83.2	502.0	94					
#16 - #30	143.2	418.8	78					
#30 - #50	199.8	275.6	51					
#50 - #100	68.5	75.8	14					
#100 - #200	5.0	7.3	1					
#200 - Btm	0.9	2.3	0.4					
Loss by Washing	1.4							
Check Total	536.8	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample			
(B) Dry weight of washed sample			
(C) Loss by washing (A-B)			
(D) % Passing #200 (C/A)*100			
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	537.7	
(B) Dry weight of washed sample	536.3	
(C) Loss by washing (A-B)	1.4	
(D) % Passing #200 (C/A)*100	0.3	
Comparison Test Results		

Additional Remarks or Comments

3A21-52

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total %	Combined	Working	JMF Working		Total %
Fraction	3/4"	1-12"			Sand			Passing	Gradation JMF	Range	Range		Retained
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	11			43			89	89	± 5	84	94	11
3/4"	30	1			43			74	78	± 5	73	83	15
1/2"	14	0			43			***58***	64	± 5	59	69	16
3/8"	6	0			43			***50***	56	± 5	51	61	8
#4	1	0			43			44	44	± 5	39	49	6
#8					40			40	39	± 4	35	43	4
#16					34			34	34	± 4	30	38	6
#30					22			22	22	± 4	18	26	12
#50					6			6	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	6
#200					0.2			0.2	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained
(#8 through #30)
22

Fine Sand % Retained
(#30 through #200)
34

(6/4/2019)

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P. 2782-327	Plant: Shafer	Date: 4/24/2020	Aggregate Sources (Pit #):	FA #1: 19129	FA #2:		
Engineer: Jon Erickson	Tester: Nick Speckman	Time: 6:35 AM		CA #1: 19129	CA #2: 19129	CA #3:	
Lot #: 4	Test #: 7	JMF #: 20-018	**Contractor only** - QA or Verification Test # corresponding to this test:				
			Agency only - QC or Verification Companion Test # corresponding to this test:				

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt. / CA #1 / Mix Prop.	12.2 / 3/4" / 35%		Comparison Test Results	Sample Wt. / CA #2 / Mix Prop.	32.4 / 1-12" / 22%		Comparison Test Results	Sample Wt. / CA #3 / Mix Prop.			Comparison Test Results
Sieve Sizes Pass - Ret.	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	12.3	100		0.3	32.4	100					
1 1/2" - 1 1/4"	0.0	12.3	100		3.4	32.1	99					
1 1/4" - 1"	0.0	12.3	100		12.3	28.8	89					
1" - 3/4"	1.3	12.3	100		14.2	16.5	51					
3/4" - 5/8"	0.0	11.0	89		0.0	2.3	7					
* 5/8" - 1/2"	5.3	11.0	-	-	1.8	2.3	-	-			-	-
1/2" - 3/8"	3.1	5.7	46		0.2	0.5	2					
3/8" - 1/4"	0.0	2.6	21		0.0	0.3	1					
* 1/4" - #4	2.1	2.6	-	-	0.1	0.3	-	-			-	-
#4 - Btm	0.5	0.5	4		0.2	0.2	1					
Check Total	12.3	± 0.2 lb of Sample Wt			32.4	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt. / FA #1 / Mix Prop.	541.8 / Sand / 43%		Comparison Test Results	Sample Wt. / FA #2 / Mix Prop.			Comparison Test Results
Sieve Sizes Pass - Ret.	Weights (g) Ind.	Cum.	% Pass	% Pass	Weights (g) Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	2.4	541.4	100					
3/8" - #4	4.0	539.0	100					
#4 - #6	0.0	535.0	99					
* #6 - #8	29.6	535.0	-	-			-	-
#8 - #16	83.2	505.4	93					
#16 - #30	146.2	422.2	78					
#30 - #50	206.2	276.0	51					
#50 - #100	63.4	69.8	13					
#100 - #200	4.6	6.4	1					
#200 - Btm	1.0	1.8	0.3					
Loss by Washing	0.8							
Check Total	541.4	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample	2816.1	5238.3	
(B) Dry weight of washed sample	2800.6	5212.4	
(C) Loss by washing (A-B)	15.5	25.9	
(D) % Passing #200 (C/A)*100	0.6	0.5	
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	541.8	
(B) Dry weight of washed sample	541.0	
(C) Loss by washing (A-B)	0.8	
(D) % Passing #200 (C/A)*100	0.1	
Comparison Test Results		

Additional Remarks or Comments

3A21-43

Composite Gradation for Job Mix Formula

Aggregate Fraction Mix Prop.	CA #1 3/4" 35%	CA #2 1-12" 22%	CA #3		FA #1 Sand 43%	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	11			43			89	89	± 5	84	94	11
3/4"	31	2			43			76	78	± 5	73	83	13
1/2"	16	0			43			60	64	± 5	59	69	16
3/8"	7	0			43			51	56	± 5	51	61	9
#4	1	0			43			44	44	± 5	39	49	7
#8					40			40	39	± 4	35	43	4
#16					34			34	34	± 4	30	38	6
#30					22			22	22	± 4	18	26	12
#50					6			6	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	6
#200	0.2	0.1			0.1			0.4	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained (#8 through #30)

22

Fine Sand % Retained (#30 through #200)

34

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	4/24/2020	Aggregate Sources (Pit #):	FA #1: 19129	FA #2:	
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	1:42 PM		CA #1: 19129	CA #2: 19129	CA #3:
Lot #:	4	Test #:	8	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:			
						Agency only - QC or Verification Companion Test # corresponding to this test:			

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	14.0		Comparison Test Results	Sample Wt.	27.9		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes Pass - Ret.	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	14.0	100		0.4	27.9	100					
1 1/2" - 1 1/4"	0.0	14.0	100		4.8	27.5	99					
1 1/4" - 1"	0.0	14.0	100		11.0	22.7	81					
1" - 3/4"	1.1	14.0	100		10.6	11.7	42					
3/4" - 5/8"	0.0	12.9	92		0.0	1.1	4					
* 5/8" - 1/2"	5.9	12.9	-	-	0.8	1.1	-	-			-	-
1/2" - 3/8"	3.8	7.0	50		0.1	0.3	1					
3/8" - 1/4"	0.0	3.2	23		0.0	0.2	1					
* 1/4" - #4	2.5	3.2	-	-	0.1	0.2	-	-			-	-
#4 - Btm	0.7	0.7	5		0.1	0.1	0					
Check Total	14.0	± 0.2 lb of Sample Wt			27.9	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	538.3		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes Pass - Ret.	Weights (g) Ind.	Cum.	% Pass	% Pass	Weights (g) Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	538.3	100					
3/8" - #4	1.7	538.3	100					
#4 - #6	0.0	536.6	100					
* #6 - #8	30.1	536.6	-	-			-	-
#8 - #16	85.6	506.5	94					
#16 - #30	145.6	420.9	78					
#30 - #50	204.0	275.3	51					
#50 - #100	63.5	71.3	13					
#100 - #200	4.7	7.8	1					
#200 - Btm	0.8	3.1	0.6					
Loss by Washing	2.3							
Check Total	538.3	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample			
(B) Dry weight of washed sample			
(C) Loss by washing (A-B)			
(D) % Passing #200 (C/A)*100			
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	538.3	
(B) Dry weight of washed sample	536.0	
(C) Loss by washing (A-B)	2.3	
(D) % Passing #200 (C/A)*100	0.4	
Comparison Test Results		

Additional Remarks or Comments

3A21-43

Composite Gradation for Job Mix Formula

Aggregate Fraction Mix Prop.	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	9			43			87	89	± 5	84	94	13
3/4"	32	1			43			76	78	± 5	73	83	11
1/2"	18	0			43			61	64	± 5	59	69	15
3/8"	8	0			43			51	56	± 5	51	61	10
#4	2	0			43			45	44	± 5	39	49	6
#8					40			40	39	± 4	35	43	5
#16					34			34	34	± 4	30	38	6
#30					22			22	22	± 4	18	26	12
#50					6			6	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	6
#200					0.3			0.3	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained (#8 through #30)

23

Fine Sand % Retained (#30 through #200)

34

(6/4/2019)

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	4/25/2020	Aggregate Sources (Pit #):	FA #1: 19129	FA #2:		
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	6:10 AM		CA #1: 19129	CA #2: 19129	CA #3:	
Lot #:	5	Test #:	9	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:				
						Agency only - QC or Verification Companion Test # corresponding to this test:				

Sieve Analysis of Coarse Aggregate

* Recommended Filler Sieve

Aggregate Fraction	Sample Wt.	13.5		Comparison Test Results	Sample Wt.	31.0		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	13.5	100		0.3	31.0	100					
1 1/2" - 1 1/4"	0.0	13.5	100		4.5	30.7	99					
1 1/4" - 1"	0.0	13.5	100		11.6	26.2	84					
1" - 3/4"	1.0	13.5	100		13.0	14.6	47					
3/4" - 5/8"	0.0	12.5	93		0.0	1.6	5					
* 5/8" - 1/2"	6.4	12.5	-	-	1.2	1.6	-	-			-	-
1/2" - 3/8"	3.2	6.2	46		0.1	0.4	1					
3/8" - 1/4"	0.0	3.0	22		0.0	0.3	1					
* 1/4" - #4	2.5	3.0	-	-	0.1	0.3	-	-			-	-
#4 - Btm	0.5	0.5	3		0.2	0.2	1					
Check Total	13.5	± 0.2 lb of Sample Wt			31.0	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	541.2		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	541.0	100					
3/8" - #4	2.3	541.0	100					
#4 - #6	0.0	538.7	100					
* #6 - #8	39.9	538.7	-	-			-	-
#8 - #16	85.3	498.8	92					
#16 - #30	143.4	413.5	76					
#30 - #50	194.7	270.1	50					
#50 - #100	67.1	75.4	14					
#100 - #200	5.4	8.3	2					
#200 - Btm	0.6	2.9	0.5					
Loss by Washing	2.3							
Check Total	541.0	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample	2844.4	5156.7	
(B) Dry weight of washed sample	2824.1	5122.5	
(C) Loss by washing (A-B)	20.3	34.2	
(D) % Passing #200 (C/A)*100	0.7	0.7	
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	541.2	
(B) Dry weight of washed sample	538.9	
(C) Loss by washing (A-B)	2.3	
(D) % Passing #200 (C/A)*100	0.4	
Comparison Test Results		

Additional Remarks or Comments

Mix 3A21-42

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	10			43			88	89	± 5	84	94	12
3/4"	33	1			43			77	78	± 5	73	83	11
1/2"	16	0			43			59	64	± 5	59	69	18
3/8"	8	0			43			51	56	± 5	51	61	8
#4	1	0			43			44	44	± 5	39	49	7
#8					40			40	39	± 4	35	43	4
#16					33			33	34	± 4	30	38	7
#30					22			22	22	± 4	18	26	11
#50					6			6	6	± 3	3	9	16
#100					1			1	0	± 2	0	2	5
#200	0.2	0.2			0.2			0.6	0.4	± 1.6% max	0.0	1.6	0.4

Coarse Sand % Retained
(#8 through #30)
22

Fine Sand % Retained
(#30 through #200)
32

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	4/25/2020	Aggregate Sources (Pit #):	FA #1: 19129	FA #2:	
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	1:15 PM		CA #1: 19129	CA #2: 19129	CA #3:
Lot #:	5	Test #:	10	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:			
						Agency only - QC or Verification Companion Test # corresponding to this test:			

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	12.7		Comparison Test Results	Sample Wt.	28.5		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	12.6	100		0.0	28.5	100					
1 1/2" - 1 1/4"	0.0	12.6	100		4.7	28.5	100					
1 1/4" - 1"	0.0	12.6	100		11.2	23.8	84					
1" - 3/4"	1.2	12.6	100		11.0	12.6	44					
3/4" - 5/8"	0.0	11.4	90		0.0	1.6	6					
* 5/8" - 1/2"	5.0	11.4	-	-	1.2	1.6	-	-			-	-
1/2" - 3/8"	3.4	6.4	51		0.1	0.4	1					
3/8" - 1/4"	0.0	3.0	24		0.0	0.3	1					
* 1/4" - #4	2.6	3.0	-	-	0.1	0.3	-	-			-	-
#4 - Btm	0.4	0.4	3		0.2	0.2	1					
Check Total	12.6	± 0.2 lb of Sample Wt			28.5	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	538.6		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	539.4	100					
3/8" - #4	3.7	539.4	100					
#4 - #6	0.0	535.7	99					
* #6 - #8	37.8	535.7	-	-			-	-
#8 - #16	85.2	497.9	92					
#16 - #30	139.7	412.7	77					
#30 - #50	193.7	273.0	51					
#50 - #100	71.1	79.3	15					
#100 - #200	5.8	8.2	2					
#200 - Btm	1.1	2.4	0.4					
Loss by Washing	1.3							
Check Total	539.4	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample			
(B) Dry weight of washed sample			
(C) Loss by washing (A-B)			
(D) % Passing #200 (C/A)*100			
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	538.6	
(B) Dry weight of washed sample	537.3	
(C) Loss by washing (A-B)	1.3	
(D) % Passing #200 (C/A)*100	0.2	
Comparison Test Results		

Additional Remarks or Comments

3A21-42

Composite Gradation for Job Mix Formula

Aggregate Fraction	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	10			43			88	89	± 5	84	94	12
3/4"	32	1			43			76	78	± 5	73	83	12
1/2"	18	0			43			61	64	± 5	59	69	15
3/8"	8	0			43			52	56	± 5	51	61	9
#4	1	0			43			44	44	± 5	39	49	8
#8					40			40	39	± 4	35	43	4
#16					33			33	34	± 4	30	38	7
#30					22			22	22	± 4	18	26	11
#50					6			6	6	± 3	3	9	16
#100					1			1	0	± 2	0	2	5
#200					0.2			0.2	0.4	± 1.6% max	0.0	1.6	0.8

Coarse Sand % Retained (#8 through #30): 22

Fine Sand % Retained (#30 through #200): 33

(6/4/2019)

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	4/27/2020
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	6:35 AM
Lot #:	6	Test #:	11	JMF #:	20-018

Aggregate Sources (Pit #):	FA #1: 19129	FA #2:			
	CA #1: 19129	CA #2: 19129	CA #3:		

Contractor only - QA or Verification Test # corresponding to this test:

Agency only - QC or Verification Companion Test # corresponding to this test:

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	10.5		Comparison Test Results	Sample Wt.	28.0		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	10.5	100		0.7	28.0	100					
1 1/2" - 1 1/4"	0.0	10.5	100		4.9	27.3	97					
1 1/4" - 1"	0.0	10.5	100		10.8	22.4	80					
1" - 3/4"	0.8	10.5	100		9.9	11.6	41					
3/4" - 5/8"	0.0	9.7	92		0.0	1.7	6					
* 5/8" - 1/2"	4.3	9.7	-	-	1.2	1.7	-	-			-	-
1/2" - 3/8"	2.9	5.4	51		0.2	0.5	2					
3/8" - 1/4"	0.0	2.5	24		0.0	0.3	1					
* 1/4" - #4	2.2	2.5	-	-	0.1	0.3	-	-			-	-
#4 - Btm	0.3	0.3	3		0.2	0.2	1					
Check Total	10.5	± 0.2 lb of Sample Wt			28.0	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	539.1		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	539.5	100					
3/8" - #4	4.4	539.5	100					
#4 - #6	0.0	535.1	99					
* #6 - #8	39.7	535.1	-	-			-	-
#8 - #16	82.6	495.4	92					
#16 - #30	139.5	412.8	77					
#30 - #50	196.2	273.3	51					
#50 - #100	69.3	77.1	14					
#100 - #200	5.7	7.8	1					
#200 - Btm	0.9	2.1	0.4					
Loss by Washing	1.2							
Check Total	539.5	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample	2751.9	5192.7	
(B) Dry weight of washed sample	2726.4	5155.3	
(C) Loss by washing (A-B)	25.5	37.4	
(D) % Passing #200 (C/A)*100	0.9	0.7	
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	539.1	
(B) Dry weight of washed sample	537.9	
(C) Loss by washing (A-B)	1.2	
(D) % Passing #200 (C/A)*100	0.2	
Comparison Test Results		

Additional Remarks or Comments

3A21-43

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	21			43			99	100	± 5	95	100	1
1"	35	9			43			87	89	± 5	84	94	12
3/4"	32	1			43			77	78	± 5	73	83	10
1/2"	18	0			43			61	64	± 5	59	69	16
3/8"	8	0			43			52	56	± 5	51	61	9
#4	1	0			43			44	44	± 5	39	49	8
#8					40			40	39	± 4	35	43	4
#16					33			33	34	± 4	30	38	7
#30					22			22	22	± 4	18	26	11
#50					6			6	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	6
#200	0.3	0.2			0.2			0.6	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained (#8 through #30)

22

Fine Sand % Retained (#30 through #200)

33

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	4/27/2020
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	2:35 PM
Lot #:	6	Test #:	12	JMF #:	20-018

Aggregate Sources (Pit #):	FA #1: 19129	FA #2:			
	CA #1: 19129	CA #2: 19129	CA #3:		

Contractor only - QA or Verification Test # corresponding to this test:

Agency only - QC or Verification Companion Test # corresponding to this test:

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt. / CA #1 / Mix Prop.	13.6 / 3/4" / 35%		Comparison Test Results	Sample Wt. / CA #2 / Mix Prop.	26.9 / 1-12" / 22%		Comparison Test Results	Sample Wt. / CA #3 / Mix Prop.			Comparison Test Results
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	13.6	100		0.8	26.9	100					
1 1/2" - 1 1/4"	0.0	13.6	100		3.3	26.2	97					
1 1/4" - 1"	0.0	13.6	100		9.2	22.9	85					
1" - 3/4"	0.9	13.6	100		12.0	13.7	51					
3/4" - 5/8"	0.0	12.7	93		0.0	1.7	6					
* 5/8" - 1/2"	6.0	12.7	-	-	1.2	1.7	-	-			-	-
1/2" - 3/8"	3.6	6.7	49		0.2	0.5	2					
3/8" - 1/4"	0.0	3.1	23		0.0	0.3	1					
* 1/4" - #4	2.5	3.1	-	-	0.1	0.3	-	-			-	-
#4 - Btm	0.6	0.6	4		0.2	0.2	1					
Check Total	13.6	± 0.2 lb of Sample Wt			26.9	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt. / FA #1 / Mix Prop.	540.6 / Sand / 43%		Comparison Test Results	Sample Wt. / FA #2 / Mix Prop.			Comparison Test Results
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	539.7	100					
3/8" - #4	2.0	539.7	100					
#4 - #6	0.0	537.7	100					
* #6 - #8	20.7	537.7	-	-			-	-
#8 - #16	98.5	517.0	96					
#16 - #30	160.8	418.5	78					
#30 - #50	200.8	257.7	48					
#50 - #100	50.5	56.9	11					
#100 - #200	3.7	6.4	1					
#200 - Btm	0.4	2.7	0.5					
Loss by Washing	2.3							
Check Total	539.7	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample			
(B) Dry weight of washed sample			
(C) Loss by washing (A-B)			
(D) % Passing #200 (C/A)*100			
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	540.6	
(B) Dry weight of washed sample	538.3	
(C) Loss by washing (A-B)	2.3	
(D) % Passing #200 (C/A)*100	0.4	
Comparison Test Results		

Additional Remarks or Comments

3A21-43

Composite Gradation for Job Mix Formula

Aggregate Fraction Mix Prop.	CA #1 3/4" 35%	CA #2 1-12" 22%	CA #3		FA #1 Sand 43%	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	21			43			99	100	± 5	95	100	1
1"	35	11			43			89	89	± 5	84	94	10
3/4"	33	1			43			77	78	± 5	73	83	12
1/2"	17	0			43			61	64	± 5	59	69	16
3/8"	8	0			43			51	56	± 5	51	61	10
#4	1	0			43			45	44	± 5	39	49	6
#8					41			41	39	± 4	35	43	4
#16					34			34	34	± 4	30	38	7
#30					21			21	22	± 4	18	26	13
#50					5			5	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	5
#200					0.2			0.2	0	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained (#8 through #30)

24

Fine Sand % Retained (#30 through #200)

34

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	4/29/2020
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	6:19 AM
Lot #:	7	Test #:	13	JMF #:	20-018

Aggregate Sources (Pit #):					
FA #1:	19129	FA #2:			
CA #1:	19129	CA #2:	19129	CA #3:	

Contractor only - QA or Verification Test # corresponding to this test:

Agency only - QC or Verification Companion Test # corresponding to this test:

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	13.8		Comparison Test Results	Sample Wt.	30.4		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	14.0	100		0.4	30.5	100					
1 1/2" - 1 1/4"	0.0	14.0	100		2.9	30.1	99					
1 1/4" - 1"	0.0	14.0	100		11.7	27.2	89					
1" - 3/4"	1.3	14.0	100		13.4	15.5	51					
3/4" - 5/8"	0.0	12.7	91		0.0	2.1	7					
* 5/8" - 1/2"	6.0	12.7	-	-	1.8	2.1	-	-			-	-
1/2" - 3/8"	3.8	6.7	48		0.1	0.3	1					
3/8" - 1/4"	0.0	2.9	21		0.0	0.2	1					
* 1/4" - #4	2.5	2.9	-	-	0.1	0.2	-	-			-	-
#4 - Btm	0.4	0.4	3		0.1	0.1	0					
Check Total	14.0	± 0.2 lb of Sample Wt			30.5	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	521.4		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	521.2	100					
3/8" - #4	0.4	521.2	100					
#4 - #6	0.0	520.8	100					
* #6 - #8	17.1	520.8	-	-			-	-
#8 - #16	95.7	503.7	97					
#16 - #30	155.0	408.0	78					
#30 - #50	194.8	253.0	49					
#50 - #100	50.7	58.2	11					
#100 - #200	4.6	7.5	1					
#200 - Btm	1.1	2.9	0.6					
Loss by Washing	1.8							
Check Total	521.2	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample	2758.0	5198.1	
(B) Dry weight of washed sample	2736.9	5165.5	
(C) Loss by washing (A-B)	21.1	32.6	
(D) % Passing #200 (C/A)*100	0.8	0.6	
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	521.4	
(B) Dry weight of washed sample	519.6	
(C) Loss by washing (A-B)	1.8	
(D) % Passing #200 (C/A)*100	0.3	
Comparison Test Results		

Additional Remarks or Comments

3A21-43

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	11			43			89	89	± 5	84	94	11
3/4"	32	2			43			76	78	± 5	73	83	13
1/2"	17	0			43			60	64	± 5	59	69	16
3/8"	7	0			43			51	56	± 5	51	61	9
#4	1	0			43			44	44	± 5	39	49	7
#8					42			42	39	± 4	35	43	2
#16					34			34	34	± 4	30	38	8
#30					21			21	22	± 4	18	26	13
#50					5			5	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	5
#200	0.3	0.1			0.3			0.7	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained
(#8 through #30)
23

Fine Sand % Retained
(#30 through #200)
34

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	4/29/2020
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	1:55 PM
Lot #:	7	Test #:	14	JMF #:	20-018

Aggregate Sources (Pit #):	FA #1: 19129	FA #2:			
	CA #1: 19129	CA #2: 19129	CA #3:		

Contractor only - QA or Verification Test # corresponding to this test:

Agency only - QC or Verification Companion Test # corresponding to this test:

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	13.8		Comparison Test Results	Sample Wt.	28.1		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes Pass - Ret.	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	13.9	100		0.0	28.2	100					
1 1/2" - 1 1/4"	0.0	13.9	100		2.2	28.2	100					
1 1/4" - 1"	0.0	13.9	100		10.4	26.0	92					
1" - 3/4"	0.9	13.9	100		13.3	15.6	55					
3/4" - 5/8"	0.0	13.0	94		0.0	2.3	8					
* 5/8" - 1/2"	4.7	13.0	-	-	1.8	2.3	-	-			-	-
1/2" - 3/8"	3.9	8.3	60		0.3	0.5	2					
3/8" - 1/4"	0.0	4.4	32		0.0	0.2	1					
* 1/4" - #4	3.3	4.4	-	-	0.1	0.2	-	-			-	-
#4 - Btm	1.1	1.1	8		0.1	0.1	0					
Check Total	13.9	± 0.2 lb of Sample Wt			28.2	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	531.7		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes Pass - Ret.	Weights (g) Ind.	Cum.	% Pass	% Pass	Weights (g) Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	532.2	100					
3/8" - #4	0.6	532.2	100					
#4 - #6	0.0	531.6	100					
* #6 - #8	16.2	531.6	-	-			-	-
#8 - #16	99.5	515.4	97					
#16 - #30	163.7	415.9	78					
#30 - #50	198.1	252.2	47					
#50 - #100	48.6	54.1	10					
#100 - #200	3.8	5.5	1					
#200 - Btm	0.5	1.7	0.3					
Loss by Washing	1.2							
Check Total	532.2	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample			
(B) Dry weight of washed sample			
(C) Loss by washing (A-B)			
(D) % Passing #200 (C/A)*100			
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	531.7	
(B) Dry weight of washed sample	530.5	
(C) Loss by washing (A-B)	1.2	
(D) % Passing #200 (C/A)*100	0.2	
Comparison Test Results		

Additional Remarks or Comments

3A21-43

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	12			43			90	89	± 5	84	94	10
3/4"	33	2			43			78	78	± 5	73	83	12
1/2"	21	0			43			64	64	± 5	59	69	14
3/8"	11	0			43			54	56	± 5	51	61	10
#4	3	0			43			46	44	± 5	39	49	8
#8					42			42	39	± 4	35	43	4
#16					34			34	34	± 4	30	38	8
#30					20			20	22	± 4	18	26	14
#50					4			4	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	4
#200					0.1			0.1	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained (#8 through #30)

26

Fine Sand % Retained (#30 through #200)

34

(6/4/2019)

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	4/30/2020	Aggregate Sources (Pit #):	FA #1: 19129 FA #2:
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	6:15 AM		CA #1: 19129 CA #2: 19129 CA #3:
Lot #:	8	Test #:	15	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:	
						Agency only - QC or Verification Companion Test # corresponding to this test:	

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	13.0		Comparison Test Results	Sample Wt.	29.1		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	13.1	100		0.3	29.2	100					
1 1/2" - 1 1/4"	0.0	13.1	100		2.7	28.9	99					
1 1/4" - 1"	0.0	13.1	100		11.9	26.2	90					
1" - 3/4"	1.1	13.1	100		12.2	14.3	49					
3/4" - 5/8"	0.0	12.0	92		0.0	2.1	7					
* 5/8" - 1/2"	5.8	12.0	-	-	1.8	2.1	-	-			-	-
1/2" - 3/8"	3.3	6.2	47		0.1	0.3	1					
3/8" - 1/4"	0.0	2.9	22		0.0	0.2	1					
* 1/4" - #4	2.3	2.9	-	-	0.1	0.2	-	-			-	-
#4 - Btm	0.6	0.6	5		0.1	0.1	0					
Check Total	13.1	± 0.2 lb of Sample Wt			29.2	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	535.8		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	535.2	100					
3/8" - #4	1.7	535.2	100					
#4 - #6	0.0	533.5	100					
* #6 - #8	17.1	533.5	-	-			-	-
#8 - #16	100.0	516.4	96					
#16 - #30	165.5	416.4	78					
#30 - #50	196.0	250.9	47					
#50 - #100	49.1	54.9	10					
#100 - #200	4.1	5.8	1					
#200 - Btm	0.5	1.7	0.3					
Loss by Washing	1.2							
Check Total	535.2	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample	2782.0	5557.4	
(B) Dry weight of washed sample	2767.6	5529.3	
(C) Loss by washing (A-B)	14.4	28.1	
(D) % Passing #200 (C/A)*100	0.5	0.5	
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	535.8	
(B) Dry weight of washed sample	534.6	
(C) Loss by washing (A-B)	1.2	
(D) % Passing #200 (C/A)*100	0.2	
Comparison Test Results		

Additional Remarks or Comments

3A41-43 & 3A41-53

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	11			43			89	89	± 5	84	94	11
3/4"	32	2			43			77	78	± 5	73	83	12
1/2"	16	0			43			60	64	± 5	59	69	17
3/8"	8	0			43			51	56	± 5	51	61	9
#4	2	0			43			45	44	± 5	39	49	6
#8					41			41	39	± 4	35	43	4
#16					34			34	34	± 4	30	38	7
#30					20			20	22	± 4	18	26	14
#50					4			4	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	4
#200	0.2	0.1			0.1			0.4	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained
(#8 through #30)
25

Fine Sand % Retained
(#30 through #200)
34

(6/4/2019)

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	4/30/2020	Aggregate Sources (Pit #):	FA #1: 19129 FA #2:
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	2:45 PM		CA #1: 19129 CA #2: 19129 CA #3:
Lot #:	8	Test #:	16	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:	
						Agency only - QC or Verification Companion Test # corresponding to this test:	

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	13.4		Comparison Test Results	Sample Wt.	27.9		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	13.5	100		0.0	28.0	100					
1 1/2" - 1 1/4"	0.0	13.5	100		1.3	28.0	100					
1 1/4" - 1"	0.0	13.5	100		12.4	26.7	95					
1" - 3/4"	1.2	13.5	100		12.4	14.3	51					
3/4" - 5/8"	0.0	12.3	91		0.0	1.9	7					
* 5/8" - 1/2"	6.0	12.3	-	-	1.5	1.9	-	-			-	-
1/2" - 3/8"	3.5	6.3	47		0.2	0.4	1					
3/8" - 1/4"	0.0	2.8	21		0.0	0.2	1					
* 1/4" - #4	2.2	2.8	-	-	0.1	0.2	-	-			-	-
#4 - Btm	0.6	0.6	4		0.1	0.1	0					
Check Total	13.5	± 0.2 lb of Sample Wt			28.0	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	533.7		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	533.9	100					
3/8" - #4	0.0	533.9	100					
#4 - #6	0.0	533.9	100					
* #6 - #8	14.0	533.9	-	-			-	-
#8 - #16	102.7	519.9	97					
#16 - #30	167.7	417.2	78					
#30 - #50	193.4	249.5	47					
#50 - #100	49.8	56.1	11					
#100 - #200	4.5	6.3	1					
#200 - Btm	0.6	1.8	0.3					
Loss by Washing	1.2							
Check Total	533.9	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample			
(B) Dry weight of washed sample			
(C) Loss by washing (A-B)			
(D) % Passing #200 (C/A)*100			
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	533.7	
(B) Dry weight of washed sample	532.5	
(C) Loss by washing (A-B)	1.2	
(D) % Passing #200 (C/A)*100	0.2	
Comparison Test Results		

Additional Remarks or Comments

3A41-53

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	11			43			89	89	± 5	84	94	11
3/4"	32	2			43			76	78	± 5	73	83	13
1/2"	16	0			43			60	64	± 5	59	69	16
3/8"	7	0			43			51	56	± 5	51	61	9
#4	1	0			43			44	44	± 5	39	49	7
#8					42			42	39	± 4	35	43	2
#16					34			34	34	± 4	30	38	8
#30					20			20	22	± 4	18	26	14
#50					5			5	6	± 3	3	9	15
#100					0			0	0	± 2	0	2	5
#200					0.1			0.1	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained (#8 through #30)

24

Fine Sand % Retained (#30 through #200)

34

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	5/1/2020
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	6:02 AM
Lot #:	9	Test #:	17	JMF #:	20-018

Aggregate Sources (Pit #):	FA #1:	19129	FA #2:		
	CA #1:	19129	CA #2:	19129	CA #3:

Contractor only - QA or Verification Test # corresponding to this test:

Agency only - QC or Verification Companion Test # corresponding to this test:

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt. / CA #1 / Mix Prop.	13.2 / 3/4" / 35%		Comparison Test Results	Sample Wt. / CA #2 / Mix Prop.	27.8 / 1-12" / 22%		Comparison Test Results	Sample Wt. / CA #3 / Mix Prop.			Comparison Test Results
Sieve Sizes Pass - Ret.	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	13.2	100		0.0	27.8	100					
1 1/2" - 1 1/4"	0.0	13.2	100		3.4	27.8	100					
1 1/4" - 1"	0.0	13.2	100		11.8	24.4	88					
1" - 3/4"	1.2	13.2	100		11.5	12.6	45					
3/4" - 5/8"	0.0	12.0	91		0.0	1.1	4					
* 5/8" - 1/2"	4.6	12.0	-	-	0.9	1.1	-	-			-	-
1/2" - 3/8"	3.7	7.4	56		0.1	0.2	1					
3/8" - 1/4"	0.0	3.7	28		0.0	0.1	0					
* 1/4" - #4	2.9	3.7	-	-	0.0	0.1	-	-			-	-
#4 - Btm	0.8	0.8	6		0.1	0.1	0					
Check Total	13.2	± 0.2 lb of Sample Wt			27.8	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt. / FA #1 / Mix Prop.	532.6 / Sand / 43%		Comparison Test Results	Sample Wt. / FA #2 / Mix Prop.			Comparison Test Results
Sieve Sizes Pass - Ret.	Weights (g) Ind.	Cum.	% Pass	% Pass	Weights (g) Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	532.9	100					
3/8" - #4	1.7	532.9	100					
#4 - #6	0.0	531.2	100					
* #6 - #8	13.3	531.2	-	-			-	-
#8 - #16	101.4	517.9	97					
#16 - #30	169.8	416.5	78					
#30 - #50	193.3	246.7	46					
#50 - #100	47.9	53.4	10					
#100 - #200	4.0	5.5	1					
#200 - Btm	0.4	1.5	0.3					
Loss by Washing	1.1							
Check Total	532.9	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample	2763.9	5610.7	
(B) Dry weight of washed sample	2748.2	5578.0	
(C) Loss by washing (A-B)	15.7	32.7	
(D) % Passing #200 (C/A)*100	0.6	0.6	
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	532.6	
(B) Dry weight of washed sample	531.5	
(C) Loss by washing (A-B)	1.1	
(D) % Passing #200 (C/A)*100	0.2	
Comparison Test Results		

Additional Remarks or Comments

3A21-43

Composite Gradation for Job Mix Formula

Aggregate Fraction Mix Prop.	CA #1 3/4" 35%	CA #2 1-12" 22%	CA #3		FA #1 Sand 43%	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	10			43			88	89	± 5	84	94	12
3/4"	32	1			43			76	78	± 5	73	83	12
1/2"	20	0			43			63	64	± 5	59	69	13
3/8"	10	0			43			53	56	± 5	51	61	10
#4	2	0			43			45	44	± 5	39	49	8
#8					42			42	39	± 4	35	43	3
#16					34			34	34	± 4	30	38	8
#30					20			20	22	± 4	18	26	14
#50					4			4	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	4
#200	0.2	0.1			0.1			0.5	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained (#8 through #30)

25

Fine Sand % Retained (#30 through #200)

34

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	5/1/2020	Aggregate Sources (Pit #):	FA #1: 19129 FA #2:
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	2:35 PM		CA #1: 19129 CA #2: 19129 CA #3:
Lot #:	9	Test #:	18	JMF #:	20-018	Contractor only - QA or Verification Test # corresponding to this test:	
						Agency only - QC or Verification Companion Test # corresponding to this test:	

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	13.1		Comparison Test Results	Sample Wt.	30.8		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes Pass - Ret.	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	13.1	100		0.0	30.8	100					
1 1/2" - 1 1/4"	0.0	13.1	100		2.9	30.8	100					
1 1/4" - 1"	0.0	13.1	100		15.2	28.0	91					
1" - 3/4"	1.1	13.1	100		11.7	12.8	42					
3/4" - 5/8"	0.0	12.0	92		0.0	1.1	4					
* 5/8" - 1/2"	5.7	12.0	-	-	0.9	1.1	-	-			-	-
1/2" - 3/8"	3.3	6.3	48		0.1	0.2	1					
3/8" - 1/4"	0.0	3.0	23		0.0	0.1	0					
* 1/4" - #4	2.3	3.0	-	-	0.0	0.1	-	-			-	-
#4 - Btm	0.7	0.7	5		0.1	0.1	0					
Check Total	13.1	± 0.2 lb of Sample Wt			30.8	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	533.2		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes Pass - Ret.	Weights (g) Ind.	Cum.	% Pass	% Pass	Weights (g) Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	532.1	100					
3/8" - #4	3.4	532.1	100					
#4 - #6	0.0	528.7	99					
* #6 - #8	15.4	528.7	-	-			-	-
#8 - #16	101.8	513.3	96					
#16 - #30	161.7	411.5	77					
#30 - #50	193.4	249.8	47					
#50 - #100	49.1	56.4	11					
#100 - #200	4.7	7.3	1					
#200 - Btm	0.3	2.6	0.5					
Loss by Washing	2.3							
Check Total	532.1	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample			
(B) Dry weight of washed sample			
(C) Loss by washing (A-B)			
(D) % Passing #200 (C/A)*100			
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	533.2	
(B) Dry weight of washed sample	530.9	
(C) Loss by washing (A-B)	2.3	
(D) % Passing #200 (C/A)*100	0.4	
Comparison Test Results		

Additional Remarks or Comments

3A21-43 & 3A41-49

Composite Gradation for Job Mix Formula

Aggregate Fraction Mix Prop.	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	9			43			87	89	± 5	84	94	13
3/4"	32	1			43			76	78	± 5	73	83	11
1/2"	17	0			43			60	64	± 5	59	69	16
3/8"	8	0			43			51	56	± 5	51	61	9
#4	2	0			43			44	44	± 5	39	49	7
#8					41			41	39	± 4	35	43	3
#16					33			33	34	± 4	30	38	8
#30					20			20	22	± 4	18	26	13
#50					5			5	6	± 3	3	9	15
#100					0			0	0	± 2	0	2	5
#200					0.2			0.2	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained (#8 through #30)

24

Fine Sand % Retained (#30 through #200)

33

(6/4/2019)

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	5/2/2020	Aggregate Sources (Pit #):	FA #1:	19129	FA #2:		
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	5:52 AM		CA #1:	19129	CA #2:	19129	CA #3:
Lot #:	10	Test #:	19	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:					
						Agency only - QC or Verification Companion Test # corresponding to this test:					

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	12.3		Comparison Test Results	Sample Wt.	27.8		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	12.4	100		0.0	27.8	100					
1 1/2" - 1 1/4"	0.0	12.4	100		2.6	27.8	100					
1 1/4" - 1"	0.0	12.4	100		12.4	25.2	91					
1" - 3/4"	0.8	12.4	100		11.3	12.9	46					
3/4" - 5/8"	0.0	11.6	94		0.0	1.6	6					
* 5/8" - 1/2"	4.5	11.6	-	-	1.4	1.6	-	-			-	-
1/2" - 3/8"	3.2	7.1	57		0.1	0.2	1					
3/8" - 1/4"	0.0	3.9	31		0.0	0.1	0					
* 1/4" - #4	2.9	3.9	-	-	0.0	0.1	-	-			-	-
#4 - Btm	1.0	1.0	8		0.1	0.1	0					
Check Total	12.4	± 0.2 lb of Sample Wt			27.8	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	534.6		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	535.1	100					
3/8" - #4	1.5	535.1	100					
#4 - #6	0.0	533.6	100					
* #6 - #8	28.5	533.6	-	-			-	-
#8 - #16	96.1	505.1	94					
#16 - #30	151.9	409.0	76					
#30 - #50	187.8	257.1	48					
#50 - #100	60.4	69.3	13					
#100 - #200	5.8	8.9	2					
#200 - Btm	1.0	3.1	0.6					
Loss by Washing	2.1							
Check Total	535.1	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample	2790.8	5628.8	
(B) Dry weight of washed sample	2769.6	5615.6	
(C) Loss by washing (A-B)	21.2	13.2	
(D) % Passing #200 (C/A)*100	0.8	0.2	
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	534.6	
(B) Dry weight of washed sample	532.5	
(C) Loss by washing (A-B)	2.1	
(D) % Passing #200 (C/A)*100	0.4	
Comparison Test Results		

Additional Remarks or Comments

3A21-43

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	10			43			88	89	± 5	84	94	12
3/4"	33	1			43			77	78	± 5	73	83	11
1/2"	20	0			43			63	64	± 5	59	69	14
3/8"	11	0			43			54	56	± 5	51	61	9
#4	3	0			43			46	44	± 5	39	49	8
#8					40			40	39	± 4	35	43	6
#16					33			33	34	± 4	30	38	7
#30					21			21	22	± 4	18	26	12
#50					6			6	6	± 3	3	9	15
#100					1			1	0	± 2	0	2	5
#200	0.3	0.0			0.3			0.6	0.4	± 1.6% max	0.0	1.6	0.4

Coarse Sand % Retained (#8 through #30)

25

Fine Sand % Retained (#30 through #200)

32

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	5/2/2020	Aggregate Sources (Pit #):	FA #1: 19129 FA #2:
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	2:05 PM		CA #1: 19129 CA #2: 19129 CA #3:
Lot #:	10	Test #:	20	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:	
						Agency only - QC or Verification Companion Test # corresponding to this test:	

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	14.3		Comparison Test Results	Sample Wt.	29.2		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	14.3	100		0.0	29.3	100					
1 1/2" - 1 1/4"	0.0	14.3	100		2.8	29.3	100					
1 1/4" - 1"	0.0	14.3	100		11.7	26.5	90					
1" - 3/4"	1.7	14.3	100		13.0	14.8	51					
3/4" - 5/8"	0.0	12.6	88		0.0	1.8	6					
* 5/8" - 1/2"	6.3	12.6	-	-	1.4	1.8	-	-			-	-
1/2" - 3/8"	3.3	6.3	44		0.2	0.4	1					
3/8" - 1/4"	0.0	3.0	21		0.0	0.2	1					
* 1/4" - #4	2.3	3.0	-	-	0.1	0.2	-	-			-	-
#4 - Btm	0.7	0.7	5		0.1	0.1	0					
Check Total	14.3	± 0.2 lb of Sample Wt			29.3	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	530.1		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	529.8	100					
3/8" - #4	3.2	529.8	100					
#4 - #6	0.0	526.6	99					
* #6 - #8	34.1	526.6	-	-			-	-
#8 - #16	82.1	492.5	93					
#16 - #30	133.3	410.4	77					
#30 - #50	197.3	277.1	52					
#50 - #100	67.6	79.8	15					
#100 - #200	6.5	12.2	2					
#200 - Btm	1.0	5.7	1.1					
Loss by Washing	4.7							
Check Total	529.8	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample			
(B) Dry weight of washed sample			
(C) Loss by washing (A-B)			
(D) % Passing #200 (C/A)*100			
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	530.1	
(B) Dry weight of washed sample	525.4	
(C) Loss by washing (A-B)	4.7	
(D) % Passing #200 (C/A)*100	0.9	
Comparison Test Results		

Additional Remarks or Comments

3A21-43

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	11			43			89	89	± 5	84	94	11
3/4"	31	1			43			75	78	± 5	73	83	14
1/2"	15	0			43			59	64	± 5	59	69	16
3/8"	7	0			43			51	56	± 5	51	61	8
#4	2	0			43			44	44	± 5	39	49	7
#8					40			40	39	± 4	35	43	4
#16					33			33	34	± 4	30	38	7
#30					22			22	22	± 4	18	26	11
#50					6			6	6	± 3	3	9	16
#100					1			1	0	± 2	0	2	5
#200					0.5			0.5	0.4	± 1.6% max	0.0	1.6	0.5

Coarse Sand % Retained
(#8 through #30)
22

Fine Sand % Retained
(#30 through #200)
33

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	5/4/2020	Aggregate Sources (Pit #):	FA #1: 19129 FA #2:
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	6:15 AM		CA #1: 19129 CA #2: 19129 CA #3:
Lot #:	11	Test #:	21	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:	
						Agency only - QC or Verification Companion Test # corresponding to this test:	

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	12.5		Comparison Test Results	Sample Wt.	27.1		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes Pass - Ret.	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	12.4	100		0.2	27.1	100					
1 1/2" - 1 1/4"	0.0	12.4	100		2.1	26.9	99					
1 1/4" - 1"	0.0	12.4	100		12.3	24.8	91					
1" - 3/4"	0.4	12.4	100		10.7	12.4	46					
3/4" - 5/8"	0.0	12.0	97		0.0	1.7	6					
* 5/8" - 1/2"	5.3	12.0	-	-	1.4	1.7	-	-			-	-
1/2" - 3/8"	3.3	6.7	54		0.1	0.3	1					
3/8" - 1/4"	0.0	3.4	27		0.0	0.2	1					
* 1/4" - #4	3.0	3.4	-	-	0.0	0.2	-	-			-	-
#4 - Btm	0.4	0.4	3		0.2	0.2	1					
Check Total	12.4	± 0.2 lb of Sample Wt			27.1	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	537.5		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes Pass - Ret.	Weights (g) Ind.	Cum.	% Pass	% Pass	Weights (g) Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	539.1	100					
3/8" - #4	0.9	539.1	100					
#4 - #6	0.0	538.2	100					
* #6 - #8	16.5	538.2	-	-			-	-
#8 - #16	96.8	521.7	97					
#16 - #30	165.8	424.9	79					
#30 - #50	199.8	259.1	48					
#50 - #100	52.3	59.3	11					
#100 - #200	4.3	7.0	1					
#200 - Btm	1.1	2.7	0.5					
Loss by Washing	1.6							
Check Total	539.1	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample	2787.7	5172.9	
(B) Dry weight of washed sample	2764.5	5147.3	
(C) Loss by washing (A-B)	23.2	25.6	
(D) % Passing #200 (C/A)*100	0.8	0.5	
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	537.7	
(B) Dry weight of washed sample	536.1	
(C) Loss by washing (A-B)	1.6	
(D) % Passing #200 (C/A)*100	0.3	
Comparison Test Results		

Additional Remarks or Comments

3A21-43

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	10			43			88	89	± 5	84	94	12
3/4"	34	1			43			78	78	± 5	73	83	10
1/2"	19	0			43			62	64	± 5	59	69	16
3/8"	9	0			43			53	56	± 5	51	61	9
#4	1	0			43			44	44	± 5	39	49	9
#8					42			42	39	± 4	35	43	2
#16					34			34	34	± 4	30	38	8
#30					21			21	22	± 4	18	26	13
#50					5			5	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	5
#200	0.3	0.1			0.2			0.6	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained (#8 through #30): 23

Fine Sand % Retained (#30 through #200): 34

(6/4/2019)

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	5/4/2020	Aggregate Sources (Pit #):	FA #1: 19129 FA #2:
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	1:35 PM		CA #1: 19129 CA #2: 19129 CA #3:
Lot #:	11	Test #:	22	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:	
						Agency only - QC or Verification Companion Test # corresponding to this test:	

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	12.2		Comparison Test Results	Sample Wt.	26.6		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	12.3	100		0.7	26.7	100					
1 1/2" - 1 1/4"	0.0	12.3	100		4.0	26.0	97					
1 1/4" - 1"	0.0	12.3	100		10.4	22.0	82					
1" - 3/4"	0.7	12.3	100		10.2	11.6	43					
3/4" - 5/8"	0.0	11.6	94		0.0	1.4	5					
* 5/8" - 1/2"	4.4	11.6	-	-	1.1	1.4	-	-			-	-
1/2" - 3/8"	3.2	7.2	59		0.1	0.3	1					
3/8" - 1/4"	0.0	4.0	33		0.0	0.2	1					
* 1/4" - #4	3.4	4.0	-	-	0.1	0.2	-	-			-	-
#4 - Btm	0.6	0.6	5		0.1	0.1	0					
Check Total	12.3	± 0.2 lb of Sample Wt			26.7	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	533.4		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	532.9	100					
3/8" - #4	0.8	532.9	100					
#4 - #6	0.0	532.1	100					
* #6 - #8	13.0	532.1	-	-			-	-
#8 - #16	105.5	519.1	97					
#16 - #30	164.6	413.6	78					
#30 - #50	195.3	249.0	47					
#50 - #100	48.0	53.7	10					
#100 - #200	4.0	5.7	1					
#200 - Btm	0.4	1.7	0.3					
Loss by Washing	1.3							
Check Total	532.9	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample			
(B) Dry weight of washed sample			
(C) Loss by washing (A-B)			
(D) % Passing #200 (C/A)*100			
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	533.4	
(B) Dry weight of washed sample	532.1	
(C) Loss by washing (A-B)	1.3	
(D) % Passing #200 (C/A)*100	0.2	
Comparison Test Results		

Additional Remarks or Comments

3A21-43

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	21			43			99	100	± 5	95	100	1
1"	35	9			43			87	89	± 5	84	94	12
3/4"	33	1			43			77	78	± 5	73	83	10
1/2"	21	0			43			64	64	± 5	59	69	13
3/8"	12	0			43			55	56	± 5	51	61	9
#4	2	0			43			45	44	± 5	39	49	10
#8					42			42	39	± 4	35	43	3
#16					34			34	34	± 4	30	38	8
#30					20			20	22	± 4	18	26	14
#50					4			4	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	4
#200					0.1			0.1	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained
(#8 through #30)
25

Fine Sand % Retained
(#30 through #200)
34

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	5/5/2020	Aggregate Sources (Pit #):	FA #1: 19129	FA #2:	
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	6:26 AM		CA #1: 19129	CA #2: 19129	CA #3:
Lot #:	12	Test #:	23	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:			
						Agency only - QC or Verification Companion Test # corresponding to this test:			

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	12.0		Comparison Test Results	Sample Wt.	27.4		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	11.9	100		1.1	27.4	100					
1 1/2" - 1 1/4"	0.0	11.9	100		5.2	26.2	96					
1 1/4" - 1"	0.0	11.9	100		13.0	21.0	77					
1" - 3/4"	0.5	11.9	100		7.5	8.0	29					
3/4" - 5/8"	0.0	11.4	96		0.0	0.5	2					
* 5/8" - 1/2"	4.1	11.4	-	-	0.3	0.5	-	-			-	-
1/2" - 3/8"	3.3	7.3	61		0.1	0.2	1					
3/8" - 1/4"	0.0	4.0	34		0.0	0.1	0					
* 1/4" - #4	3.4	4.0	-	-	0.0	0.1	-	-			-	-
#4 - Btm	0.6	0.6	5		0.1	0.1	0					
Check Total	11.9	± 0.2 lb of Sample Wt			27.4	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	535.6		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	536.3	100					
3/8" - #4	0.1	536.3	100					
#4 - #6	0.0	536.2	100					
* #6 - #8	13.9	536.2	-	-			-	-
#8 - #16	103.5	522.3	97					
#16 - #30	171.3	418.8	78					
#30 - #50	194.3	247.5	46					
#50 - #100	47.2	53.2	10					
#100 - #200	4.3	6.0	1					
#200 - Btm	0.7	1.7	0.3					
Loss by Washing	1.0							
Check Total	536.3	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample	2806.6	5160.5	
(B) Dry weight of washed sample	2788.2	5133.5	
(C) Loss by washing (A-B)	18.4	27.0	
(D) % Passing #200 (C/A)*100	0.7	0.5	
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	535.6	
(B) Dry weight of washed sample	534.6	
(C) Loss by washing (A-B)	1.0	
(D) % Passing #200 (C/A)*100	0.2	
Comparison Test Results		

Additional Remarks or Comments

3A21-43

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	21			43			99	100	± 5	95	100	1
1"	35	6			43			84	89	± 5	84	94	15
3/4"	34	0			43			77	78	± 5	73	83	7
1/2"	21	0			43			65	64	± 5	59	69	12
3/8"	12	0			43			55	56	± 5	51	61	10
#4	2	0			43			45	44	± 5	39	49	10
#8					42			42	39	± 4	35	43	3
#16					34			34	34	± 4	30	38	8
#30					20			20	22	± 4	18	26	14
#50					4			4	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	4
#200	0.2	0.1			0.1			0.5	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained (#8 through #30)

25

Fine Sand % Retained (#30 through #200)

34

(6/4/2019)

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	5/5/2020	Aggregate Sources (Pit #):	FA #1: 19129	FA #2:		
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	1:11 PM		CA #1: 19129	CA #2: 19129	CA #3:	
Lot #:	12	Test #:	24	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:				
						Agency only - QC or Verification Companion Test # corresponding to this test:				

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	12.3		Comparison Test Results	Sample Wt.	27.9		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	12.3	100		0.2	27.9	100					
1 1/2" - 1 1/4"	0.0	12.3	100		3.2	27.7	99					
1 1/4" - 1"	0.0	12.3	100		10.7	24.5	88					
1" - 3/4"	1.0	12.3	100		11.6	13.7	49					
3/4" - 5/8"	0.0	11.4	92		0.0	2.2	8					
* 5/8" - 1/2"	5.7	11.4	-	-	1.8	2.2	-	-			-	-
1/2" - 3/8"	3.0	5.7	46		0.1	0.3	1					
3/8" - 1/4"	0.0	2.6	21		0.0	0.2	1					
* 1/4" - #4	2.1	2.6	-	-	0.1	0.2	-	-			-	-
#4 - Btm	0.5	0.5	4		0.1	0.1	1					
Check Total	12.3	± 0.2 lb of Sample Wt			27.9	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	537.9		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	537.8	100					
3/8" - #4	0.0	537.8	100					
#4 - #6	0.0	537.8	100					
* #6 - #8	12.9	537.8	-	-			-	-
#8 - #16	104.1	524.9	98					
#16 - #30	172.1	420.8	78					
#30 - #50	196.5	248.7	46					
#50 - #100	46.0	52.2	10					
#100 - #200	4.5	6.2	1					
#200 - Btm	0.4	1.7	0.3					
Loss by Washing	1.3							
Check Total	537.8	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample			
(B) Dry weight of washed sample			
(C) Loss by washing (A-B)			
(D) % Passing #200 (C/A)*100			
Comparison Test Results			
Fine Aggregate	FA #1	FA #2	
(A) Dry weight of original sample	537.9		
(B) Dry weight of washed sample	536.6		
(C) Loss by washing (A-B)	1.3		
(D) % Passing #200 (C/A)*100	0.2		
Comparison Test Results			

Additional Remarks or Comments

Mix 3A21-43

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	11			43			89	89	± 5	84	94	11
3/4"	32	2			43			77	78	± 5	73	83	12
1/2"	16	0			43			59	64	± 5	59	69	18
3/8"	7	0			43			51	56	± 5	51	61	8
#4	1	0			43			45	44	± 5	39	49	6
#8					42			42	39	± 4	35	43	3
#16					34			34	34	± 4	30	38	8
#30					20			20	22	± 4	18	26	14
#50					4			4	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	4
#200					0.1			0.1	0	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained (#8 through #30)

25

Fine Sand % Retained (#30 through #200)

34

(6/4/2019)

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	5/6/2020	Aggregate Sources (Pit #):	FA #1: 19129 FA #2:
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	5:59 AM		CA #1: 19129 CA #2: 19129 CA #3:
Lot #:	13	Test #:	25	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:	
						Agency only - QC or Verification Companion Test # corresponding to this test:	

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	14.2		Comparison Test Results	Sample Wt.	29.3		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	14.2	100		0.0	29.2	100					
1 1/2" - 1 1/4"	0.0	14.2	100		2.3	29.2	100					
1 1/4" - 1"	0.0	14.2	100		14.5	26.9	92					
1" - 3/4"	1.1	14.2	100		11.1	12.4	43					
3/4" - 5/8"	0.0	13.1	92		0.0	1.3	5					
* 5/8" - 1/2"	6.2	13.1	-	-	1.1	1.3	-	-			-	-
1/2" - 3/8"	3.9	6.9	49		0.1	0.2	1					
3/8" - 1/4"	0.0	3.0	21		0.0	0.2	1					
* 1/4" - #4	2.5	3.0	-	-	0.1	0.2	-	-			-	-
#4 - Btm	0.6	0.6	4		0.1	0.1	0					
Check Total	14.2	± 0.2 lb of Sample Wt			29.2	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	536.1		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	535.6	100					
3/8" - #4	0.6	535.6	100					
#4 - #6	0.0	535.0	100					
* #6 - #8	15.1	535.0	-	-			-	-
#8 - #16	105.7	519.9	97					
#16 - #30	168.7	414.2	77					
#30 - #50	191.3	245.5	46					
#50 - #100	47.8	54.2	10					
#100 - #200	4.6	6.4	1					
#200 - Btm	0.6	1.8	0.3					
Loss by Washing	1.2							
Check Total	535.6	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample	2789.0	5222.2	
(B) Dry weight of washed sample	2775.9	5203.3	
(C) Loss by washing (A-B)	13.1	18.9	
(D) % Passing #200 (C/A)*100	0.5	0.4	
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	536.1	
(B) Dry weight of washed sample	534.9	
(C) Loss by washing (A-B)	1.2	
(D) % Passing #200 (C/A)*100	0.2	
Comparison Test Results		

Additional Remarks or Comments

3A21-49

Composite Gradation for Job Mix Formula

Aggregate Fraction	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	9			43			87	89	± 5	84	94	13
3/4"	32	1			43			76	78	± 5	73	83	11
1/2"	17	0			43			60	64	± 5	59	69	16
3/8"	7	0			43			51	56	± 5	51	61	9
#4	1	0			43			44	44	± 5	39	49	7
#8					42			42	39	± 4	35	43	2
#16					33			33	34	± 4	30	38	9
#30					20			20	22	± 4	18	26	13
#50					4			4	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	4
#200	0.2	0.1			0.1			0.4	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained (#8 through #30)

24

Fine Sand % Retained (#30 through #200)

33

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	5/6/2020
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	2:34 PM
Lot #:	13	Test #:	26	JMF #:	20-018

Aggregate Sources (Pit #):	FA #1: 19129	FA #2:		
	CA #1: 19129	CA #2: 19129	CA #3:	
Contractor only - QA or Verification Test # corresponding to this test:				
Agency only - QC or Verification Companion Test # corresponding to this test:				

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	14.0		Comparison Test Results	Sample Wt.	30.0		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	14.0	100		0.0	30.1	100					
1 1/2" - 1 1/4"	0.0	14.0	100		3.5	30.1	100					
1 1/4" - 1"	0.0	14.0	100		13.9	26.6	88					
1" - 3/4"	0.7	14.0	100		11.2	12.8	42					
3/4" - 5/8"	0.0	13.3	95		0.0	1.6	5					
* 5/8" - 1/2"	5.4	13.3	-	-	1.2	1.6	-	-			-	-
1/2" - 3/8"	3.7	7.9	56		0.1	0.4	1					
3/8" - 1/4"	0.0	4.2	30		0.0	0.3	1					
* 1/4" - #4	3.2	4.2	-	-	0.1	0.3	-	-			-	-
#4 - Btm	1.0	1.0	7		0.2	0.2	1					
Check Total	14.0	± 0.2 lb of Sample Wt			30.1	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	532.8		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	532.5	100					
3/8" - #4	1.4	532.5	100					
#4 - #6	0.0	531.1	100					
* #6 - #8	13.1	531.1	-	-			-	-
#8 - #16	101.6	518.0	97					
#16 - #30	171.7	416.4	78					
#30 - #50	192.8	244.7	46					
#50 - #100	46.3	51.9	10					
#100 - #200	4.3	5.6	1					
#200 - Btm	0.3	1.3	0.2					
Loss by Washing	1.0							
Check Total	532.5	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample			
(B) Dry weight of washed sample			
(C) Loss by washing (A-B)			
(D) % Passing #200 (C/A)*100			
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	532.8	
(B) Dry weight of washed sample	531.8	
(C) Loss by washing (A-B)	1.0	
(D) % Passing #200 (C/A)*100	0.2	
Comparison Test Results		

Additional Remarks or Comments

3A21-49

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	9			43			87	89	± 5	84	94	13
3/4"	33	1			43			77	78	± 5	73	83	10
1/2"	20	0			43			63	64	± 5	59	69	14
3/8"	11	0			43			54	56	± 5	51	61	9
#4	2	0			43			46	44	± 5	39	49	8
#8					42			42	39	± 4	35	43	4
#16					34			34	34	± 4	30	38	8
#30					20			20	22	± 4	18	26	14
#50					4			4	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	4
#200					0.1			0.1	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained
(#8 through #30)
26

Fine Sand % Retained
(#30 through #200)
34

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	5/7/2020	Aggregate Sources (Pit #):	FA #1: 19129 FA #2:
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	6:32 AM		CA #1: 19129 CA #2: 19129 CA #3:
Lot #:	14	Test #:	27	JMF #:	20-018	**Contractor only** - QA or Verification Test # corresponding to this test:	
						Agency only - QC or Verification Companion Test # corresponding to this test:	

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt. / CA #1 / Mix Prop.	13.4 / 3/4" / 35%		Comparison Test Results	Sample Wt. / CA #2 / Mix Prop.	26.4 / 1-12" / 22%		Comparison Test Results	Sample Wt. / CA #3 / Mix Prop.			Comparison Test Results
Sieve Sizes Pass - Ret.	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass	Weights (lb) Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	13.3	100		0.4	26.4	100					
1 1/2" - 1 1/4"	0.0	13.3	100		4.3	26.0	98					
1 1/4" - 1"	0.0	13.3	100		11.9	21.6	82					
1" - 3/4"	0.9	13.3	100		8.5	9.8	37					
3/4" - 5/8"	0.0	12.4	93		0.0	1.3	5					
* 5/8" - 1/2"	4.9	12.4	-	-	1.2	1.3	-	-			-	-
1/2" - 3/8"	3.3	7.5	56		0.0	0.1	0					
3/8" - 1/4"	0.0	4.2	32		0.0	0.1	0					
* 1/4" - #4	3.4	4.2	-	-	0.0	0.1	-	-			-	-
#4 - Btm	0.8	0.8	6		0.1	0.1	0					
Check Total	13.3	± 0.2 lb of Sample Wt			26.4	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt. / FA #1 / Mix Prop.	533.1 / Sand / 43%		Comparison Test Results	Sample Wt. / FA #2 / Mix Prop.			Comparison Test Results
Sieve Sizes Pass - Ret.	Weights (g) Ind.	Cum.	% Pass	% Pass	Weights (g) Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	534.5	100					
3/8" - #4	0.2	534.5	100					
#4 - #6	0.0	534.3	100					
* #6 - #8	14.2	534.3	-	-			-	-
#8 - #16	103.6	520.1	97					
#16 - #30	171.8	416.5	78					
#30 - #50	192.7	244.7	46					
#50 - #100	46.7	52.0	10					
#100 - #200	4.4	5.3	1					
#200 - Btm	0.4	0.9	0.2					
Loss by Washing	0.5							
Check Total	534.5	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample	2795.5	5223.7	
(B) Dry weight of washed sample	2771.9	5190.6	
(C) Loss by washing (A-B)	23.6	33.1	
(D) % Passing #200 (C/A)*100	0.8	0.6	
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	533.1	
(B) Dry weight of washed sample	532.6	
(C) Loss by washing (A-B)	0.5	
(D) % Passing #200 (C/A)*100	0.1	
Comparison Test Results		

Additional Remarks or Comments

3A41-49

Composite Gradation for Job Mix Formula

Aggregate / Fraction / Mix Prop.	CA #1 / 3/4" / 35%	CA #2 / 1-12" / 22%	CA #3		FA #1 / Sand / 43%	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	8			43			86	89	± 5	84	94	14
3/4"	33	1			43			77	78	± 5	73	83	9
1/2"	20	0			43			63	64	± 5	59	69	14
3/8"	11	0			43			54	56	± 5	51	61	9
#4	2	0			43			45	44	± 5	39	49	9
#8					42			42	39	± 4	35	43	3
#16					34			34	34	± 4	30	38	8
#30					20			20	22	± 4	18	26	14
#50					4			4	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	4
#200	0.3	0.1			0.1			0.5	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained (#8 through #30)

25

Fine Sand % Retained (#30 through #200)

34

Minnesota Department of Transportation

JMF Concrete Aggregate Worksheet

S.P.	2782-327	Plant:	Shafer	Date:	5/7/2020	Aggregate Sources (Pit #):	FA #1: 19129 FA #2: / CA #1: 19129 CA #2: 19129 CA #3:
Engineer:	Jon Erickson	Tester:	Nick Speckman	Time:	1:15 PM	**Contractor only** - QA or Verification Test # corresponding to this test:	
Lot #:	14	Test #:	28	JMF #:	20-018	**Agency only** - QC or Verification Companion Test # corresponding to this test:	

Sieve Analysis of Coarse Aggregate

Aggregate Fraction	Sample Wt.	11.7		Comparison Test Results	Sample Wt.	25.3		Comparison Test Results	Sample Wt.			Comparison Test Results
	CA #1	3/4"			CA #2	1-12"			CA #3			
	Mix Prop.	35%			Mix Prop.	22%			Mix Prop.			
Sieve Sizes	Weights (lb)				Weights (lb)				Weights (lb)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
2" - 1 1/2"	0.0	11.7	100		0.3	25.3	100					
1 1/2" - 1 1/4"	0.0	11.7	100		2.4	25.0	99					
1 1/4" - 1"	0.0	11.7	100		11.8	22.6	89					
1" - 3/4"	0.4	11.7	100		9.9	10.8	43					
3/4" - 5/8"	0.0	11.3	97		0.0	0.9	4					
* 5/8" - 1/2"	4.1	11.3	-	-	0.7	0.9	-	-			-	-
1/2" - 3/8"	3.1	7.2	62		0.1	0.2	1					
3/8" - 1/4"	0.0	4.1	35		0.0	0.1	0					
* 1/4" - #4	3.4	4.1	-	-	0.0	0.1	-	-			-	-
#4 - Btm	0.7	0.7	6		0.1	0.1	0					
Check Total	11.7	± 0.2 lb of Sample Wt			25.3	± 0.2 lb of Sample Wt				± 0.2 lb of Sample Wt		

* Recommended Filler Sieve

Sieve Analysis of Fine Aggregate

Aggregate Fraction	Sample Wt.	536.7		Comparison Test Results	Sample Wt.			Comparison Test Results
	FA #1	Sand			FA #2			
	Mix Prop.	43%			Mix Prop.			
Sieve Sizes	Weights (g)				Weights (g)			
Pass - Ret.	Ind.	Cum.	% Pass	% Pass	Ind.	Cum.	% Pass	% Pass
1/2" - 3/8"	0.0	535.8	100					
3/8" - #4	1.0	535.8	100					
#4 - #6	0.0	534.8	100					
* #6 - #8	13.5	534.8	-	-			-	-
#8 - #16	101.9	521.3	97					
#16 - #30	172.5	419.4	78					
#30 - #50	193.0	246.9	46					
#50 - #100	48.1	53.9	10					
#100 - #200	4.3	5.8	1					
#200 - Btm	0.3	1.5	0.3					
Loss by Washing	1.2							
Check Total	535.8	± 0.3% of Sample Wt				± 0.3% of Sample Wt		

Percent Passing #200 Sieve Test

Coarse Aggregate	CA #1	CA #2	CA #3
(A) Dry weight of original sample			
(B) Dry weight of washed sample			
(C) Loss by washing (A-B)			
(D) % Passing #200 (C/A)*100			
Comparison Test Results			

Fine Aggregate	FA #1	FA #2
(A) Dry weight of original sample	536.7	
(B) Dry weight of washed sample	535.5	
(C) Loss by washing (A-B)	1.2	
(D) % Passing #200 (C/A)*100	0.2	
Comparison Test Results		

Additional Remarks or Comments

3A41-49

Composite Gradation for Job Mix Formula

Aggregate	CA #1	CA #2	CA #3		FA #1	FA #2		Total % Passing	Combined Gradation JMF	Working Range	JMF Working Range		Total % Retained
Fraction	3/4"	1-12"			Sand								
Mix Prop.	35%	22%			43%								
2"	35	22			43			100	100	± 5	95	100	0
1 1/2"	35	22			43			100	100	± 5	95	100	0
1"	35	9			43			87	89	± 5	84	94	13
3/4"	34	1			43			78	78	± 5	73	83	9
1/2"	22	0			43			65	64	± 5	59	69	13
3/8"	12	0			43			55	56	± 5	51	61	10
#4	2	0			43			45	44	± 5	39	49	10
#8					42			42	39	± 4	35	43	3
#16					34			34	34	± 4	30	38	8
#30					20			20	22	± 4	18	26	14
#50					4			4	6	± 3	3	9	16
#100					0			0	0	± 2	0	2	4
#200					0.1			0.1	0.4	± 1.6% max	0.0	1.6	0.0

Coarse Sand % Retained (#8 through #30)

25

Fine Sand % Retained (#30 through #200)

34

B2.2: Aggregates: Moving Average

Minnesota Department of Transportation

JMF Moving Average Summary

Plant: Shafer SP: 2782-327

Test #:							1						2						3					
JMF #:	20-018						20-018						20-018						20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range		Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range		Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range		Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100			100	95	100	100			100	95	100	100			100	95	100	100		**100**	100	95	100
1 1/2"	100			100	95	100	99			100	95	100	100			100	95	100	99		**100**	100	95	100
1"	88			89	84	94	86			89	84	94	89			89	84	94	87		**88**	89	84	94
3/4"	77			78	73	83	76			78	73	83	77			78	73	83	77		**77**	78	73	83
1/2"	62			64	59	69	61			64	59	69	67			64	59	69	67		**64**	64	59	69
3/8"	53			56	51	61	52			56	51	61	58			56	51	61	58		**55**	56	51	61
#4	45			44	39	49	44			44	39	49	47			44	39	49	46		**46**	44	39	49
#8	40			39	35	43	40			39	35	43	40			39	35	43	40		**40**	39	35	43
#16	33			34	30	38	33			34	30	38	33			34	30	38	33		**33**	34	30	38
#30	22			22	18	26	22			22	18	26	22			22	18	26	22		**22**	22	18	26
#50	6			6	3	9	6			6	3	9	6			6	3	9	6		**6**	6	3	9
#100	1			0	0	2	1			0	0	2	0			0	0	2	1		**1**	0	0	2
#200	0.4			0	0.0	1.6	0.7			0	0.0	1.6	0.2			0	0.0	1.6	0.6		**0.5**	0	0.0	1.6
Remarks or Comments																								

Minnesota Department of Transportation

JMF Moving Average Summary

Plant: Shafer

SP: 2782-327

Test #:	4					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	100		**100**	100	95	100
1"	88		**88**	89	84	94
3/4"	77		**77**	78	73	83
1/2"	63		**65**	64	59	69
3/8"	53		**55**	56	51	61
#4	45		**46**	44	39	49
#8	40		**40**	39	35	43
#16	33		**33**	34	30	38
#30	22		**22**	22	18	26
#50	6		**6**	6	3	9
#100	1		**1**	0	0	2
#200	0.3		**0.5**	0	0.0	1.6
Remarks or Comments						

Test #:	5					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	100		**100**	100	95	100
1"	85		**87**	89	84	94
3/4"	75		**77**	78	73	83
1/2"	60		**64**	64	59	69
3/8"	51		**55**	56	51	61
#4	44		**46**	44	39	49
#8	40		**40**	39	35	43
#16	33		**33**	34	30	38
#30	21		**22**	22	18	26
#50	6		**6**	6	3	9
#100	0		**1**	0	0	2
#200	0.4		**0.4**	0	0.0	1.6
Remarks or Comments						

Test #:	6					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	100		**100**	100	95	100
1"	89		**87**	89	84	94
3/4"	74		**76**	78	73	83
1/2"	58		**62**	64	59	69
3/8"	50		**53**	56	51	61
#4	44		**45**	44	39	49
#8	40		**40**	39	35	43
#16	34		**33**	34	30	38
#30	22		**22**	22	18	26
#50	6		**6**	6	3	9
#100	0		**1**	0	0	2
#200	0.2		**0.4**	0	0.0	1.6
Remarks or Comments						

Test #:	7					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	100		**100**	100	95	100
1"	89		**88**	89	84	94
3/4"	76		**76**	78	73	83
1/2"	60		**60**	64	59	69
3/8"	51		**51**	56	51	61
#4	44		**44**	44	39	49
#8	40		**40**	39	35	43
#16	34		**34**	34	30	38
#30	22		**22**	22	18	26
#50	6		**6**	6	3	9
#100	0		**0**	0	0	2
#200	0.4		**0.3**	0	0.0	1.6
Remarks or Comments						

Minnesota Department of Transportation

JMF Moving Average Summary

Plant: Shafer SP: 2782-327

Test #:	8						9						10						11					
JMF #:	20-018						20-018						20-018						20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range		Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range		Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range		Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100	100		**100**	100	95	100	100		**100**	100	95	100	100		**100**	100	95	100
1 1/2"	100		**100**	100	95	100	100		**100**	100	95	100	100		**100**	100	95	100	99		**100**	100	95	100
1"	87		**88**	89	84	94	88		**88**	89	84	94	88		**88**	89	84	94	87		**88**	89	84	94
3/4"	76		**75**	78	73	83	77		**76**	78	73	83	76		**76**	78	73	83	77		**77**	78	73	83
1/2"	61		**60**	64	59	69	59		**60**	64	59	69	61		**60**	64	59	69	61		**61**	64	59	69
3/8"	51		**51**	56	51	61	51		**51**	56	51	61	52		**51**	56	51	61	52		**52**	56	51	61
#4	45		**44**	44	39	49	44		**44**	44	39	49	44		**44**	44	39	49	44		**44**	44	39	49
#8	40		**40**	39	35	43	40		**40**	39	35	43	40		**40**	39	35	43	40		**40**	39	35	43
#16	34		**34**	34	30	38	33		**34**	34	30	38	33		**34**	34	30	38	33		**33**	34	30	38
#30	22		**22**	22	18	26	22		**22**	22	18	26	22		**22**	22	18	26	22		**22**	22	18	26
#50	6		**6**	6	3	9	6		**6**	6	3	9	6		**6**	6	3	9	6		**6**	6	3	9
#100	0		**0**	0	0	2	1		**0**	0	0	2	1		**1**	0	0	2	0		**1**	0	0	2
#200	0.3		**0.3**	0	0.0	1.6	0.6		**0.4**	0	0.0	1.6	0.2		**0.4**	0	0.0	1.6	0.6		**0.4**	0	0.0	1.6
Remarks or Comments																								

(6/4/2019)

Minnesota Department of Transportation

JMF Moving Average Summary

Plant: Shafer

SP: 2782-327

Test #:	12					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	99		**100**	100	95	100
1"	89		**88**	89	84	94
3/4"	77		**77**	78	73	83
1/2"	61		**61**	64	59	69
3/8"	51		**52**	56	51	61
#4	45		**44**	44	39	49
#8	41		**40**	39	35	43
#16	34		**33**	34	30	38
#30	21		**22**	22	18	26
#50	5		**6**	6	3	9
#100	0		**1**	0	0	2
#200	0.2		**0.4**	0	0.0	1.6
Remarks or Comments						

Test #:	13					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	100		**100**	100	95	100
1"	89		**88**	89	84	94
3/4"	76		**77**	78	73	83
1/2"	60		**61**	64	59	69
3/8"	51		**52**	56	51	61
#4	44		**44**	44	39	49
#8	42		**41**	39	35	43
#16	34		**34**	34	30	38
#30	21		**22**	22	18	26
#50	5		**6**	6	3	9
#100	0		**0**	0	0	2
#200	0.7		**0.4**	0	0.0	1.6
Remarks or Comments						

Test #:	14					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	100		**100**	100	95	100
1"	90		**89**	89	84	94
3/4"	78		**77**	78	73	83
1/2"	64		**62**	64	59	69
3/8"	54		**52**	56	51	61
#4	46		**45**	44	39	49
#8	42		**41**	39	35	43
#16	34		**34**	34	30	38
#30	20		**21**	22	18	26
#50	4		**5**	6	3	9
#100	0		**0**	0	0	2
#200	0.1		**0.4**	0	0.0	1.6
Remarks or Comments						

Test #:	15					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	100		**100**	100	95	100
1"	89		**89**	89	84	94
3/4"	77		**77**	78	73	83
1/2"	60		**61**	64	59	69
3/8"	51		**52**	56	51	61
#4	45		**45**	44	39	49
#8	41		**42**	39	35	43
#16	34		**34**	34	30	38
#30	20		**21**	22	18	26
#50	4		**5**	6	3	9
#100	0		**0**	0	0	2
#200	0.4		**0.4**	0	0.0	1.6
Remarks or Comments						

(6/4/2019)

Minnesota Department of Transportation

JMF Moving Average Summary

Plant: Shafer

SP: 2782-327

Test #:	16					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	100		**100**	100	95	100
1"	89		**89**	89	84	94
3/4"	76		**77**	78	73	83
1/2"	60		**61**	64	59	69
3/8"	51		**52**	56	51	61
#4	44		**45**	44	39	49
#8	42		**42**	39	35	43
#16	34		**34**	34	30	38
#30	20		**20**	22	18	26
#50	5		**5**	6	3	9
#100	0		**0**	0	0	2
#200	0.1		**0.3**	0	0.0	1.6
Remarks or Comments						

Test #:	17					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	100		**100**	100	95	100
1"	88		**89**	89	84	94
3/4"	76		**77**	78	73	83
1/2"	63		**62**	64	59	69
3/8"	53		**52**	56	51	61
#4	45		**45**	44	39	49
#8	42		**42**	39	35	43
#16	34		**34**	34	30	38
#30	20		**20**	22	18	26
#50	4		**4**	6	3	9
#100	0		**0**	0	0	2
#200	0.5		**0.3**	0	0.0	1.6
Remarks or Comments						

Test #:	18					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	100		**100**	100	95	100
1"	87		**88**	89	84	94
3/4"	76		**76**	78	73	83
1/2"	60		**61**	64	59	69
3/8"	51		**52**	56	51	61
#4	44		**45**	44	39	49
#8	41		**42**	39	35	43
#16	33		**34**	34	30	38
#30	20		**20**	22	18	26
#50	5		**5**	6	3	9
#100	0		**0**	0	0	2
#200	0.2		**0.3**	0	0.0	1.6
Remarks or Comments						

Test #:	19					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	100		**100**	100	95	100
1"	88		**88**	89	84	94
3/4"	77		**76**	78	73	83
1/2"	63		**62**	64	59	69
3/8"	54		**52**	56	51	61
#4	46		**45**	44	39	49
#8	40		**41**	39	35	43
#16	33		**34**	34	30	38
#30	21		**20**	22	18	26
#50	6		**5**	6	3	9
#100	1		**0**	0	0	2
#200	0.6		**0.4**	0	0.0	1.6
Remarks or Comments						

(6/4/2019)

Minnesota Department of Transportation

JMF Moving Average Summary

Plant: Shafer

SP: 2782-327

Test #:	20					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	100		**100**	100	95	100
1"	89		**88**	89	84	94
3/4"	75		**76**	78	73	83
1/2"	59		**61**	64	59	69
3/8"	51		**52**	56	51	61
#4	44		**45**	44	39	49
#8	40		**41**	39	35	43
#16	33		**33**	34	30	38
#30	22		**21**	22	18	26
#50	6		**5**	6	3	9
#100	1		**1**	0	0	2
#200	0.5		**0.5**	0	0.0	1.6
Remarks or Comments						

Test #:	21					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	100		**100**	100	95	100
1"	88		**88**	89	84	94
3/4"	78		**77**	78	73	83
1/2"	62		**61**	64	59	69
3/8"	53		**52**	56	51	61
#4	44		**45**	44	39	49
#8	42		**41**	39	35	43
#16	34		**33**	34	30	38
#30	21		**21**	22	18	26
#50	5		**6**	6	3	9
#100	0		**1**	0	0	2
#200	0.6		**0.5**	0	0.0	1.6
Remarks or Comments						

Test #:	22					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	99		**100**	100	95	100
1"	87		**88**	89	84	94
3/4"	77		**77**	78	73	83
1/2"	64		**62**	64	59	69
3/8"	55		**53**	56	51	61
#4	45		**45**	44	39	49
#8	42		**41**	39	35	43
#16	34		**34**	34	30	38
#30	20		**21**	22	18	26
#50	4		**5**	6	3	9
#100	0		**1**	0	0	2
#200	0.1		**0.5**	0	0.0	1.6
Remarks or Comments						

Test #:	23					
JMF #:	20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100
1 1/2"	99		**100**	100	95	100
1"	84		**87**	89	84	94
3/4"	77		**77**	78	73	83
1/2"	65		**63**	64	59	69
3/8"	55		**54**	56	51	61
#4	45		**45**	44	39	49
#8	42		**42**	39	35	43
#16	34		**34**	34	30	38
#30	20		**21**	22	18	26
#50	4		**5**	6	3	9
#100	0		**0**	0	0	2
#200	0.5		**0.4**	0	0.0	1.6
Remarks or Comments						

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Minnesota Department of Transportation

JMF Moving Average Summary

Plant: Shafer

SP: 2782-327

Test #:	24						25						26						27					
JMF #:	20-018						20-018						20-018						20-018					
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range		Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range		Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range		Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100	100		**100**	100	95	100	100		**100**	100	95	100	100		**100**	100	95	100
1 1/2"	100		**100**	100	95	100	100		**100**	100	95	100	100		**100**	100	95	100	100		**100**	100	95	100
1"	89		**87**	89	84	94	87		**87**	89	84	94	87		**87**	89	84	94	86		**87**	89	84	94
3/4"	77		**77**	78	73	83	76		**77**	78	73	83	77		**77**	78	73	83	77		**77**	78	73	83
1/2"	59		**63**	64	59	69	60		**62**	64	59	69	63		**62**	64	59	69	63		**61**	64	59	69
3/8"	51		**54**	56	51	61	51		**53**	56	51	61	54		**53**	56	51	61	54		**53**	56	51	61
#4	45		**45**	44	39	49	44		**45**	44	39	49	46		**45**	44	39	49	45		**45**	44	39	49
#8	42		**42**	39	35	43	42		**42**	39	35	43	42		**42**	39	35	43	42		**42**	39	35	43
#16	34		**34**	34	30	38	33		**34**	34	30	38	34		**34**	34	30	38	34		**34**	34	30	38
#30	20		**20**	22	18	26	20		**20**	22	18	26	20		**20**	22	18	26	20		**20**	22	18	26
#50	4		**4**	6	3	9	4		**4**	6	3	9	4		**4**	6	3	9	4		**4**	6	3	9
#100	0		**0**	0	0	2	0		**0**	0	0	2	0		**0**	0	0	2	0		**0**	0	0	2
#200	0.1		**0.3**	0	0.0	1.6	0.4		**0.3**	0	0.0	1.6	0.1		**0.3**	0	0.0	1.6	0.5		**0.3**	0	0.0	1.6
Remarks or Comments																								

Minnesota Department of Transportation

JMF Moving Average Summary

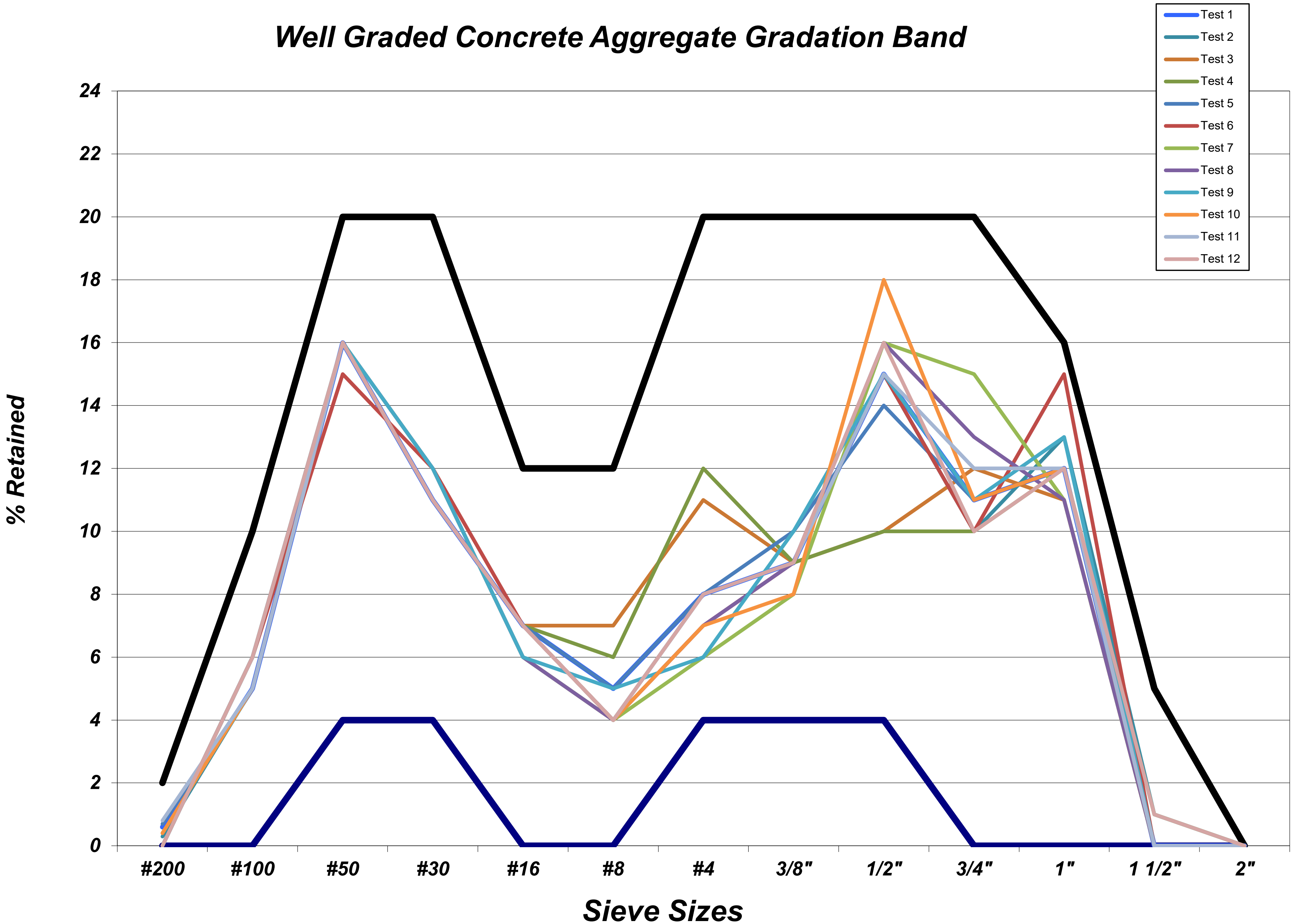
Plant: Shafer

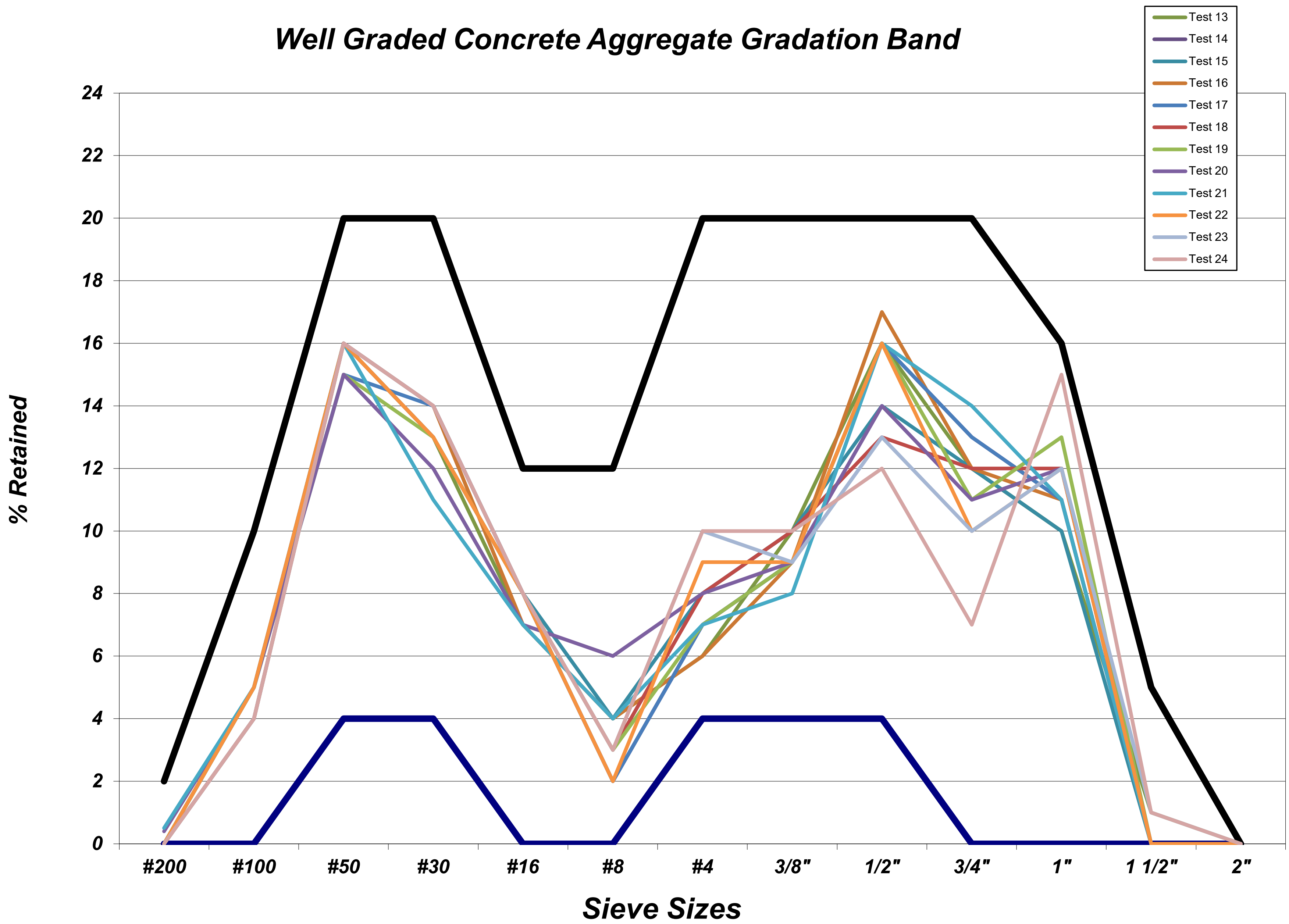
SP: 2782-327

Test #:	28																							
JMF #:	20-018																							
Sieve	Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range		Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range		Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range		Gradation Results	Comparison Test Results	Moving Average	Total % Passing	JMF Working Range	
2"	100		**100**	100	95	100																		
1 1/2"	100		**100**	100	95	100																		
1"	87		**87**	89	84	94																		
3/4"	78		**77**	78	73	83																		
1/2"	65		**63**	64	59	69																		
3/8"	55		**54**	56	51	61																		
#4	45		**45**	44	39	49																		
#8	42		**42**	39	35	43																		
#16	34		**34**	34	30	38																		
#30	20		**20**	22	18	26																		
#50	4		**4**	6	3	9																		
#100	0		**0**	0	0	2																		
#200	0.1		**0.3**	0	0.0	1.6																		
Remarks or Comments																								

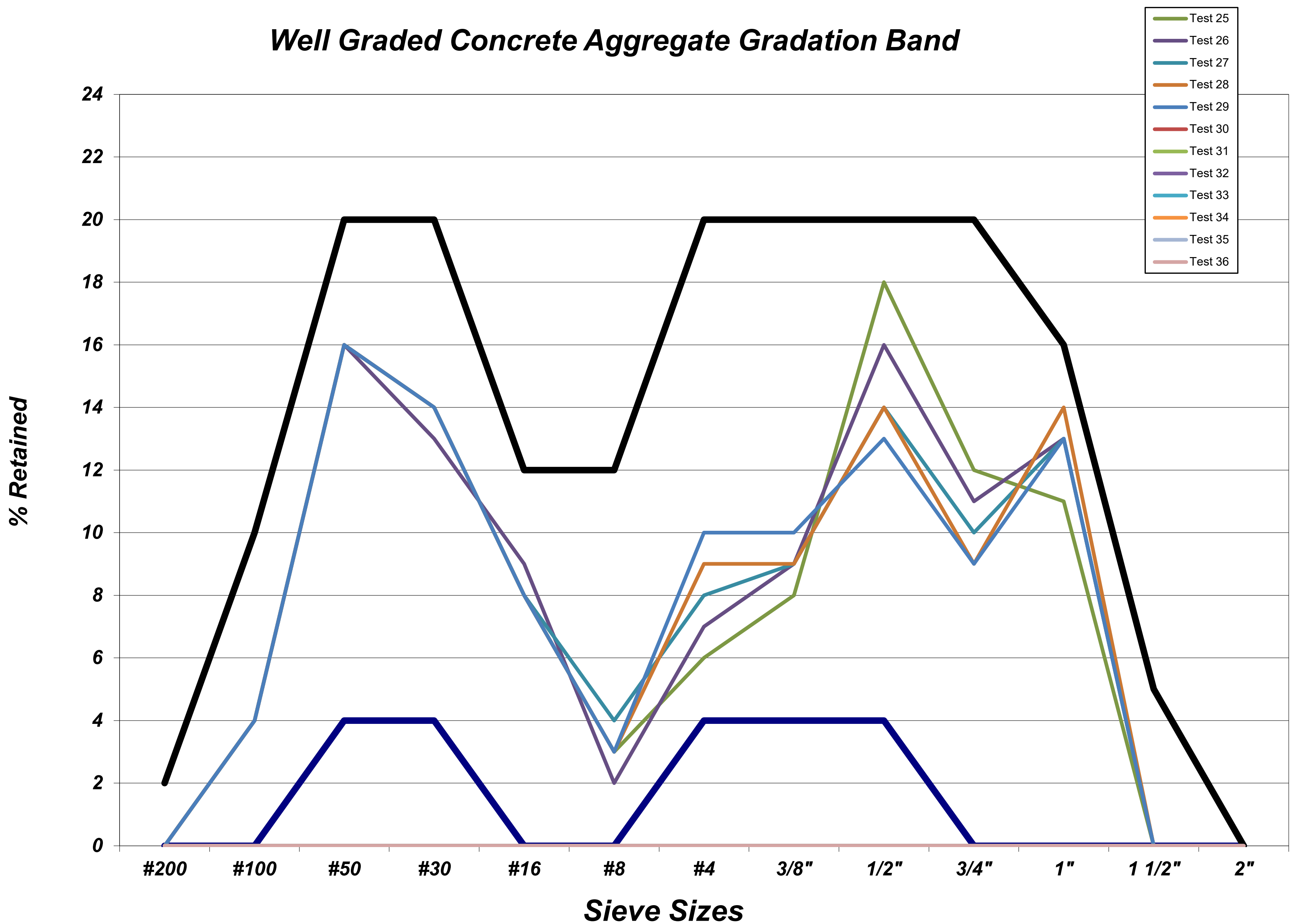
B2.3: Aggregates: QA test reports

B2.4: Aggregates: Tarantula Curves


Well Graded Concrete Aggregate Gradation Band
% Retained
24
22
20
18
16
14
12
10
8
6
4
2
0
#200
#100
#50
#30
#16
#8
#4
3/8"
1/2"
3/4"
1"
1 1/2"
2"
Sieve Sizes
Test 1
Test 2
Test 3
Test 4
Test 5
Test 6
Test 7
Test 8
Test 9
Test 10
Test 11
Test 12



Well Graded Concrete Aggregate Gradation Band
% Retained
0
2
4
6
8
10
12
14
16
18
20
22
24
#200
#100
#50
#30
#16
#8
#4
3/8"
1/2"
3/4"
1"
1 1/2"
2"
Sieve Sizes
Test 13
Test 14
Test 15
Test 16
Test 17
Test 18
Test 19
Test 20
Test 21
Test 22
Test 23
Test 24



Well Graded Concrete Aggregate Gradation Band
% Retained
24
22
20
18
16
14
12
10
8
6
4
2
0
#200
#100
#50
#30
#16
#8
#4
3/8"
1/2"
3/4"
1"
1 1/2"
2"
Sieve Sizes
Test 25
Test 26
Test 27
Test 28
Test 29
Test 30
Test 31
Test 32
Test 33
Test 34
Test 35
Test 36

B2.5: Aggregates: Moisture Content

Aggregates Moisture Content

TEST #		1	2	3	4	5	6	7	8	9
DATE		4/21/20	4/21/20	4/21/20	4/22/20	4/22/20	4/22/20	4/23/20	4/23/20	4/23/20
TIME		8:15 AM	10:55 AM	3:20 PM	7:45 AM	11:00 AM	1:25PM	8:55 AM	2:00 PM	4:45PM
Moisture Content (%)	Sand	3.5	3.3	3.2	3.1	3.2	3.1	2.8	3.2	2.6
	3/4-	1.9	1.8	2.1	1.8	2.6	2.3	2.3	2.0	2.3
	(1 1/2)	1.2	1.6	0.9	1.5	1.1	1.5	1.2	0.8	1.0

TEST #		10	11	12	13	14	15	16	17	18
DATE		4/24/20	4/24/20	4/24/20	4/25/20	4/25/20	4/27/20	4/27/20	4/27/20	4/29/20
TIME		7:50 AM	11:30 AM	3:05 PM	7:55 AM	11:20 AM	8:40 AM	12:40 PM	3:30 AM	8:55 AM
Moisture Content (%)	Sand	2.9	3.0	3.4	3.2	2.6	2.8	3.0	3.4	4.5
	3/4-	2.0	2.3	2.1	2.2	1.9	2.7	1.9	2.0	2.7
	(1 1/2)	1.2	1.3	1.7	1.3	0.9	0.9	0.8	0.8	1.7

TEST #		19	20	21	22	23	24	25	26	27
DATE		4/29/20	4/29/20	4/30/20	4/29/20	5/1/20	5/1/20	5/1/20	5/2/20	5/2/20
TIME		11:35 AM	3:35 PM	9:35 AM	1:45 PM	8:45 AM	11:40 AM	3:35 PM	7:55 AM	10:30 AM
Moisture Content (%)	Sand	4.0	4.0	3.7	3.7	4.0	3.6	3.9	3.8	4.1
	3/4-	2.3	2.3	2.1	2.2	2.3	2.2	2.1	2.2	2.3
	(1 1/2)	1.9	1.8	1.5	1.7	1.5	1.4	1.6	0.9	2.0

TEST #		28	29	30	31	32	33	34	35	36
DATE		5/4/20	5/4/20	5/4/20	4/5/20	5/5/20	5/5/20	5/6/20	5/6/20	5/6/20
TIME		7:42 AM	11:00 AM	3:00 PM	8:45 AM	12:50PM	3:25 PM	7:40 AM	11:15 AM	3:20 PM
Moisture Content (%)	Sand	3.5	3.2	3.2	3.7	3.5	3.9	3.5	3.2	3.3
	3/4-	2.2	2.2	2.3	1.6	2.1	2.0	1.8	1.6	1.9
	(1 1/2)	0.9	1.0	0.9	0.9	0.8	0.8	0.8	0.7	1.2

B3.1: Concrete: Water/ Cementitious Ratio

W/C ratios

TEST #	1	2	3	4	5	6	7	8
DATE	4/21/2020	4/21/2020	4/21/2020	4/22/2020	4/22/2020	4/22/2020	4/23/2020	4/23/2020
TIME	8:15 AM	10:55 AM	3:20 PM	7:45 AM	11:00 AM	1:25PM	8:55 AM	2:00 PM
Calculated average w/cm	0.36	0.35	0.35	0.35	0.35	0.36	0.32	0.30
Measured w/cm (microwave test)	0.32	0.34			0.35		0.32	

TEST #	9	10	11	12	13	14	15	16
DATE	4/23/2020	4/24/2020	4/24/2020	4/24/2020	4/25/2020	4/25/2020	4/27/2020	4/27/2020
TIME	4:45PM	7:50 AM	11:30 AM	3:05 PM	7:55 AM	11:20 AM	8:40 AM	12:40 PM
Calculated average w/cm	0.29	0.36	0.35	0.35	0.36	0.35	0.34	0.33
Measured w/cm (microwave test)		0.33	0.35		0.34		0.36	

TEST #	17	18	19	20	21	22	23	24
DATE	4/27/2020	4/29/2020	4/29/2020	4/29/2020	4/30/2020	4/29/2020	5/1/2020	5/1/2020
TIME	3:30 AM	8:55 AM	11:35 AM	3:35 PM	9:35 AM	1:45 PM	8:45 AM	11:40 AM
Calculated average w/cm	0.35	0.33	0.34	0.36	0.3	0.31	0.36	0.37
Measured w/cm (microwave test)		0.33	0.37		0.31		0.36	

TEST #	25	26	27	28	29	30	31	32
DATE	5/1/2020	5/2/2020	5/2/2020	5/4/2020	5/4/2020	5/4/2020	4/5/2020	5/5/2020
TIME	3:35 PM	7:55 AM	10:30 AM	7:42 AM	11:00 AM	3:00 PM	8:45 AM	12:50PM
Calculated average w/cm	0.38	0.35	0.36	0.35	0.36	0.37	0.35	0.36
Measured w/cm (microwave test)		0.36	0.34	0.34			0.36	0.36

TEST #	33	34	35	36	37
DATE	5/5/2020	5/6/2020	5/6/2020	5/6/2020	5/7/2020
TIME	3:25 PM	7:40 AM	11:15 AM	3:20 PM	7:50 AM
Calculated average w/cm	0.37	0.36	0.37	0.39	0.35
Measured w/cm (microwave test)		0.37			0.33

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Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/21/2020
TIME	8:15 AM
TICKET #	25
LOT #	1
TEST #	1
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)

SLAG, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	742		3048	3054.6				
WT OF SAMPLE + PAN (DRY), (g)	722.6		2998	3021.5				
WT OF PAN, (g)	174.9		379.7	249.3				
TOTAL MOISTURE FACTOR	0.035		0.019	0.012				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.030		0.007	0.000				
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679				
TOTAL MOISTURE, (lb/cy)	46		21	8		=	75	(C)
FREE MOISTURE, (lb/cy)	40		8	0		=	48	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		=	27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
21	145	9	3185	1365
22	145	0	3185	1360
23	145	9	3195	1355
24	144	5	3205	1380
25	146	2	3190	1350
26	146	7	3185	1380
27	145	7	3175	1350
28	146	11	3170	1350
29	143	10	3190	1355
30	144	4	3180	1360
AVE.	144.9	6.4	3186	1360.5
		AVE. CM	4546.5	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 151.3 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 157.5 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 172.2 (H)

TOTAL MIX WATER USED, (lb/cy) 205.5 (I)
(D + G)

W/C RATIO 0.36 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 233.2 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 43.9 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.2 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 144.8 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1377.7 g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3189.6 g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 3083.9 g

TOTAL MEASURED WATER CONTENT, **WT_M** 228.1 lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.72 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** 200.4 lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** 743.1 g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** 963.1 g
(WD - WR4) - WS

% PASSING #4, **P4** 56.4 %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** 52.7 %

$$\frac{[((\sum \text{Agg. Design WT.}) \times (\text{P4JMF}/100)) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** 0.92
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** 209.9 lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** 182.2 lb/cy
AWT_M - WT_A

ADJUSTED W/C RATIO 0.32
((AMW) / (AVE CM / A)) COMPARE TO (J)

(6/18/2019)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/21/2020
TIME	10:55 AM
TICKET #	112
LOT #	2
TEST #	2
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)

SLAG, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL
FRACTION	Sand		3/4-	1 1/2		
WT OF SAMPLE + PAN (WET), (g)	785.3		3064.9	3102.5		
WT OF SAMPLE + PAN (DRY), (g)	766		3016.6	3058.7		
WT OF PAN, (g)	174.6		379.3	248.7		
TOTAL MOISTURE FACTOR	0.033		0.018	0.016		
ABSORPTION FACTOR	0.005		0.012	0.012		
FREE MOISTURE FACTOR	0.028		0.006	0.004		
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679		
TOTAL MOISTURE, (lb/cy)	44		19	11		= 74 (C)
FREE MOISTURE, (lb/cy)	37		6	3		= 46 (D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		= 27.72 (E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
108	145	8	3195	1375
109	145	5	3235	1360
110	145	0	3220	1370
111	145	4	3235	1380
112	145	0	3195	1365
113	145	0	3175	1365
114	145	0	3200	1380
115	145	0	3215	1360
116	145	1	3170	1350
117	145	0	3175	1365
AVE.	145.0	1.8	3201.5	1367
	AVE. CM	4568.5		

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 146.8 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 152.9 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 175.2 (H)

TOTAL MIX WATER USED, (lb/cy) 198.9 (I)
(D + G)

W/C RATIO 0.35 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 226.6 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 43.9 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.2 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 144.8 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1376.1 g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3214.7 g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 3105 g

TOTAL MEASURED WATER CONTENT, **WT_M** 233.3 lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.72 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** 205.6 lb/cy
$WT_M - WT_A$

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** 786.6 g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** 942.3 g
(WD - WR4) - WS

% PASSING #4, **P4** 54.5 %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** 52.8 %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** 0.96
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** 224 lb/cy
WT_M X CF — COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** 196.3 lb/cy
AWT_M - E

ADJUSTED W/C RATIO 0.34
((AMW) / (AVE CM / A)) — COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/21/2020
TIME	3:20 PM
TICKET #	248
LOT #	2
TEST #	3
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170

SLAG, (lb/cy)

DESIGN W/C 0.39

TOTAL CEMENTITIOUS, (lb/cy) = 570 (B)

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	777.8		2948.3	3057.6				
WT OF SAMPLE + PAN (DRY), (g)	759		2894.5	3031.4				
WT OF PAN, (g)	174.8		379.6	249.3				
TOTAL MOISTURE FACTOR	0.032		0.021	0.009				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.027		0.009	-0.003				
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679				
TOTAL MOISTURE, (lb/cy)	42		23	6		=	71	(C)
FREE MOISTURE, (lb/cy)	36		10	-2		=	44	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		=	27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
244	144	5	3210	1360
245	144	0	3220	1350
246	144	0	3210	1365
247	143	4	3225	1350
248	143	7	3215	1350
249	143	4	3185	1370
250	144	4	3225	1370
251	144	4	3200	1365
252	144	6	3215	1350
253	144	10	3215	1350
AVE.	143.7	4.4	3212	1358
		AVE. CM	4570	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 148.1 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 154.2 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 177.2 (H)

TOTAL MIX WATER USED, (lb/cy) 198.2 (I)
(D + G)

W/C RATIO 0.35 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 225.9 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 43.9 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.2 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 144.8 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ____ g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ____ g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ____ g

TOTAL MEASURED WATER CONTENT, **WT_M** ____ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ____ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ____ lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ____ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ____ g
(WD - WR4) - WS

% PASSING #4, **P4** ____ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ____ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** ____
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ____ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ____ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ____
((AMW) / (AVE CM / A)) COMPARE TO (J)

(6/18/2019)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/22/2020
TIME	7:45 AM
TICKET #	30
LOT #	2
TEST #	4
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170

SLAG, (lb/cy)

TOTAL CEMENTITIOUS, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	781.6		3023.5	2987.2				
WT OF SAMPLE + PAN (DRY), (g)	763.4		2976.8	2947.9				
WT OF PAN, (g)	174.6		379.7	249				
TOTAL MOISTURE FACTOR	0.031		0.018	0.015				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.026		0.006	0.003				
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679				
TOTAL MOISTURE, (lb/cy)	41		19	10		=	70	(C)
FREE MOISTURE, (lb/cy)	34		6	2		=	42	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		=	27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
26	146	6	3210	1360
27	146	8	3220	1355
28	146	12	3215	1360
29	146	4	3230	1350
30	147	0	3220	1385
31	147	4	3210	1360
32	147	7	3215	1360
33	147	4	3200	1385
34	147	0	3210	1380
35	147	1	3210	1380
AVE.	146.6	4.6	3214	1367.5
		AVE. CM	4581.5	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 151.2 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 157.4 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 179.7 (H)

TOTAL MIX WATER USED, (lb/cy) 199.4 (I)
(D + G)

W/C RATIO 0.35 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 227.1 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** ______ lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** ______ lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** ______ lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1375.6 g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3096.8 g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 2998.6 g

TOTAL MEASURED WATER CONTENT, **WT_M** #VALUE! lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.72 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** #VALUE! lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ______ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ______ g
(WD - WR4) - WS

% PASSING #4, **P4** ______ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ______ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** ______
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ______ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ______ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ______
((AMW) / (AVE CM / A)) COMPARE TO (J)

(6/18/2019)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/22/2020
TIME	11:00 AM
TICKET #	143
LOT #	2
TEST #	5
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)

SLAG, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	779.8		3044	3008.4				
WT OF SAMPLE + PAN (DRY), (g)	760.9		2977.4	2978.3				
WT OF PAN, (g)	174.8		379.7	249.3				
TOTAL MOISTURE FACTOR	0.032		0.026	0.011				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.027		0.014	-0.001				
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679				
TOTAL MOISTURE, (lb/cy)	42		28	7		=	77	(C)
FREE MOISTURE, (lb/cy)	36		15	-1		=	50	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		=	27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
139	144	3	3175	1365
140	144	0	3195	1355
141	144	0	3170	1365
142	142	0	3225	1360
143	139	3	3215	1365
144	140	4	3230	1350
145	140	3	3220	1370
146	140	0	3200	1355
147	140	6	3210	1365
148	140	3	3230	1360
AVE.	141.3	2.2	3207	1361
		AVE. CM	4568	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 143.5 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 149.4 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 171.3 (H)

TOTAL MIX WATER USED, (lb/cy) 199.4 (I)
(D + G)

W/C RATIO 0.35 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 227.1 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 44.3 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.6 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 146.4 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1375.8 g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3155.2 g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 3053 g

TOTAL MEASURED WATER CONTENT, **WT_M** 227.0 lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.72 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** 199.3 lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** 784.9 g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** 892.3 g
(WD - WR4) - WS

% PASSING #4, **P4** 53.2 %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** 52.8 %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** 0.99
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** 224.7 lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** 197 lb/cy
AWT_M - E

ADJUSTED W/C RATIO 0.35
((AMW) / (AVE CM / A)) COMPARE TO (J)

(6/18/2019)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/22/2020
TIME	1:25PM
TICKET #	217
LOT #	2
TEST #	6
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170

SLAG, (lb/cy)

TOTAL CEMENTITIOUS, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL	
FRACTION	Sand		3/4-	1 1/2			
WT OF SAMPLE + PAN (WET), (g)	735.7		3032.5	2976.3			
WT OF SAMPLE + PAN (DRY), (g)	719		2973.1	2936.2			
WT OF PAN, (g)	174.8		379.8	249.2			
TOTAL MOISTURE FACTOR	0.031		0.023	0.015			
ABSORPTION FACTOR	0.005		0.012	0.012			
FREE MOISTURE FACTOR	0.026		0.011	0.003			
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679			
TOTAL MOISTURE, (lb/cy)	41		25	10		= 76	(C)
FREE MOISTURE, (lb/cy)	34		12	2		= 48	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		= 27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
213	142	1	3205	1375
214	142	2	3170	1355
215	142	4	3195	1360
216	142	6	3210	1365
217	142	6	3210	1365
218	142	3	3200	1375
219	142	5	3195	1365
220	142	6	3200	1360
221	142	15	3210	1355
222	142	26	3230	1390
AVE.	142.0	7.4	3202.5	1366.5
		AVE. CM	4569	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 149.4 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 155.6 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 173.3 (H)

TOTAL MIX WATER USED, (lb/cy) 203.6 (I)
(D + G)

W/C RATIO 0.36 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 231.3 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 44.3 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.6 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 146.4 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ____ g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ____ g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ____ g

TOTAL MEASURED WATER CONTENT, **WT_M** ____ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ____ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ____ lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ____ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ____ g
(WD - WR4) - WS

% PASSING #4, **P4** ____ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ____ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** ____
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ____ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ____ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ____
((AMW) / (AVE CM / A)) COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/23/2020
TIME	8:55 AM
TICKET #	11
LOT #	3
TEST #	7
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-52COL BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 220
CEMENT, (lb/cy) 400
FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)
SLAG, (lb/cy) = 570 (B)
DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	757.6		2951.9	3003.9				
WT OF SAMPLE + PAN (DRY), (g)	741.9		2894.7	2970.4				
WT OF PAN, (g)	174.8		379.9	249.2				
TOTAL MOISTURE FACTOR	0.028		0.023	0.012				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.023		0.011	0.000				
DESIGN WT (OVEN DRY), (lb/cy)	1324		1082	680				
TOTAL MOISTURE, (lb/cy)	37		25	8		=	70	(C)
FREE MOISTURE, (lb/cy)	30		12	0		=	42	(D)
ABSORBED MOISTURE, (lb/cy)	6.62		12.98	8.16		=	27.76	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
7	116	7	3195	1360
8	116	6	3185	1360
9	124	15	3210	1355
10	134	0	3215	1360
11	136	10	3220	1355
12	136	9	3180	1355
13	136	0	3215	1350
14	132	0	3230	1355
15	132	0	3220	1350
16	128	0	3200	1350
AVE.	129.0	4.7	3207	1355
		AVE. CM	4562	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 133.7 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 139.2 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 178.7 (H)

TOTAL MIX WATER USED, (lb/cy) 181.2 (I)
(D + G)

W/C RATIO 0.32 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 209.0 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3
MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb
MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 43.9 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.2 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 144.8 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1376.9 g
MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3170.8 g
MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 3069.6 g

TOTAL MEASURED WATER CONTENT, **WT_M** 220.6 lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.76 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** 192.8 lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** 771.6 g
MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** 921.1 g
(WD - WR4) - WS
% PASSING #4, **P4** 54.4 %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %
% PASSING #4 FROM TOTAL MIX, **P4TM** 52.7 %

$$\frac{[((\sum \text{Agg. Design WT.}) \times P4JMF) + (\text{AVE CM} / A)]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / A)]} \times 100$$

CORRECTION FACTOR, **CF** 0.96
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** 211.8 lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** 184 lb/cy
AWT_M - E

ADJUSTED W/C RATIO 0.32
((AMW) / (AVE CM / A)) COMPARE TO (J)

(6/18/2019)

DOT

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/23/2020
TIME	2:00 PM
TICKET #	44
LOT #	3
TEST #	8
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-52COL BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 220

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)

SLAG, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	751		3016.1	3048.7				
WT OF SAMPLE + PAN (DRY), (g)	733.4		2963.2	3026.6				
WT OF PAN, (g)	174.7		379.8	249.1				
TOTAL MOISTURE FACTOR	0.032		0.02	0.008				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.027		0.008	-0.004				
DESIGN WT (OVEN DRY), (lb/cy)	1324		1082	680				
TOTAL MOISTURE, (lb/cy)	42		22	5		=	69	(C)
FREE MOISTURE, (lb/cy)	36		9	-3		=	42	(D)
ABSORBED MOISTURE, (lb/cy)	6.62		12.98	8.16		=	27.76	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
40	107	9	3195	1350
41	105	13	3180	1355
42	111	12	3200	1355
43	119	12	3205	1365
44	126	4	3205	1360
45	126	7	3215	1355
46	129	0	3200	1355
47	119	4	3225	1360
48	123	7	3215	1365
49	123	5	3210	1360
AVE.	118.8	7.3	3205	1358
		AVE. CM	4563	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 126.1 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 131.3 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 178.8 (H)

TOTAL MIX WATER USED, (lb/cy) 173.3 (I)
(D + G)

W/C RATIO 0.30 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 201.1 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 43.9 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.2 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 144.8 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ____ g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ____ g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ____ g

TOTAL MEASURED WATER CONTENT, **WT_M** ____ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ____ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ____ lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ____ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ____ g
(WD - WR4) - WS

% PASSING #4, **P4** ____ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ____ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** ____
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ____ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ____ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ____
((AMW) / (AVE CM / A)) COMPARE TO (J)

(6/18/2019)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/23/2020
TIME	4:45PM
TICKET #	61
LOT #	3
TEST #	9
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-52COL BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 220

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170

SLAG, (lb/cy)

TOTAL CEMENTITIOUS, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	782.6		3036.2	2990				
WT OF SAMPLE + PAN (DRY), (g)	767.1		2976.2	2962.2				
WT OF PAN, (g)	174.7		379.8	249.3				
TOTAL MOISTURE FACTOR	0.026		0.023	0.01				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.021		0.011	-0.002				
DESIGN WT (OVEN DRY), (lb/cy)	1324		1082	680				
TOTAL MOISTURE, (lb/cy)	34		25	7		=	66	(C)
FREE MOISTURE, (lb/cy)	28		12	-1		=	39	(D)
ABSORBED MOISTURE, (lb/cy)	6.62		12.98	8.16		=	27.76	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
57	124	1	3215	1350
58	124	0	3185	1380
59	124	0	3195	1370
60	124	6	3225	1360
61	124	0	3215	1355
62	116	11	3195	1355
63	120	0	3205	1355
64	112	11	3210	1355
65	112	0	3180	1355
66	112	17	3205	1350
AVE.	119.2	4.6	3203	1358.5

AVE. CM 4561.5

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 123.8 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 128.9 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 181.6 (H)

TOTAL MIX WATER USED, (lb/cy) 167.9 (I)
(D + G)

W/C RATIO 0.29 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 195.7 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 43.9 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.2 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 144.8 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ______ g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ______ g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ______ g

TOTAL MEASURED WATER CONTENT, **WT_M** ______ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ______ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ______ lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ______ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ______ g
(WD - WR4) - WS

% PASSING #4, **P4** ______ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ______ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** ______
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ______ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ______ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ______
((AMW) / (AVE CM / A)) COMPARE TO (J)

(6/18/2019)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/24/2020
TIME	7:50 AM
TICKET #	14
LOT #	4
TEST #	10
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)

SLAG, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL	
FRACTION	Sand		3/4-	1 1/2			
WT OF SAMPLE + PAN (WET), (g)	778.2		3001.9	2957.1			
WT OF SAMPLE + PAN (DRY), (g)	761.4		2951.7	2925.8			
WT OF PAN, (g)	174.8		379.9	249.2			
TOTAL MOISTURE FACTOR	0.029		0.02	0.012			
ABSORPTION FACTOR	0.005		0.012	0.012			
FREE MOISTURE FACTOR	0.024		0.008	0.000			
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679			
TOTAL MOISTURE, (lb/cy)	38		22	8		= 68	(C)
FREE MOISTURE, (lb/cy)	32		9	0		= 41	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		= 27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
10	154	0	3215	1350
11	154	0	3215	1355
12	152	0	3195	1360
13	152	0	3190	1355
14	156	14	3230	1360
15	156	30	3200	1365
16	153	0	3200	1360
17	150	10	3210	1350
18	151	6	3215	1365
19	151	10	3210	1380
AVE.	152.9	7.0	3208	1360

AVE. CM 4568

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 159.9 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 166.5 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 180.0 (H)

TOTAL MIX WATER USED, (lb/cy) 207.5 (I)
(D + G)

W/C RATIO 0.36 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 235.2 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 44.2 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.5 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 146.0 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1378 g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3356.4 g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 3241.9 g

TOTAL MEASURED WATER CONTENT, **WT_M** 228.1 lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.72 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** 200.4 lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** 829.6 g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** 1034.3 g
(WD - WR4) - WS

% PASSING #4, **P4** 55.5 %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** 52.8 %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** 0.94
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** 214.4 lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** 186.7 lb/cy
AWT_M - E

ADJUSTED W/C RATIO 0.33
((AMW) / (AVE CM / A)) COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/24/2020
TIME	11:30 AM
TICKET #	74
LOT #	4
TEST #	11
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)

SLAG, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	755.9		3062.2	2946.3				
WT OF SAMPLE + PAN (DRY), (g)	739.1		3001.2	2911.1				
WT OF PAN, (g)	174.8		379.8	249.4				
TOTAL MOISTURE FACTOR	0.03		0.023	0.013				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.025		0.011	0.001				
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679				
TOTAL MOISTURE, (lb/cy)	40		25	9		=	74	(C)
FREE MOISTURE, (lb/cy)	33		12	1		=	46	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		=	27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
70	147	0	3180	1355
71	147	0	3220	1350
72	147	0	3200	1360
73	146	0	3180	1350
74	146	1	3220	1375
75	146	15	3200	1360
76	146	7	3210	1370
77	147	0	3210	1360
78	147	5	3225	1365
79	147	0	3220	1375
AVE.	146.6	2.8	3206.5	1362
		AVE. CM	4568.5	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 149.4 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 155.6 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 175.2 (H)

TOTAL MIX WATER USED, (lb/cy) 201.6 (I)
(D + G)

W/C RATIO 0.35 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 229.3 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 44.2 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.5 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 146.0 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1375 g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3153.4 g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 3046.5 g

TOTAL MEASURED WATER CONTENT, **WT_M** 237.0 lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.72 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** 209.3 lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** 758.3 g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** 913.2 g
(WD - WR4) - WS

% PASSING #4, **P4** 54.6 %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** 52.8 %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / A)]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / A)]} \times 100$$

CORRECTION FACTOR, **CF** 0.96
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** 227.5 lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** 199.8 lb/cy
AWT_M - E

ADJUSTED W/C RATIO 0.35
((AMW) / (AVE CM / A)) COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/24/2020
TIME	3:05 PM
TICKET #	180
LOT #	4
TEST #	12
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170

SLAG, (lb/cy)

TOTAL CEMENTITIOUS, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL	
FRACTION	Sand		3/4-	1 1/2			
WT OF SAMPLE + PAN (WET), (g)	754.3		3052.2	2979.7			
WT OF SAMPLE + PAN (DRY), (g)	735.2		2997.4	2934.9			
WT OF PAN, (g)	174.6		379.7	249.3			
TOTAL MOISTURE FACTOR	0.034		0.021	0.017			
ABSORPTION FACTOR	0.005		0.012	0.012			
FREE MOISTURE FACTOR	0.029		0.009	0.005			
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679			
TOTAL MOISTURE, (lb/cy)	45		23	12		= 80	(C)
FREE MOISTURE, (lb/cy)	38		10	3		= 51	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		= 27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
176	144	0	3225	1360
177	142	0	3215	1360
178	140	6	3220	1360
179	140	0	3200	1360
180	142	1	3210	1350
181	141	3	3220	1365
182	141	2	3200	1365
183	141	5	3220	1355
184	141	0	3215	1360
185	140	2	3175	1365
AVE.	141.2	1.9	3210	1360

AVE. CM 4570

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 143.1 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 149.0 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 170.5 (H)

TOTAL MIX WATER USED, (lb/cy) 200.0 (I)
(D + G)

W/C RATIO 0.35 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 227.7 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 44.2 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.5 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 146.0 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ___ g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ___ g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ___ g

TOTAL MEASURED WATER CONTENT, **WT_M** ___ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ___ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ___ lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ___ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ___ g
(WD - WR4) - WS

% PASSING #4, **P4** ___ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ___ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** ___
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ___ lb/cy
WT_M X CF — COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ___ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ___
((AMW) / (AVE CM / A)) — COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/25/2020
TIME	7:55 AM
TICKET #	16
LOT #	5
TEST #	13
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-42 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 218

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 160

SLAG, (lb/cy)

TOTAL CEMENTITIOUS, (lb/cy) = 560 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL	
FRACTION	Sand		3/4-	1 1/2			
WT OF SAMPLE + PAN (WET), (g)	759		2984.5	3007.2			
WT OF SAMPLE + PAN (DRY), (g)	740.7		2929.2	2972.8			
WT OF PAN, (g)	174.8		379.7	249.6			
TOTAL MOISTURE FACTOR	0.032		0.022	0.013			
ABSORPTION FACTOR	0.005		0.012	0.012			
FREE MOISTURE FACTOR	0.027		0.010	0.001			
DESIGN WT (OVEN DRY), (lb/cy)	1330		1087	683			
TOTAL MOISTURE, (lb/cy)	43		24	9		= 76	(C)
FREE MOISTURE, (lb/cy)	36		11	1		= 48	(D)
ABSORBED MOISTURE, (lb/cy)	6.65		13.04	8.20		= 27.89	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
12	146	3	3220	1280
13	146	0	3175	1270
14	146	3	3205	1280
15	146	0	3175	1280
16	146	7	3215	1295
17	146	0	3200	1280
18	146	4	3230	1280
19	146	3	3170	1275
20	146	3	3175	1295
21	146	3	3200	1285
AVE.	146.0	2.6	3196.5	1282
		AVE. CM	4478.5	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 148.6 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 154.7 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 169.0 (H)

TOTAL MIX WATER USED, (lb/cy) 202.7 (I)
(D + G)

W/C RATIO 0.36 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 230.6 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 44.04 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.34 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 145.4 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1373.9 g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3298.3 g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 3184 g

TOTAL MEASURED WATER CONTENT, **WT_M** 233.2 lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.89 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** 205.3 lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** 798.6 g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** 1011.5 g
(WD - WR4) - WS

% PASSING #4, **P4** 55.9 %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** 52.6 %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** 0.93
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** 216.9 lb/cy
WT_M X CF
COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** 189 lb/cy
AWT_M - E

ADJUSTED W/C RATIO 0.34
((AMW) / (AVE CM / A))
COMPARE TO (J)

(6/18/2019)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/25/2020
TIME	11:20 AM
TICKET #	41
LOT #	5
TEST #	14
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-42 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 218

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 160 TOTAL CEMENTITIOUS, (lb/cy)

SLAG, (lb/cy) = 560 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	752.3		3004.7	3042.9				
WT OF SAMPLE + PAN (DRY), (g)	737.6		2955.3	3017.1				
WT OF PAN, (g)	174.7		379.8	249.3				
TOTAL MOISTURE FACTOR	0.026		0.019	0.009				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.021		0.007	-0.003				
DESIGN WT (OVEN DRY), (lb/cy)	1330		1087	683				
TOTAL MOISTURE, (lb/cy)	35		21	6		=	62	(C)
FREE MOISTURE, (lb/cy)	28		8	-2		=	34	(D)
ABSORBED MOISTURE, (lb/cy)	6.65		13.04	8.20		=	27.89	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
37	148	4	3195	1275
38	149	10	3210	1280
39	150	8	3220	1280
40	150	8	3195	1275
41	150	7	3210	1280
42	150	10	3195	1310
43	150	6	3210	1285
44	150	9	3170	1275
45	150	8	3195	1280
46	150	9	3195	1290
AVE.	149.7	7.9	3199.5	1283
		AVE. CM	4482.5	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 157.6 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 164.1 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 182.6 (H)

TOTAL MIX WATER USED, (lb/cy) 198.1 (I)
(D + G)

W/C RATIO 0.35 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 226.0 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 44.04 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.34 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 145.4 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ____ g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ____ g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ____ g

TOTAL MEASURED WATER CONTENT, **WT_M** ____ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ____ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ____ lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ____ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ____ g
(WD - WR4) - WS

% PASSING #4, **P4** ____ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ____ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** ____
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ____ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ____ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ____
((AMW) / (AVE CM / A)) COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/27/2020
TIME	8:40 AM
TICKET #	11
LOT #	6
TEST #	15
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3a21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170

SLAG, (lb/cy)

TOTAL CEMENTITIOUS, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL	
FRACTION	Sand		3/4-	1 1/2			
WT OF SAMPLE + PAN (WET), (g)	1032.3		3316	3860.2			
WT OF SAMPLE + PAN (DRY), (g)	1008.7		3239.7	3827.1			
WT OF PAN, (g)	174.8		379.8	249.2			
TOTAL MOISTURE FACTOR	0.028		0.027	0.009			
ABSORPTION FACTOR	0.005		0.012	0.012			
FREE MOISTURE FACTOR	0.023		0.015	-0.003			
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679			
TOTAL MOISTURE, (lb/cy)	37		29	6		= 72	(C)
FREE MOISTURE, (lb/cy)	30		16	-2		= 44	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		= 27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
7	145	2	3210	1375
8	145	1	3240	1350
9	145	1	3185	1365
10	145	1	3190	1370
11	145	0	3210	1360
12	145	2	3210	1355
13	145	0	3170	1350
14	145	0	3180	1365
15	145	5	3230	1360
16	145	2	3210	1355
AVE.	145.0	1.4	3203.5	1360.5
		AVE. CM	4564	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 146.4 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 152.4 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 176.9 (H)

TOTAL MIX WATER USED, (lb/cy) 196.4 (I)
(D + G)

W/C RATIO 0.34 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 224.1 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL**	0.25	ft^3
MASS OF UNIT WT. BUCKET, **BWT**	7.7	lb
MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT**	44.4	lb
MASS OF CONCRETE, (CBWT - BWT), **CWT**	36.7	lb
UNIT WT. OF CONCRETE, CWT / VOL, **UW**	146.8	lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS**	1373.7	g
MASS OF TRAY, CLOTH & WET CONCRETE, **WF**	3243.3	g
MASS OF PAN, CLOTH & DRY CONCRETE, **WD**	3132.8	g
TOTAL MEASURED WATER CONTENT, **WT_M** (WF - WD / WF - WS) x 27 x UW	234.3	lb/cy
ESTIMATED ABSORBED WATER CONTENT, **WT_A** Sum of Absorbed Moistures (E)	27.72	lb/cy
ESTIMATED MIXING WATER CONTENT, **MW** WT_M - WT_A	206.6	lb/cy

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4**	834.6	g
MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** (WD - WR4) - WS	924.5	g
% PASSING #4, **P4** WP4 / (WD-WS)	52.6	%
% PASSING #4 FROM JMF, **P4JMF**	44.0	%
% PASSING #4 FROM TOTAL MIX, **P4TM** [((∑ Agg. Design WT.) x P4JMF)+ (AVE CM / A)] / [(∑ Agg. Design WT.) + (AVE CM / A)] x 100	52.7	%
CORRECTION FACTOR, **CF** (100 - P4 / 100 - P4TM)	1	
ADJUSTED TOTAL WATER CONTENT, **AWT_M** WT_M X CF	234.3	lb/cy COMPARE TO (K)
ADJUSTED MIXING WATER CONTENT, **AMW** AWT_M - E	206.6	lb/cy
ADJUSTED W/C RATIO ((AMW) / (AVE CM / A))	0.36	COMPARE TO (J)

(6/18/2019)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/27/2020
TIME	12:40 PM
TICKET #	51
LOT #	6
TEST #	16
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3a21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170

SLAG, (lb/cy)

DESIGN W/C 0.39

TOTAL CEMENTITIOUS, (lb/cy) = 570 (B)

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	949.1		3136.1	3654.9				
WT OF SAMPLE + PAN (DRY), (g)	926.6		3085.6	3628.9				
WT OF PAN, (g)	175		380.4	249.3				
TOTAL MOISTURE FACTOR	0.03		0.019	0.008				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.025		0.007	-0.004				
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679				
TOTAL MOISTURE, (lb/cy)	40		21	5		=	66	(C)
FREE MOISTURE, (lb/cy)	33		8	-3		=	38	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		=	27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
47	140	4	3205	1360
48	140	4	3220	1355
49	141	6	3215	1360
50	141	5	3300	1370
51	142	4	3205	1365
52	142	2	3220	1355
53	142	2	3225	1370
54	142	2	3210	1365
55	142	2	3200	1390
56	142	3	3175	1370
AVE.	141.4	3.4	3217.5	1366
		AVE. CM	4583.5	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 144.8 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 150.8 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 183.6 (H)

TOTAL MIX WATER USED, (lb/cy) 188.8 (I)
(D + G)

W/C RATIO 0.33 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 216.5 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** ______ lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** ______ lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** ______ lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ______ g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ______ g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ______ g

TOTAL MEASURED WATER CONTENT, **WT_M** ______ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ______ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ______ lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ______ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ______ g
(WD - WR4) - WS

% PASSING #4, **P4** ______ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ______ %
[((∑ Agg. Design WT.) x P4JMF)+ (AVE CM / A)] / [(∑ Agg. Design WT.) + (AVE CM / A)] x 100

CORRECTION FACTOR, **CF** ______
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ______ lb/cy
WT_M X CF
COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ______ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ______
((AMW) / (AVE CM / A))
COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/27/2020
TIME	3:30 AM
TICKET #	89
LOT #	6
TEST #	17
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3a21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)

SLAG, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	903		3268.7	3342.9				
WT OF SAMPLE + PAN (DRY), (g)	879.3		3212.4	3319.1				
WT OF PAN, (g)	175.1		380.2	349.5				
TOTAL MOISTURE FACTOR	0.034		0.02	0.008				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.029		0.008	-0.004				
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679				
TOTAL MOISTURE, (lb/cy)	45		22	5		=	72	(C)
FREE MOISTURE, (lb/cy)	38		9	-3		=	44	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		=	27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
85	142	3	3185	1360
86	142	8	3230	1355
87	142	6	3230	1365
88	142	6	3210	1350
89	142	9	3230	1355
90	144	5	3200	1350
91	144	3	3180	1350
92	144	6	3205	1355
93	144	9	3210	1355
94	144	4	3180	1375
AVE.	143.0	5.9	3206	1357
		AVE. CM	4563	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 148.9 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 155.0 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 176.9 (H)

TOTAL MIX WATER USED, (lb/cy) 199.0 (I)
(D + G)

W/C RATIO 0.35 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 226.7 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** ______ lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** ______ lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** ______ lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ______ g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ______ g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ______ g

TOTAL MEASURED WATER CONTENT, **WT_M** ______ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ______ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ______ lb/cy
$WT_M - WT_A$

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ______ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ______ g
(WD - WR4) - WS

% PASSING #4, **P4** ______ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ______ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / A)]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / A)]} \times 100$$

CORRECTION FACTOR, **CF** ______
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ______ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ______ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ______
((AMW) / (AVE CM / A)) COMPARE TO (J)

MnDOT

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/29/2020
TIME	8:55 AM
TICKET #	28
LOT #	7
TEST #	18
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170

SLAG, (lb/cy)

TOTAL CEMENTITIOUS, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL	
FRACTION	Sand		3/4-	1 1/2			
WT OF SAMPLE + PAN (WET), (g)	741.4		2960.8	3029.9			
WT OF SAMPLE + PAN (DRY), (g)	717.1		2893.4	2982.8			
WT OF PAN, (g)	175		380.3	249.3			
TOTAL MOISTURE FACTOR	0.045		0.027	0.017			
ABSORPTION FACTOR	0.005		0.012	0.012			
FREE MOISTURE FACTOR	0.040		0.015	0.005			
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679			
TOTAL MOISTURE, (lb/cy)	59		29	12		= 100	(C)
FREE MOISTURE, (lb/cy)	53		16	3		= 72	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		= 27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
24	115	0	3190	1350
25	113	0	3230	1355
26	111	3	3220	1360
27	111	0	3225	1355
28	111	2	3180	1355
29	111	3	3195	1360
30	111	3	3225	1350
31	111	2	3200	1350
32	111	3	3220	1355
33	111	0	3180	1355
AVE.	111.6	1.6	3206.5	1354.5
		AVE. CM	4561	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 113.2 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 117.9 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 149.9 (H)

TOTAL MIX WATER USED, (lb/cy) 189.9 (I)
(D + G)

W/C RATIO 0.33 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 217.6 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 44 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.3 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 145.2 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1374 g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3109.4 g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 3012.8 g

TOTAL MEASURED WATER CONTENT, **WT_M** 218.2 lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.72 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** 190.5 lb/cy
$WT_M - WT_A$

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** 755.2 g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** 883.6 g
(WD - WR4) - WS

% PASSING #4, **P4** 53.9 %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** 52.7 %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** 0.98
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** 213.8 lb/cy
WT_M X CF
COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** 186.1 lb/cy
AWT_M - E

ADJUSTED W/C RATIO 0.33
((AMW) / (AVE CM / A))
COMPARE TO (J)

(6/18/2019)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/29/2020
TIME	11:35 AM
TICKET #	69
LOT #	7
TEST #	19
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)

SLAG, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL	
FRACTION	Sand		3/4-	1 1/2			
WT OF SAMPLE + PAN (WET), (g)	775		2913.4	2951.3			
WT OF SAMPLE + PAN (DRY), (g)	751.7		2857.4	2901.2			
WT OF PAN, (g)	174.8		380.1	249.4			
TOTAL MOISTURE FACTOR	0.04		0.023	0.019			
ABSORPTION FACTOR	0.005		0.012	0.012			
FREE MOISTURE FACTOR	0.035		0.011	0.007			
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679			
TOTAL MOISTURE, (lb/cy)	53		25	13		= 91	(C)
FREE MOISTURE, (lb/cy)	46		12	5		= 63	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		= 27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
65	117	4	3190	1360
66	114	9	3190	1350
67	117	10	3220	1360
68	121	5	3210	1350
69	121	0	3195	1350
70	121	5	3170	1355
71	122	2	3210	1350
72	122	7	3215	1355
73	122	4	3225	1375
74	122	4	3230	1355
AVE.	119.9	5.0	3205.5	1356
		AVE. CM	4561.5	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 124.9 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 130.1 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 158.5 (H)

TOTAL MIX WATER USED, (lb/cy) 193.1 (I)
(D + G)

W/C RATIO 0.34 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 220.8 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 44 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.3 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 145.2 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1374.5 g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3021.3 g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 2922.2 g

TOTAL MEASURED WATER CONTENT, **WT_M** 235.9 lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.72 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** 208.2 lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** 739.4 g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** 808.3 g
(WD - WR4) - WS

% PASSING #4, **P4** 52.2 %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** 52.7 %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / A)]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / A)]} \times 100$$

CORRECTION FACTOR, **CF** 1.01
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** 238.3 lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** 210.6 lb/cy
AWT_M - E

ADJUSTED W/C RATIO 0.37
((AMW) / (AVE CM / A)) COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/29/2020
TIME	3:35 PM
TICKET #	91
LOT #	7
TEST #	20
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)

SLAG, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL	
FRACTION	Sand		3/4-	1 1/2			
WT OF SAMPLE + PAN (WET), (g)	776.9		3052.6	2996.2			
WT OF SAMPLE + PAN (DRY), (g)	753.6		2993.1	2947.5			
WT OF PAN, (g)	174.8		380	249.5			
TOTAL MOISTURE FACTOR	0.04		0.023	0.018			
ABSORPTION FACTOR	0.005		0.012	0.012			
FREE MOISTURE FACTOR	0.035		0.011	0.006			
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679			
TOTAL MOISTURE, (lb/cy)	53		25	12		= 90	(C)
FREE MOISTURE, (lb/cy)	46		12	4		= 62	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		= 27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
87	121	0	3215	1355
88	119	13	3210	1370
89	120	21	3180	1360
90	118	18	3210	1365
91	123	12	3185	1365
92	125	13	3185	1365
93	125	13	3205	1370
94	127	12	3195	1350
95	128	11	3205	1350
96	129	13	3230	1370
AVE.	123.5	12.6	3202	1362

AVE. CM 4564

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 136.1 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 141.7 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 159.6 (H)

TOTAL MIX WATER USED, (lb/cy) 203.7 (I)
(D + G)

W/C RATIO 0.36 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 231.4 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 44 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.3 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 145.2 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ____ g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ____ g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ____ g

TOTAL MEASURED WATER CONTENT, **WT_M** ____ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ____ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ____ lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ____ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ____ g
(WD - WR4) - WS

% PASSING #4, **P4** ____ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ____ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / A)]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / A)]} \times 100$$

CORRECTION FACTOR, **CF** ____
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ____ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ____ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ____
((AMW) / (AVE CM / A)) COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/30/2020
TIME	9:35 AM
TICKET #	9
LOT #	21
TEST #	21
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A41-53COL BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 420

FLY ASH, (lb/cy) 180

SLAG, (lb/cy)

DESIGN W/C 0.37

TOTAL CEMENTITIOUS, (lb/cy) = 600 (B)

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	754.9		3062.2	2969.8				
WT OF SAMPLE + PAN (DRY), (g)	734.4		3008.2	2929.2				
WT OF PAN, (g)	174.8		379.9	249.5				
TOTAL MOISTURE FACTOR	0.037		0.021	0.015				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.032		0.009	0.003				
DESIGN WT (OVEN DRY), (lb/cy)	1310		1070	676				
TOTAL MOISTURE, (lb/cy)	48		22	10		=	80	(C)
FREE MOISTURE, (lb/cy)	42		10	2		=	54	(D)
ABSORBED MOISTURE, (lb/cy)	6.55		12.84	8.11		=	27.50	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
5	104	12	3350	1445
6	105	17	3335	1435
7	105	19	3355	1445
8	110	15	3345	1435
9	110	4	3330	1435
10	111	9	3335	1435
11	113	10	3330	1435
12	114	8	3365	1435
13	116	7	3345	1430
14	116	6	3370	1450
AVE.	110.4	10.7	3346	1438
		AVE. CM	4784	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 121.1 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 126.1 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 177.9 (H)

TOTAL MIX WATER USED, (lb/cy) 180.1 (I)
(D + G)

W/C RATIO 0.30 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 207.6 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 42.9 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 35.2 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 140.8 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1373.8 g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3142.2 g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 3035.6 g

TOTAL MEASURED WATER CONTENT, **WT_M** 229.2 lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.5 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** 201.7 lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** 731.2 g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** 930.6 g
(WD - WR4) - WS

% PASSING #4, **P4** 56.0 %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** 53.2 %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** 0.94
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** 215.4 lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** 187.9 lb/cy
AWT_M - E

ADJUSTED W/C RATIO 0.31
((AMW) / (AVE CM / A)) COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/29/2020
TIME	1:45 PM
TICKET #	19
LOT #	8
TEST #	22
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A41-53COL BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 420

FLY ASH, (lb/cy) 180

SLAG, (lb/cy) ______

TOTAL CEMENTITIOUS, (lb/cy) = 600 (B)

DESIGN W/C 0.37

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL
FRACTION	Sand		3/4-	1 1/2		
WT OF SAMPLE + PAN (WET), (g)	770.7		3061.6	3009.3		
WT OF SAMPLE + PAN (DRY), (g)	749.3		3003.1	2962.6		
WT OF PAN, (g)	174.8		379.9	249.4		
TOTAL MOISTURE FACTOR	0.037		0.022	0.017		
ABSORPTION FACTOR	0.005		0.012	0.012		
FREE MOISTURE FACTOR	0.032		0.010	0.005		
DESIGN WT (OVEN DRY), (lb/cy)	1310		1070	676		
TOTAL MOISTURE, (lb/cy)	48		24	11		= 83 (C)
FREE MOISTURE, (lb/cy)	42		11	3		= 56 (D)
ABSORBED MOISTURE, (lb/cy)	6.55		12.84	8.11		= 27.50 (E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
15	116	6	3365	1440
16	117	1	3360	1430
17	117	5	3350	1430
18	117	5	3355	1430
19	117	6	3330	1430
20	117	7	3380	1430
21	117	4	3335	1440
22	113	6	3375	1450
23	113	23	3380	1435
24	124	15	3360	1430
AVE.	116.8	7.8	3359	1434.5
		AVE. CM	4793.5	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 124.6 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 129.7 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 176.4 (H)

TOTAL MIX WATER USED, (lb/cy) 185.7 (I)
(D + G)

W/C RATIO 0.31 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 213.2 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** ______ lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** ______ lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** ______ lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ______ g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ______ g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ______ g

TOTAL MEASURED WATER CONTENT, **WT_M** ______ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ______ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ______ lb/cy
$WT_M - WT_A$

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ______ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ______ g
(WD - WR4) - WS

% PASSING #4, **P4** ______ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ______ %
[((∑ Agg. Design WT.) x P4JMF)+ (AVE CM / A)] / [(∑ Agg. Design WT.) + (AVE CM / A)] x 100

CORRECTION FACTOR, **CF** ______
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ______ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ______ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ______
((AMW) / (AVE CM / A)) COMPARE TO (J)

(6/18/2019)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	5/1/2020
TIME	8:45 AM
TICKET #	17
LOT #	9
TEST #	23
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)

SLAG, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	768.4		3036.6	3038.2				
WT OF SAMPLE + PAN (DRY), (g)	745.3		2977.6	2997.3				
WT OF PAN, (g)	168.7		380	249.2				
TOTAL MOISTURE FACTOR	0.04		0.023	0.015				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.035		0.011	0.003				
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679				
TOTAL MOISTURE, (lb/cy)	53		25	10		=	88	(C)
FREE MOISTURE, (lb/cy)	46		12	2		=	60	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		=	27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
13	137	5	3210	1360
14	137	3	3220	1365
15	137	5	3205	1380
16	137	4	3230	1375
17	137	2	3210	1350
18	137	5	3195	1350
19	137	0	3215	1355
20	135	0	3210	1355
21	134	2	3185	1350
22	134	0	3185	1355
AVE.	136.2	2.6	3206.5	1359.5
		AVE. CM	4566	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 138.8 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 144.5 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 161.6 (H)

TOTAL MIX WATER USED, (lb/cy) 204.5 (I)
(D + G)

W/C RATIO 0.36 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 232.2 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 43.85 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.15 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 144.6 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1372 g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3105.6 g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 3006.2 g

TOTAL MEASURED WATER CONTENT, **WT_M** 223.9 lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.72 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** 196.2 lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** 802.3 g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** 831.9 g
(WD - WR4) - WS

% PASSING #4, **P4** 50.9 %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** 52.8 %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / A)]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / A)]} \times 100$$

CORRECTION FACTOR, **CF** 1.04
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** 232.9 lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** 205.2 lb/cy
AWT_M - E

ADJUSTED W/C RATIO 0.36
((AMW) / (AVE CM / A)) COMPARE TO (J)

(6/18/2019)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	5/1/2020
TIME	11:40 AM
TICKET #	39
LOT #	9
TEST #	24
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170

SLAG, (lb/cy)

DESIGN W/C 0.39

TOTAL CEMENTITIOUS, (lb/cy) = 570 (B)

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL	
FRACTION	Sand		3/4-	1 1/2			
WT OF SAMPLE + PAN (WET), (g)	769.3		3108.6	3054.6			
WT OF SAMPLE + PAN (DRY), (g)	748.2		3048.6	3016.7			
WT OF PAN, (g)	168.2		379.6	249			
TOTAL MOISTURE FACTOR	0.036		0.022	0.014			
ABSORPTION FACTOR	0.005		0.012	0.012			
FREE MOISTURE FACTOR	0.031		0.010	0.002			
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679			
TOTAL MOISTURE, (lb/cy)	48		24	10		= 82	(C)
FREE MOISTURE, (lb/cy)	41		11	1		= 53	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		= 27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
35	135	9	3220	1360
36	136	4	3180	1355
37	136	8	3210	1370
38	137	4	3210	1365
39	137	10	3205	1350
40	136	14	3180	1360
41	141	15	3170	1365
42	142	16	3230	1375
43	144	16	3210	1360
44	146	9	3180	1360
AVE.	139.0	10.5	3199.5	1362
		AVE. CM	4561.5	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 149.5 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 155.7 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 168.1 (H)

TOTAL MIX WATER USED, (lb/cy) 208.7 (I)
(D + G)

W/C RATIO 0.37 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 236.4 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 43.85 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.15 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 144.6 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ____ g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ____ g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ____ g

TOTAL MEASURED WATER CONTENT, **WT_M** ____ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ____ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ____ lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ____ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ____ g
(WD - WR4) - WS

% PASSING #4, **P4** ____ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ____ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** ____
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ____ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ____ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ____
((AMW) / (AVE CM / A)) COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	5/1/2020
TIME	3:35 PM
TICKET #	60
LOT #	9
TEST #	25
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A41-49 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 234

CEMENT, (lb/cy) 420

FLY ASH, (lb/cy) 180

SLAG, (lb/cy)

TOTAL CEMENTITIOUS, (lb/cy) = 600 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL	
FRACTION	Sand		3/4-	1 1/2			
WT OF SAMPLE + PAN (WET), (g)	740.7		2951.4	3030.7			
WT OF SAMPLE + PAN (DRY), (g)	719.2		2897.7	2986.3			
WT OF PAN, (g)	168.4		379.9	249.1			
TOTAL MOISTURE FACTOR	0.039		0.021	0.016			
ABSORPTION FACTOR	0.005		0.012	0.012			
FREE MOISTURE FACTOR	0.034		0.009	0.004			
DESIGN WT (OVEN DRY), (lb/cy)	1296		1059	666			
TOTAL MOISTURE, (lb/cy)	51		22	11		= 84	(C)
FREE MOISTURE, (lb/cy)	44		10	3		= 57	(D)
ABSORBED MOISTURE, (lb/cy)	6.48		12.71	7.99		= 27.18	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
56	157	6	3350	1435
57	157	7	3380	1440
58	156	10	3345	1445
59	156	8	3360	1435
60	156	7	3385	1445
61	156	10	3380	1440
62	156	12	3345	1450
63	156	8	3385	1440
64	156	16	3385	1455
65	158	13	3375	1440
AVE.	156.4	9.7	3369	1442.5
		AVE. CM	4811.5	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 166.1 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 173.0 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 176.3 (H)

TOTAL MIX WATER USED, (lb/cy) 230.0 (I)
(D + G)

W/C RATIO 0.38 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 257.2 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 43.85 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.15 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 144.6 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ____ g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ____ g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ____ g

TOTAL MEASURED WATER CONTENT, **WT_M** ____ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ____ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ____ lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ____ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ____ g
(WD - WR4) - WS

% PASSING #4, **P4** ____ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ____ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** ____
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ____ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ____ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ____
((AMW) / (AVE CM / A)) COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	5/2/2020
TIME	7:55 AM
TICKET #	30
LOT #	10
TEST #	26
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170

SLAG, (lb/cy)

TOTAL CEMENTITIOUS, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	772.9		3082	3126.5				
WT OF SAMPLE + PAN (DRY), (g)	750.9		3022.9	3101.6				
WT OF PAN, (g)	168.5		379.8	249.2				
TOTAL MOISTURE FACTOR	0.038		0.022	0.009				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.033		0.010	-0.003				
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679				
TOTAL MOISTURE, (lb/cy)	50		24	6		=	80	(C)
FREE MOISTURE, (lb/cy)	44		11	-2		=	53	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		=	27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
26	136	4	3225	1380
27	136	3	3215	1370
28	136	2	3215	1355
29	136	3	3195	1350
30	136	4	3215	1350
31	136	3	3205	1370
32	136	2	3190	1350
33	136	2	3225	1360
34	137	2	3220	1370
35	137	1	3210	1355
AVE.	136.2	2.6	3211.5	1361
		AVE. CM	4572.5	

TOTAL AVERAGE BATCH WATER, (GAL) (AVE. BATCH WATER + AVE. TEMPER WATER)	138.8	(F)
ACTUAL BATCH WATER USED, (lb/cy) ((F x 8.33) / A)	144.5	(G)
MAXIMUM BATCH WATER AVAILABLE, (GAL) (((AVE. CM * 0.40) - D)*A) / 8.33))	168.7	(H)
TOTAL MIX WATER USED, (lb/cy) (D + G)	197.5	(I)
W/C RATIO (I / AVE. CM)	0.35	(J)
TOTAL WATER IN CONCRETE, (lb/cy) (E + I)	225.2	(K)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL**	0.25	ft^3
MASS OF UNIT WT. BUCKET, **BWT**	7.7	lb
MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT**	44.25	lb
MASS OF CONCRETE, (CBWT - BWT), **CWT**	36.55	lb
UNIT WT. OF CONCRETE, CWT / VOL, **UW**	146.2	lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS**	1370	g
MASS OF TRAY, CLOTH & WET CONCRETE, **WF**	3176.5	g
MASS OF PAN, CLOTH & DRY CONCRETE, **WD**	3064	g
TOTAL MEASURED WATER CONTENT, **WT_M** (WF - WD / WF - WS) x 27 x UW	245.8	lb/cy
ESTIMATED ABSORBED WATER CONTENT, **WT_A** Sum of Absorbed Moistures (E)	27.72	lb/cy
ESTIMATED MIXING WATER CONTENT, **MW** $WT_M - WT_A$	218.1	lb/cy

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4**	761.1	g
MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** (WD - WR4) - WS	932.9	g
% PASSING #4, **P4** WP4 / (WD-WS)	55.1	%
% PASSING #4 FROM JMF, **P4JMF**	44.0	%
% PASSING #4 FROM TOTAL MIX, **P4TM**	52.8	%

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** (100 - P4 / 100 - P4TM)	0.95	
ADJUSTED TOTAL WATER CONTENT, **AWT_M** WT_M X CF	233.5	lb/cy COMPARE TO (K)
ADJUSTED MIXING WATER CONTENT, **AMW** AWT_M - E	205.8	lb/cy
ADJUSTED W/C RATIO ((AMW) / (AVE CM / A))	0.36	COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	5/2/2020
TIME	10:30 AM
TICKET #	122
LOT #	10
TEST #	27
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)

SLAG, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL	
FRACTION	Sand		3/4-	1 1/2			
WT OF SAMPLE + PAN (WET), (g)	779.3		3099.3	3077.8			
WT OF SAMPLE + PAN (DRY), (g)	755.1		3039.4	3022.1			
WT OF PAN, (g)	168.6		379.9	249			
TOTAL MOISTURE FACTOR	0.041		0.023	0.02			
ABSORPTION FACTOR	0.005		0.012	0.012			
FREE MOISTURE FACTOR	0.036		0.011	0.008			
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679			
TOTAL MOISTURE, (lb/cy)	54		25	14		= 93	(C)
FREE MOISTURE, (lb/cy)	48		12	5		= 65	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		= 27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
118	128	4	3215	1370
119	128	6	3220	1360
120	128	8	3210	1355
121	128	3	3215	1355
122	128	5	3200	1360
123	128	8	3200	1350
124	128	4	3235	1355
125	130	3	3220	1365
126	130	3	3220	1375
127	130	9	3215	1385
AVE.	128.6	5.3	3215	1363
		AVE. CM	4578	

TOTAL AVERAGE BATCH WATER, (GAL) (AVE. BATCH WATER + AVE. TEMPER WATER)	133.9	(F)
ACTUAL BATCH WATER USED, (lb/cy) ((F x 8.33) / A)	139.4	(G)
MAXIMUM BATCH WATER AVAILABLE, (GAL) (((AVE. CM * 0.40) - D)*A) / 8.33))	157.4	(H)
TOTAL MIX WATER USED, (lb/cy) (D + G)	204.4	(I)
W/C RATIO (I / AVE. CM)	0.36	(J)
TOTAL WATER IN CONCRETE, (lb/cy) (E + I)	232.1	(K)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL**	0.25	ft^3
MASS OF UNIT WT. BUCKET, **BWT**	7.7	lb
MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT**	44.25	lb
MASS OF CONCRETE, (CBWT - BWT), **CWT**	36.55	lb
UNIT WT. OF CONCRETE, CWT / VOL, **UW**	146.2	lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS**	1369.9	g
MASS OF TRAY, CLOTH & WET CONCRETE, **WF**	3189.7	g
MASS OF PAN, CLOTH & DRY CONCRETE, **WD**	3085.2	g
TOTAL MEASURED WATER CONTENT, $\mathbf{WT_M}$ (WF - WD / WF - WS) x 27 x UW	226.7	lb/cy
ESTIMATED ABSORBED WATER CONTENT, $\mathbf{WT_A}$ Sum of Absorbed Moistures (E)	27.72	lb/cy
ESTIMATED MIXING WATER CONTENT, **MW** $WT_M - WT_A$	199	lb/cy

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4**	791.2	g
MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** (WD - WR4) - WS	924.1	g
% PASSING #4, **P4** WP4 / (WD-WS)	53.9	%
% PASSING #4 FROM JMF, **P4JMF**	44.0	%
% PASSING #4 FROM TOTAL MIX, **P4TM** [((∑ Agg. Design WT.) x P4JMF)+ (AVE CM / A)] / [(∑ Agg. Design WT.) + (AVE CM / A)] x 100	52.8	%
CORRECTION FACTOR, **CF** (100 - P4 / 100 - P4TM)	0.98	
ADJUSTED TOTAL WATER CONTENT, $\mathbf{AWT_M}$ WT_M X CF	222.2	lb/cy COMPARE TO (K)
ADJUSTED MIXING WATER CONTENT, **AMW** AWT_M - E	194.5	lb/cy
ADJUSTED W/C RATIO ((AMW) / (AVE CM / A))	0.34	COMPARE TO (J)

DOT

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	5/4/2020
TIME	7:42 AM
TICKET #	7
LOT #	11
TEST #	28
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3a21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)

SLAG, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	1291.4		3100.2	3170.4				
WT OF SAMPLE + PAN (DRY), (g)	1253.5		3042.3	3144.7				
WT OF PAN, (g)	168		380.5	265				
TOTAL MOISTURE FACTOR	0.035		0.022	0.009				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.030		0.010	-0.003				
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679				
TOTAL MOISTURE, (lb/cy)	46		24	6		=	76	(C)
FREE MOISTURE, (lb/cy)	40		11	-2		=	49	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		=	27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
3	139	6	3175	1360
4	139	9	3195	1355
5	142	8	3225	1360
6	144	4	3190	1365
7	145	0	3200	1350
8	144	0	3175	1360
9	144	0	3185	1355
10	143	0	3170	1365
11	143	1	3185	1355
12	143	4	3210	1355
AVE.	142.6	3.2	3191	1358
		AVE. CM	4549	

TOTAL AVERAGE BATCH WATER, (GAL) (AVE. BATCH WATER + AVE. TEMPER WATER)	145.8	(F)
ACTUAL BATCH WATER USED, (lb/cy) ((F x 8.33) / A)	151.8	(G)
MAXIMUM BATCH WATER AVAILABLE, (GAL) (((AVE. CM * 0.40) - D)*A) / 8.33))	171.4	(H)
TOTAL MIX WATER USED, (lb/cy) (D + G)	200.8	(I)
W/C RATIO (I / AVE. CM)	0.35	(J)
TOTAL WATER IN CONCRETE, (lb/cy) (E + I)	228.5	(K)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL**	0.25	ft^3
MASS OF UNIT WT. BUCKET, **BWT**	7.7	lb
MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT**	44	lb
MASS OF CONCRETE, (CBWT - BWT), **CWT**	36.3	lb
UNIT WT. OF CONCRETE, CWT / VOL, **UW**	145.2	lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS**	1369.7	g
MASS OF TRAY, CLOTH & WET CONCRETE, **WF**	3195.6	g
MASS OF PAN, CLOTH & DRY CONCRETE, **WD**	3091.2	g
TOTAL MEASURED WATER CONTENT, **WT_M** (WF - WD / WF - WS) x 27 x UW	224.2	lb/cy
ESTIMATED ABSORBED WATER CONTENT, **WT_A** Sum of Absorbed Moistures (E)	27.72	lb/cy
ESTIMATED MIXING WATER CONTENT, **MW** WT_M - WT_A	196.5	lb/cy

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4**	808.8	g
MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** (WD - WR4) - WS	912.7	g
% PASSING #4, **P4** WP4 / (WD-WS)	53.0	%
% PASSING #4 FROM JMF, **P4JMF**	44.0	%
% PASSING #4 FROM TOTAL MIX, **P4TM** [((∑ Agg. Design WT.) x P4JMF)+ (AVE CM / A)] / [(∑ Agg. Design WT.) + (AVE CM / A)] x 100	52.7	%
CORRECTION FACTOR, **CF** (100 - P4 / 100 - P4TM)	0.99	
ADJUSTED TOTAL WATER CONTENT, **AWT_M** WT_M X CF	222	lb/cy COMPARE TO (K)
ADJUSTED MIXING WATER CONTENT, **AMW** AWT_M - E	194.3	lb/cy
ADJUSTED W/C RATIO ((AMW) / (AVE CM / A))	0.34	COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	5/4/2020
TIME	11:00 AM
TICKET #	22
LOT #	11
TEST #	29
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3a21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222
CEMENT, (lb/cy) 400
FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)
SLAG, (lb/cy) = 570 (B)
DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	973.8		2941.1	3036.1				
WT OF SAMPLE + PAN (DRY), (g)	948.8		2886.4	3009.5				
WT OF PAN, (g)	168.2		380.3	264.9				
TOTAL MOISTURE FACTOR	0.032		0.022	0.01				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.027		0.010	-0.002				
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679				
TOTAL MOISTURE, (lb/cy)	42		24	7		=	73	(C)
FREE MOISTURE, (lb/cy)	36		11	-1		=	46	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		=	27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
18	145	0	3170	1355
19	144	0	3200	1360
20	144	0	3190	1350
21	141	3	3215	1350
22	141	5	3190	1350
23	140	21	3210	1355
24	145	19	3180	1355
25	149	13	3175	1350
26	149	12	3195	1350
27	152	6	3185	1365
AVE.	145.0	7.9	3191	1354
		AVE. CM	4545	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 152.9 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 159.2 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 174.1 (H)

TOTAL MIX WATER USED, (lb/cy) 205.2 (I)
(D + G)

W/C RATIO 0.36 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 232.9 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3
MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb
MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** ____ lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** ____ lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** ____ lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ____ g
MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ____ g
MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ____ g

TOTAL MEASURED WATER CONTENT, **WT_M** ____ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ____ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ____ lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ____ g
MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ____ g
(WD - WR4) - WS
% PASSING #4, **P4** ____ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %
% PASSING #4 FROM TOTAL MIX, **P4TM** ____ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** ____
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ____ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ____ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ____
((AMW) / (AVE CM / A)) COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	5/4/2020
TIME	3:00 PM
TICKET #	47
LOT #	11
TEST #	30
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)

SLAG, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	1127.6		2973.1	3243.8				
WT OF SAMPLE + PAN (DRY), (g)	1098.1		2914.8	3217.1				
WT OF PAN, (g)	168.1		380.3	265.1				
TOTAL MOISTURE FACTOR	0.032		0.023	0.009				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.027		0.011	-0.003				
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679				
TOTAL MOISTURE, (lb/cy)	42		25	6		=	73	(C)
FREE MOISTURE, (lb/cy)	36		12	-2		=	46	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		=	27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
43	142	3	3185	1355
44	142	3	3185	1365
45	142	3	3220	1350
46	147	18	3205	1350
47	151	15	3195	1350
48	153	7	3205	1360
49	153	16	3190	1365
50	153	11	3220	1350
51	153	11	3170	1365
52	153	10	3210	1370
AVE.	148.9	9.7	3198.5	1358

AVE. CM 4556.5

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 158.6 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 165.1 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 174.6 (H)

TOTAL MIX WATER USED, (lb/cy) 211.1 (I)
(D + G)

W/C RATIO 0.37 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 238.8 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** ______ lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** ______ lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** ______ lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ______ g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ______ g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ______ g

TOTAL MEASURED WATER CONTENT, **WT_M** ______ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ______ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ______ lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ______ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ______ g
(WD - WR4) - WS

% PASSING #4, **P4** ______ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ______ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** ______
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ______ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ______ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ______
((AMW) / (AVE CM / A)) COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	4/5/2020
TIME	8:45 AM
TICKET #	41
LOT #	12
TEST #	31
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170

SLAG, (lb/cy)

TOTAL CEMENTITIOUS, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL
FRACTION	Sand		3/4-	1 1/2		
WT OF SAMPLE + PAN (WET), (g)	775.7		3090	2978		
WT OF SAMPLE + PAN (DRY), (g)	753.8		3046.6	2955.1		
WT OF PAN, (g)	167.5		380.6	263.8		
TOTAL MOISTURE FACTOR	0.037		0.016	0.009		
ABSORPTION FACTOR	0.005		0.012	0.012		
FREE MOISTURE FACTOR	0.032		0.004	-0.003		
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679		
TOTAL MOISTURE, (lb/cy)	49		17	6		= 72 (C)
FREE MOISTURE, (lb/cy)	42		4	-2		= 44 (D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		= 27.72 (E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
37	149	3	3190	1365
38	149	3	3205	1370
39	149	0	3220	1355
40	149	0	3220	1360
41	147	2	3205	1355
42	146	0	3200	1350
43	145	0	3175	1355
44	145	4	3190	1365
45	145	3	3225	1370
46	145	7	3225	1370
AVE.	146.9	2.2	3205.5	1361.5

AVE. CM 4567

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 149.1 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 155.3 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 177.0 (H)

TOTAL MIX WATER USED, (lb/cy) 199.3 (I)
(D + G)

W/C RATIO 0.35 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 227.0 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 43.97 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.27 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 145.1 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1367.9 g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3133.2 g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 3027.2 g

TOTAL MEASURED WATER CONTENT, **WT_M** 235.2 lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.72 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** 207.5 lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** 780.1 g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** 879.2 g
(WD - WR4) - WS

% PASSING #4, **P4** 53.0 %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** 52.8 %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / A)]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / A)]} \times 100$$

CORRECTION FACTOR, **CF** 0.99
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** 232.8 lb/cy
WT_M X CF
COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** 205.1 lb/cy
AWT_M - E

ADJUSTED W/C RATIO 0.36
((AMW) / (AVE CM / A))
COMPARE TO (J)

MnDOT

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	5/5/2020
TIME	12:50PM
TICKET #	100
LOT #	12
TEST #	32
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170 TOTAL CEMENTITIOUS, (lb/cy)

SLAG, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	769.3		3179.3	3035.2				
WT OF SAMPLE + PAN (DRY), (g)	749.2		3122.8	3011.9				
WT OF PAN, (g)	167.1		380.5	263.8				
TOTAL MOISTURE FACTOR	0.035		0.021	0.008				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.030		0.009	-0.004				
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679				
TOTAL MOISTURE, (lb/cy)	46		23	5		=	74	(C)
FREE MOISTURE, (lb/cy)	40		10	-3		=	47	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		=	27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
96	142	8	3215	1355
97	144	11	3170	1370
98	144	8	3220	1365
99	144	9	3230	1355
100	144	7	3215	1355
101	144	6	3215	1365
102	144	3	3230	1360
103	144	0	3185	1350
104	144	3	3210	1355
105	144	10	3225	1350
AVE.	143.8	6.5	3211.5	1358
		AVE. CM	4569.5	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 150.3 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 156.5 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 174.3 (H)

TOTAL MIX WATER USED, (lb/cy) 203.5 (I)
(D + G)

W/C RATIO 0.36 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 231.2 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 43.97 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.27 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 145.1 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1367.3 g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3079.7 g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 2982 g

TOTAL MEASURED WATER CONTENT, **WT_M** 223.5 lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.72 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** 195.8 lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** 801.3 g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** 813.4 g
(WD - WR4) - WS

% PASSING #4, **P4** 50.4 %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** 52.8 %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** 1.05
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** 234.7 lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** 207 lb/cy
AWT_M - E

ADJUSTED W/C RATIO 0.36
((AMW) / (AVE CM / A)) COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	5/5/2020
TIME	3:25 PM
TICKET #	126
LOT #	12
TEST #	33
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A21-43 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 222

CEMENT, (lb/cy) 400

FLY ASH, (lb/cy) 170

SLAG, (lb/cy) ____ TOTAL CEMENTITIOUS, (lb/cy) = 570 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	773.5		2993.4	3054.2				
WT OF SAMPLE + PAN (DRY), (g)	751		2941.9	3030.8				
WT OF PAN, (g)	167.1		380.6	263.8				
TOTAL MOISTURE FACTOR	0.039		0.02	0.008				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.034		0.008	-0.004				
DESIGN WT (OVEN DRY), (lb/cy)	1322		1080	679				
TOTAL MOISTURE, (lb/cy)	52		22	5		=	79	(C)
FREE MOISTURE, (lb/cy)	45		9	-3		=	51	(D)
ABSORBED MOISTURE, (lb/cy)	6.61		12.96	8.15		=	27.72	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
122	145	0	3215	1360
123	143	4	3200	1380
124	144	5	3230	1375
125	144	1	3225	1350
126	144	3	3215	1355
127	144	2	3220	1380
128	144	16	3230	1350
129	145	10	3185	1350
130	150	20	3225	1350
131	152	20	3200	1355
AVE.	145.5	8.1	3214.5	1360.5
		AVE. CM	4575	

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 153.6 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 159.9 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 170.7 (H)

TOTAL MIX WATER USED, (lb/cy) 210.9 (I)
(D + G)

W/C RATIO 0.37 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 238.6 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 43.97 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.27 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 145.1 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ____ g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ____ g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ____ g

TOTAL MEASURED WATER CONTENT, **WT_M** ____ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ____ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ____ lb/cy
$WT_M - WT_A$

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ____ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ____ g
(WD - WR4) - WS

% PASSING #4, **P4** ____ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ____ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** ____
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ____ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ____ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ____
((AMW) / (AVE CM / A)) COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	5/6/2020
TIME	7:40 AM
TICKET #	7
LOT #	13
TEST #	34
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A41-49 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 234

CEMENT, (lb/cy) 420

FLY ASH, (lb/cy) 180

SLAG, (lb/cy)

TOTAL CEMENTITIOUS, (lb/cy) = 600 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL	
FRACTION	Sand		3/4-	1 1/2			
WT OF SAMPLE + PAN (WET), (g)	764.7		3040.5	3123.6			
WT OF SAMPLE + PAN (DRY), (g)	744.5		2993.9	3099.7			
WT OF PAN, (g)	167.1		380.5	263.2			
TOTAL MOISTURE FACTOR	0.035		0.018	0.008			
ABSORPTION FACTOR	0.005		0.012	0.012			
FREE MOISTURE FACTOR	0.030		0.006	-0.004			
DESIGN WT (OVEN DRY), (lb/cy)	1296		1059	666			
TOTAL MOISTURE, (lb/cy)	45		19	5		= 69	(C)
FREE MOISTURE, (lb/cy)	39		6	-3		= 42	(D)
ABSORBED MOISTURE, (lb/cy)	6.48		12.71	7.99		= 27.18	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
3	152	22	3375	1440
4	155	15	3365	1430
5	159	11	3380	1430
6	161	7	3390	1430
7	161	11	3360	1435
8	161	9	3370	1435
9	161	7	3390	1455
10	160	7	3390	1430
11	160	12	3385	1435
12	160	12	3390	1445
AVE.	159.0	11.3	3379.5	1436.5

AVE. CM 4816

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 170.3 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 177.3 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 190.9 (H)

TOTAL MIX WATER USED, (lb/cy) 219.3 (I)
(D + G)

W/C RATIO 0.36 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 246.5 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 44.2 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.5 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 146.0 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1366 g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3164.7 g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 3046.3 g

TOTAL MEASURED WATER CONTENT, **WT_M** 259.5 lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.18 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** 232.3 lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** 748.6 g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** 931.7 g
(WD - WR4) - WS

% PASSING #4, **P4** 55.4 %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** 53.3 %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** 0.96
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** 249.1 lb/cy
WT_M X CF
COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** 221.9 lb/cy
AWT_M - E

ADJUSTED W/C RATIO 0.37
((AMW) / (AVE CM / A))
COMPARE TO (J)

MnDOT

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	5/6/2020
TIME	11:15 AM
TICKET #	29
LOT #	13
TEST #	35
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A41-49 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 234

CEMENT, (lb/cy) 420

FLY ASH, (lb/cy) 180

SLAG, (lb/cy) ______

TOTAL CEMENTITIOUS, (lb/cy) = 600 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL	
FRACTION	Sand		3/4-	1 1/2			
WT OF SAMPLE + PAN (WET), (g)	754.4		3052.7	3000.1			
WT OF SAMPLE + PAN (DRY), (g)	736.2		3011	2980.2			
WT OF PAN, (g)	166.9		380.6	263.6			
TOTAL MOISTURE FACTOR	0.032		0.016	0.007			
ABSORPTION FACTOR	0.005		0.012	0.012			
FREE MOISTURE FACTOR	0.027		0.004	-0.005			
DESIGN WT (OVEN DRY), (lb/cy)	1296		1059	666			
TOTAL MOISTURE, (lb/cy)	41		17	5		= 63	(C)
FREE MOISTURE, (lb/cy)	35		4	-3		= 36	(D)
ABSORBED MOISTURE, (lb/cy)	6.48		12.71	7.99		= 27.18	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
25	171	9	3370	1435
26	171	7	3330	1435
27	171	5	3360	1435
28	171	7	3350	1435
29	171	13	3380	1435
30	172	12	3365	1440
31	172	7	3350	1450
32	172	7	3385	1435
33	172	8	3375	1435
34	172	12	3330	1435
AVE.	171.5	8.7	3359.5	1437

AVE. CM 4796.5

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 180.2 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 187.6 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 195.8 (H)

TOTAL MIX WATER USED, (lb/cy) 223.6 (I)
(D + G)

W/C RATIO 0.37 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 250.8 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 44.2 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.5 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 146.0 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ______ g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ______ g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ______ g

TOTAL MEASURED WATER CONTENT, **WT_M** ______ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ______ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ______ lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ______ g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ______ g
(WD - WR4) - WS

% PASSING #4, **P4** ______ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** ______ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / A)]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / A)]} \times 100$$

CORRECTION FACTOR, **CF** ______
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ______ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ______ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ______
((AMW) / (AVE CM / A)) COMPARE TO (J)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	5/6/2020
TIME	3:20 PM
TICKET #	45
LOT #	13
TEST #	36
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A41-49 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 234
CEMENT, (lb/cy) 420
FLY ASH, (lb/cy) 180
SLAG, (lb/cy)
DESIGN W/C 0.39

TOTAL CEMENTITIOUS, (lb/cy) = 600 (B)

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3		TOTAL	
FRACTION	Sand		3/4-	1 1/2				
WT OF SAMPLE + PAN (WET), (g)	758.8		2933.6	3020.8				
WT OF SAMPLE + PAN (DRY), (g)	739.7		2885.9	2988.8				
WT OF PAN, (g)	167.1		380.6	263.6				
TOTAL MOISTURE FACTOR	0.033		0.019	0.012				
ABSORPTION FACTOR	0.005		0.012	0.012				
FREE MOISTURE FACTOR	0.028		0.007	0.000				
DESIGN WT (OVEN DRY), (lb/cy)	1296		1059	666				
TOTAL MOISTURE, (lb/cy)	43		20	8		=	71	(C)
FREE MOISTURE, (lb/cy)	36		7	0		=	43	(D)
ABSORBED MOISTURE, (lb/cy)	6.48		12.71	7.99		=	27.18	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
41	172	16	3370	1430
42	174	13	3365	1430
43	174	9	3375	1430
44	174	5	3365	1435
45	171	5	3385	1470
46	171	5	3335	1430
47	171	9	3365	1430
48	171	11	3365	1435
49	171	16	3330	1430
50	171	12	3350	1435
AVE.	172.0	10.1	3360.5	1435.5

AVE. CM 4796

TOTAL AVERAGE BATCH WATER, (GAL)
(AVE. BATCH WATER + AVE. TEMPER WATER) 182.1 (F)

ACTUAL BATCH WATER USED, (lb/cy)
((F x 8.33) / A) 189.6 (G)

MAXIMUM BATCH WATER AVAILABLE, (GAL)
(((AVE. CM * 0.40) - D)*A) / 8.33)) 189.0 (H)

TOTAL MIX WATER USED, (lb/cy) 232.6 (I)
(D + G)

W/C RATIO 0.39 (J)
(I / AVE. CM)

TOTAL WATER IN CONCRETE, (lb/cy) 259.8 (K)
(E + I)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3
MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb
MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 44.2 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.5 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 146.0 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** ____ g
MASS OF TRAY, CLOTH & WET CONCRETE, **WF** ____ g
MASS OF PAN, CLOTH & DRY CONCRETE, **WD** ____ g

TOTAL MEASURED WATER CONTENT, **WT_M** ____ lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** ____ lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** ____ lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** ____ g
MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** ____ g
(WD - WR4) - WS
% PASSING #4, **P4** ____ %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %
% PASSING #4 FROM TOTAL MIX, **P4TM** ____ %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** ____
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** ____ lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** ____ lb/cy
AWT_M - E

ADJUSTED W/C RATIO ____
((AMW) / (AVE CM / A)) COMPARE TO (J)

(6/18/2019)

Minnesota Department of Transportation

Concrete W/C Ratio Calculation Worksheet

S.P.	2782-327
DATE	5/7/2014
TIME	7:50 AM
TICKET #	10
LOT #	14
TEST #	37
TESTER	Mark Kosmalski
ENGINEER	Jon Erickson

MIX DESIGN 3A41-49 BATCH SIZE, (cy) 8 (A)

WATER, (lb/cy) 234

CEMENT, (lb/cy) 420

FLY ASH, (lb/cy) 180

SLAG, (lb/cy)

TOTAL CEMENTITIOUS, (lb/cy) = 600 (B)

DESIGN W/C 0.39

BATCH REPORT

	FA #1	FA #2	CA #1	CA #2	CA #3	TOTAL	
FRACTION	Sand		3/4-	1 1/2			
WT OF SAMPLE + PAN (WET), (g)	741.9		3067.6	2980.7			
WT OF SAMPLE + PAN (DRY), (g)	722.8		3006.7	2954.6			
WT OF PAN, (g)	168.6		380	249.8			
TOTAL MOISTURE FACTOR	0.034		0.023	0.01			
ABSORPTION FACTOR	0.005		0.012	0.012			
FREE MOISTURE FACTOR	0.029		0.011	-0.002			
DESIGN WT (OVEN DRY), (lb/cy)	1296		1059	666			
TOTAL MOISTURE, (lb/cy)	44		24	7		= 75	(C)
FREE MOISTURE, (lb/cy)	38		12	-1		= 49	(D)
ABSORBED MOISTURE, (lb/cy)	6.48		12.71	7.99		= 27.18	(E)

WATER/CEMENT CALCULATION

TICKET #	BATCH WATER (GAL)	TEMPER WATER (GAL)	CEMENT CONTENT (lbs)	FLY ASH/SLAG CONTENT (lbs)
6	154	0	3340	1430
7	151	2	3365	1435
8	151	3	3340	1435
9	151	3	3385	1435
10	151	4	3355	1435
11	151	3	3355	1435
12	151	3	3365	1435
13	151	6	3365	1435
14	151	13	3330	1435
15	151	8	3390	1435
AVE.	151.3	4.5	3359	1434.5

AVE. CM 4793.5

TOTAL AVERAGE BATCH WATER, (GAL) (AVE. BATCH WATER + AVE. TEMPER WATER)	155.8	(F)
ACTUAL BATCH WATER USED, (lb/cy) ((F x 8.33) / A)	162.2	(G)
MAXIMUM BATCH WATER AVAILABLE, (GAL) (((AVE. CM * 0.40) - D)*A) / 8.33))	183.1	(H)
TOTAL MIX WATER USED, (lb/cy) (D + G)	211.2	(I)
W/C RATIO (I / AVE. CM)	0.35	(J)
TOTAL WATER IN CONCRETE, (lb/cy) (E + I)	238.4	(K)

UNIT WEIGHT TEST

VOLUME OF UNIT WEIGHT BUCKET, **VOL** 0.25 ft^3

MASS OF UNIT WT. BUCKET, **BWT** 7.7 lb

MASS OF UNIT WT. BUCKET & CONCRETE, **CBWT** 43.9 lb

MASS OF CONCRETE, (CBWT - BWT), **CWT** 36.2 lb

UNIT WT. OF CONCRETE, CWT / VOL, **UW** 144.8 lb/cf

MICROWAVE OVEN TEST

MASS OF TRAY & CLOTH, **WS** 1367.7 g

MASS OF TRAY, CLOTH & WET CONCRETE, **WF** 3147.5 g

MASS OF PAN, CLOTH & DRY CONCRETE, **WD** 3039.7 g

TOTAL MEASURED WATER CONTENT, **WT_M** 236.8 lb/cy
(WF - WD / WF - WS) x 27 x UW

ESTIMATED ABSORBED WATER CONTENT, **WT_A** 27.18 lb/cy
Sum of Absorbed Moistures (E)

ESTIMATED MIXING WATER CONTENT, **MW** 209.6 lb/cy
WT_M - WT_A

% PASSING #4 SIEVE

MASS OF SAMPLE RETAINED #4 SIEVE, **WR4** 741.2 g

MASS. OF SAMPLE PASSING #4 SIEVE, **WP4** 930.8 g
(WD - WR4) - WS

% PASSING #4, **P4** 55.7 %
WP4 / (WD-WS)

% PASSING #4 FROM JMF, **P4JMF** 44.0 %

% PASSING #4 FROM TOTAL MIX, **P4TM** 53.3 %

$$\frac{[((\sum \text{Agg. Design WT.}) \times \text{P4JMF}) + (\text{AVE CM} / \text{A})]}{[(\sum \text{Agg. Design WT.}) + (\text{AVE CM} / \text{A})]} \times 100$$

CORRECTION FACTOR, **CF** 0.95
(100 - P4 / 100 - P4TM)

ADJUSTED TOTAL WATER CONTENT, **AWT_M** 225 lb/cy
WT_M X CF COMPARE TO (K)

ADJUSTED MIXING WATER CONTENT, **AMW** 197.8 lb/cy
AWT_M - E

ADJUSTED W/C RATIO 0.33
((AMW) / (AVE CM / A)) COMPARE TO (J)

B3.2: Concrete: Ingredients Summary

Minnesota Department of Transportation

Concrete Ingredient Summary

S.P.: 2782-327 **Engineer:** Jon Erickson
Plant: Shafer X433 **Inspector:** Mark Kosmalski

Total Batched Quantity (cubic yards)	14,366
Final Cement Overrun/Underrun (%)	0.14

Date	Product Type	Batched Quantity (lb)	Required Quantity (lb)	Daily Overrun/Underrrun (%)	Cummulative Overrun/Underrrun (%)	Mix Type	Batched Quantity (cubic yards)
4/21/20	Cement	576.15	575.50	0.11	0.11	3A21-43	2877.5
	Fly Ash/Slag	245.10	244.59	0.21	0.21		
	Water	51,678.00	51,680.00	0.00	0.00		
	FA#1	1,962.58	1,966.18	-0.18	-0.18		
	FA#2						
	FA#3						
	CA#1	1,577.44	1,583.46	-0.38	-0.38		
	CA#2	998.58	989.64	0.90	0.90		
	CA#3						
	CA#4					Waste	
4/22/20	Cement	403.67	402.72	0.24	0.16	3A21-43	1784
	Fly Ash/Slag	168.91	168.44	0.28	0.24	3A21-45	224
	Water	35,701.00	35,838.00	-0.38	-0.16		
	FA#1	1,361.19	1,369.31	-0.59	-0.35		
	FA#2						
	FA#3						
	CA#1	1,102.66	1,107.53	-0.44	-0.40		
	CA#2	694.76	691.01	0.54	0.76		
	CA#3						
	CA#4					Waste	
4/23/20	Cement	112.05	112.00	0.04	0.15	3A21-52 COL	560
	Fly Ash/Slag	47.54	47.60	-0.13	0.20		
	Water	8,100.00	8,100.00	0.00	-0.15		
	FA#1	380.78	381.51	-0.19	-0.33		
	FA#2						
	FA#3						
	CA#1	308.72	309.26	-0.17	-0.38		
	CA#2	193.76	192.23	0.80	0.76		
	CA#3						
	CA#4					Waste	
4/24/20	Cement	399.32	398.40	0.23	0.17	3A21-43	1992
	Fly Ash/Slag	169.44	169.32	0.07	0.17		
	Water	36,619.00	36,620.00	0.00	-0.11		
	FA#1	1,352.92	1,355.79	-0.21	-0.30		
	FA#2						
	FA#3						
	CA#1	1,096.81	1,098.53	-0.16	-0.32		
	CA#2	692.57	685.04	1.10	0.85		
	CA#3						
	CA#4					Waste	

(1/2018)

Minnesota Department of Transportation

Concrete Ingredient Summary

S.P.: 2782-327 **Engineer:** Jon Erickson

Plant: Shafer X433 **Inspector:** Mark Kosmalski

Total Batched Quantity (cubic yards)	14,366
Final Cement Overrun/Underrun (%)	0.14

4/25/20	Cement	110.52	110.40	0.11	0.17	3A21-42	552
	Fly Ash/Slag	44.18	44.16	0.05	0.16		
	Water	10,204.00	10,204.00	0.00	-0.10		
	FA#1	377.29	378.25	-0.25	-0.30		
	FA#2						
	FA#3						
	CA#1	305.70	306.15	-0.15	-0.31		
	CA#2	192.58	190.68	1.00	0.86		
	CA#3						
	CA#4					Waste	
4/27/20	Cement	193.71	193.60	0.06	0.16	3a21-43	968
	Fly Ash/Slag	82.29	82.28	0.01	0.14		
	Water	17,405.00	17,405.00	0.00	-0.09		
	FA#1	657.32	658.65	-0.20	-0.29		
	FA#2	533.36	534.36	-0.19	-0.19		
	FA#3	335.07	331.44	1.10	1.10		
	CA#1						
	CA#2						
	CA#3						
	CA#4					Waste	
4/29/20	Cement	217.85	217.60	0.11	0.15	3A21-43	1088
	Fly Ash/Slag	92.43	92.48	-0.05	0.12		
	Water	16,486.00	16,486.00	0.00	-0.08		
	FA#1	751.66	752.64	-0.13	-0.27		
	FA#2						
	FA#3						
	CA#1	599.99	601.12	-0.19	-0.29		
	CA#2	380.01	375.04	1.33	0.92		
	CA#3						
	CA#4					Waste	
4/30/20	Cement	57.02	57.12	-0.18	0.14	24	3A41-49
	Fly Ash/Slag	24.44	24.48	-0.16	0.11	248	3A41-53 COL
	Water	4,063.00	4,063.00	0.00	-0.08		
	FA#1	184.68	185.06	-0.21	-0.27		
	FA#2						
	FA#3						
	CA#1	148.31	148.63	-0.22	-0.29		
	CA#2	94.42	93.10	1.42	0.93		
	CA#3						
	CA#4					Waste	

Minnesota Department of Transportation

Concrete Ingredient Summary

S.P.: 2782-327 **Engineer:** Jon Erickson

Plant: Shafer X433 **Inspector:** Mark Kosmalski

Total Batched Quantity (cubic yards)	14,366
Final Cement Overrun/Underrun (%)	0.14

5/1/20	Cement	122.28	122.24	0.03	0.14	3A21-43	376
	Fly Ash/Slag	52.10	52.12	-0.04	0.10		
	Water	10,719.00	10,719.00	0.00	-0.07		
	FA#1	407.89	408.69	-0.20	-0.27		
	FA#2						
	FA#3						
	CA#1	328.01	328.56	-0.17	-0.28		
	CA#2	207.60	204.87	1.33	0.95		
	CA#3						
	CA#4					Waste	
5/2/20	Cement	330.40	329.60	0.24	0.15	3A21-43	1648
	Fly Ash/Slag	140.39	140.08	0.22	0.12		
	Water	27,649.00	27,649.00	0.00	-0.06		
	FA#1	1,131.66	1,133.58	-0.17	-0.25		
	FA#2						
	FA#3						
	CA#1	907.26	908.30	-0.11	-0.26		
	CA#2	573.70	566.47	1.28	1.00		
	CA#3						
	CA#4					Waste	
5/4/20	Cement	89.46	89.60	-0.16	0.14	3a21-43	448
	Fly Ash/Slag	38.07	38.08	-0.03	0.11		
	Water	8,105.00	8,105.00	0.00	-0.06		
	FA#1	303.75	304.37	-0.20	-0.25		
	FA#2						
	FA#3						
	CA#1	246.68	246.99	-0.13	-0.26		
	CA#2	155.95	154.54	0.91	1.00		
	CA#3						
	CA#4					Waste	
5/5/20	Cement	239.08	238.40	0.29	0.15	3A21-43	1192
	Fly Ash/Slag	101.24	101.32	-0.08	0.10		
	Water	21,755.00	21,756.00	0.00	-0.06		
	FA#1	815.61	817.40	-0.22	-0.25		
	FA#2						
	FA#3						
	CA#1	653.58	654.89	-0.20	-0.25		
	CA#2	412.73	408.56	1.02	1.00		
	CA#3						
	CA#4					Waste	

(1/2018)

Minnesota Department of Transportation

Concrete Ingredient Summary

S.P.: 2782-327 **Engineer:** Jon Erickson
Plant: Shafer X433 **Inspector:** Mark Kosmalski

Total Batched Quantity (cubic yards)	14,366
Final Cement Overrun/Underrun (%)	0.14

5/6/20	Cement	85.70	85.68	0.02	0.15	3A41-49	408
	Fly Ash/Slag	36.67	36.72	-0.14	0.09		
	Water	8,390.00	8,390.00	0.00	-0.05		
	FA#1	272.93	273.34	-0.15	-0.25		
	FA#2						
	FA#3						
	CA#1	219.37	219.81	-0.20	-0.25		
	CA#2	137.80	136.86	0.69	0.99		
	CA#3						
	CA#4					Waste	
5/7/20	Cement	52.05	52.08	-0.06	0.14	3A41-49	248
	Fly Ash/Slag	22.30	22.32	-0.09	0.09		
	Water	5,008.00	5,008.00	0.00	-0.05		
	FA#1	166.02	166.41	-0.23	-0.25		
	FA#2						
	FA#3						
	CA#1	133.48	133.70	-0.16	-0.25		
	CA#2	83.59	83.14	0.54	0.98		
	CA#3						
	CA#4					Waste	
	Cement						
	Fly Ash/Slag						
	Water						
	FA#1						
	FA#2						
	FA#3						
	CA#1						
	CA#2						
	CA#3						
	CA#4					Waste	
	Cement						
	Fly Ash/Slag						
	Water						
	FA#1						
	FA#2						
	FA#3						
	CA#1						
	CA#2						
	CA#3						
	CA#4					Waste	

B3.3: Concrete: Unit Weight

Concrete Unit weight

TEST #	1	2	3	4	5	6	7	8	9	10
Date	4/21/20	4/21/20	4/21/20	4/22/20	4/22/20	4/22/20	4/23/20	4/23/20	4/23/20	4/24/20
Unit weight (lb/yd^3)	144.80	144.80	144.80	#N/A	146.40	146.40	144.80	144.80	144.80	146.00

TEST #	11	12	13	14	15	16	17	18	19	20
Date	4/24/20	4/24/20	4/25/20	4/25/20	4/27/20	4/27/20	4/27/20	4/29/20	4/29/20	4/29/20
Unit weight (lb/yd^3)	146.00	146.00	145.40	145.40	146.80	#N/A	#N/A	145.20	145.20	145.20

TEST #	21	22	23	24	25	26	27	28	29	30
Date	4/30/20	4/29/20	5/1/20	5/1/20	5/1/20	5/2/20	5/2/20	5/4/20	5/4/20	5/4/20
Unit weight (lb/yd^3)	140.80	#N/A	144.60	144.60	144.60	146.20	146.20	145.20	#N/A	#N/A

TEST #	31	32	33	34	35	36	37
Date	4/5/20	5/5/20	5/5/20	5/6/20	5/6/20	5/6/20	5/7/14
Unit weight (lb/yd^3)	145.10	145.10	145.10	146.00	146.00	146.00	144.80

B3.4: Concrete: Fresh Air Content

Date	Time	Place	Temp	Air	Beams	ACF	Total Yds	Slump	Mix
4/21/20	7:15 AM	Plant	60	10					3A21-43
	7:30 AM	660+15	60	8.8					
	9:08 AM	655+50	59	8.8					
	10:08 AM	651+75	62	8.5					
	11:20 AM	647+75	62	8.4					
	12:25 PM	643+00	61	7.4					
	1:10 PM	640+50	61		84BC				
	1:20 PM	640+00	61	7.7					
	1:58 PM	638+50	62	8.1					
	2:15 PM	638+50	62	6.9		1.2			
	3:00 PM	635+00	61	8.7					
	3:15 PM	635+00	61	8.1		0.6			
	3:40 PM	631+00	62	8.8					
	5:00 PM	627+00	60	7.5					
	6:05 PM	624+20	61		84ADEF				
	6:15 PM	623+20	63	7.7					
							2878		

Ramsey Rd. 75 MOW

SP 2782-327 4/21/2020

AirTec Consult Air Cont

7:15 AM 660+00 60 8.6 CORR WITH CONTRACTOR

8:45 AM 656+00 62 8.4 8.6
BACK FROM

1:58 PM 638+50 62 7.1 CORR WITH CONTRACTOR

Date	Time	Place	Temp	Air	Beams	ACF	Total Yds	Slump	Mix
4/22/20	6:53 AM	Plant	57	7.7					3A21-43
	7:10 AM	620+35	60	7.4					3A21-43
	8:10 AM	617+00	60	7.5					3A21-43
	9:10 AM	614+50	59	8.8					3A21-43
	9:18 AM	614+50	59	7.8		1			3A21-43
	10:28 AM	607+65	57	8.5					3A21-43
	11:28 AM	604+25	59	7.9					3A21-43
	12:59 PM	599+50	59	8.4					3A21-43
	1:21 PM	598+50	56		85 A-F				3A21-43
	1:40 PM	597+25	56	8.2					3A21-45
	3:23 PM	Plant	56	9					3A21-45
	3:35 PM	666+10	58	8.8					3A21-45
	4:10 PM	664+00	57		86 A-D				3A21-45
	4:13 PM	663+75	57	8.1					3A21-45
	4:18 PM	663+75	57	7.4		0.7			3A21-45

3A21-43=1784
3A21-45=224

7:10 620+30 7.1 63
9:25 613+25 BEFOR 7.9 AFTER 7.1 61°
4:05 664+20 8.0 60°

MJW
RPT # 76

Date	Time	Place	Temp	Air	Beams	ACF	Total Yds	Slump	Mix
4/23/20	7:34 AM	Plant	63	10.1					3A21-52
	7:50 AM	764+75	73	8					
	2:20 PM	757+30	65	8.3					
	2:28 PM	757+30	65	7.9		0.4			
	5:41 PM	763+75	63		87 A-D		56 560		

750 AM NBTRAN @ 764+40 62° 8^{0} CONT 8^{0}

~~9~~ 12:20 NB TRAN 757+00 84° BEFOR 7^{7} 6^{9} AFTER

3:10 pm SB TRANSIT 757+80 67° 8"

Date	Time	Place	Temp	Air	Beams	ACF	Total Yds	Slump	Mix
4/24/20	6:48 AM	Plant	59	7.9					3A21-43
	7:04 AM	569+95	64	6.5					
	10:40 AM	650+35	58	7.1					
	10:49 AM	650+35	58	6.7		0.4			
	12:10 PM	643+50	59	7.3					
	1:10 PM	635+25	62	8.5					
	2:45 PM	625+25	57	7.9					
	3:45 PM	617+75	57	7.1					
	4:45 PM	609+25	57	7.3					
	4:53 PM	609+25	58	6.2		1.1			
	5:14 PM	606+50	58		88 A-F				
	5:24 PM	605+00	57	7.5					
							1992		

7:10 SB35W 659+95 $6^{\underline{2}}$ $63^{\underline{o}}$
11:00 SB35 648+60 $6^{\underline{6}}$ BEFOR $6^{\underline{1}}$ AFTER $61^{\underline{o}}$
1:40 SB35W 633+90 $8^{\underline{2}}$ $60^{\underline{o}}$

MJW

Date	Time	Place	Temp	Air	Beams	ACF	Total Yds	Slump	Mix
4/25/20	7:07 AM	Plant	60	9.2					3A21-42
	7:25 AM	603+25	65	8.2					
	8:10 AM	602+00	65	7.6					
	8:20 AM	602+00	66	6.6		1			
	8:30 AM	599+65	65		89 B-E				
	12:00 PM	29+25	67	7.2					
	12:10 PM	29+25	67	6.7		0.5			
	1:15 PM	25+75	66		89 A, F-I				
							552		

7:20 AM Temp 62 Air 8[illegible] Air Temp
11:10 AM 63 7.5 6.9 SB 35W 661+00 5 HLD
SB35W 664+00 Before After

Date	Time	Place	Temp	Air	Beams	ACF	Total Yds	Slump	Mix
4/27/20	7:57 AM	Plant	57	8					3A21-43
	8:08 AM	666+08	62	6.5					
	8:20 AM	666+25	59	7.8					
	10:20 AM	39+60	57		90B-E				
	12:10 PM	76+69	57	8.9					
	12:22 PM	76+69	57	7		1.9			
	1:15 PM	63+00	62	8.7					
	5:38 PM	596+65	60	8.9					
	5:47 PM	596+65	60	7.8		1.1			
	6:10 PM	596+50	60		90 A,F-H				
							968		

8:08 AM 666+10 6.2 60° "CONTRACT" 7.8
8:20 AM 666+25 7.2

9:50 3 BENT 38+70 BEFORE 8.1 AFTER 7.6

4:10 SB35W 627+20 7.5 60°

MJW

Date	Time	Place	Temp	Air	Beams	ACF	Total Yds	Slump	Mix
4/29/20	7:07 AM	Plant	55	9.2					3A21-43
	7:21 AM	624+90	58	8.8					
	9:43 AM	612+85	52	8.8					
	9:51 AM	612+85	52	7.9		1.1			
	12:08 PM	598+90	52	8.8					
	12:15 PM	598+90	52	7.8		1			
	6:44 PM	657+45	58	8.6					
	7:10 PM	659+50	57		A-E #91				
							1088		

7:25 829+90 57 8 7

11:55 608+75 7 5 Before 7 0 After Conc 58° Air 45

Date	Time	Place	Temp	Air	Beams	ACF	Total Yds	Slump	Mix
4/30/20	6:46 AM	Plant	53	9					3A41-49
	7:02 AM	738+60	57	7.2				3.75"	3A41-49
	7:23 AM	740+00	57		92 ABC		Mix Verif.		3A41-49
	8:51 AM	Plant	55	10.1					3A41-53
	9:10 AM	764+25	55	8.2				2.5"	3A41-53
	3:49 PM	757+00	60	7.9					3A41-53
	3:52 PM	757+00	60	7		0.9			3A41-53
	4:30 PM	758+00	60		93 A-E		(Red)		3A41-53
							3A41-49 24 Yards		
							3A41-53 248 Yards		
							272 Yards Total		

① @ 3A41-49 (SB65 Redone)
MnDot 7^{2} Cont 7^{3} Slump 3/4 Conc Temp 59

@ 3041-53 (RED) NB Transit 764+70
MnDot 8^{1} Contractor 8^{2} Slump $3\frac{1}{4}$ Conc Temp 57

Date	Time	Place	Temp	Air	Beams	ACF	Total Yds	Slump	Mix
5/1/20	6:50 AM	Plant	57	9.4					3A21-43
	7:15 AM	25+50	61	8.6					3A21-43
	11:48 AM	750+00	60	8.1					3A21-43
	11:52 AM	750+00	61	7.4		0.7			3A21-43
	12:00 PM	740+50	62		94A V1-3				3A21-43
	1:46 PM	Plant	65	9.6					3A41-49
	2:05 PM	791+50	68	9.5					3A41-49
	2:25 PM	730+50	64	8.4				2-1/2"	3A41-49
	5:30 PM	735+50	67		95A				3A41-49
							376		3A21-43
							224		3A41-49
							600		Total

		temp	Air
7:18AM	- 25+50	60°	8.8 %
11:50	- 750+00	60°	8.2 %

Date	Time	Place	Temp	Air	Beams	ACF	Total Yds	Slump	Mix
5/2/20	6:48 AM	Plant	59	8.8					3A21-43
	7:08 AM	725+00	63	8					
	8:31 AM	728+75	58	7.6					
	8:45 AM	728+75	58	6.7		0.9			
	9:31 AM	732+25	59	7.2					
	10:42 AM	737+00	59	7.8					
	11:54 AM	739+75	64	8.4					
	2:01 PM	746+50	66	7.2					
	2:13 PM	746+50	66	6.8		0.4			
	2:30 PM	746+75	66		96 A				
							1648		

7:10 - 725+00 63° 8.1 %

10:43 - 737+00 59° 7.2 %

Date	Time	Place	Temp	Air	Beams	ACF	Total Yds	Slump	Mix
5/4/20	7:01 AM	Plant	53	9.8					3A21-43
	7:16 AM	39+85	60	8.8					
	11:08 AM	26+25	61	7.6					
	11:19 AM	26+25	61	7.2		0.4			
	2:25 PM	74+80	63	7.9					
	2:34 PM	74+80	63	7.1		0.8			
		72+20	63		97 A				
							448		

7:19 39+85 60 8.6%

11:08 26+25 60 7.5%

Date	Time	Place	Temp	Air	Beams	ACF	Total Yds	Slump	Mix
5/5/20	6:49 AM	Plant	10.2						3A21-43
	7:12 AM	725+03	8.9						
	8:50 AM	732+00	8.8						
	10:58 AM	740+75	8						
	11:11 AM	740+75	7.4						
	3:22 PM	728+15	7.6						
	3:30 PM	728+15	6.5						
	4:01 PM	726+50		98A					
							1192		

7:15 725+03 – 54° 9.0%
11:00 740+75 – 60° 7.5%

Date	Time	Place	Temp	Air	Beams	ACF	Total Yds	Slump	Mix
5/6/20	6:53 AM	Plant	53	9.6					3A41-49
	7:10 AM	740+50	61	8.8				4 1/4"	
	1:21 PM	737+50	61	8.4				4"	
	4:30 PM	45+00	62		99 A 49V				
							408		

@7:09 740+50 Contractor 8.8 M-Boot 8.7 Temp 54 - Slump 4"

12:59pm 7.9 60 Slump 3½

Date	Time	Place	Temp	Air	Beams	ACF	Total Yds	Slump	Mix
5/7/20	6:43 AM	Plant	50						3A41-49
	7:03 AM	728+40	58						
	2:00 AM	C-Repair	62		100A				
							248		

705 AM Contractor 8.8 MnDOT 8.2 Slump 4" Conc Tem 57 Air Temp 42

11:00 AM 35 Exit 8.2 Slump 3½ Con Tem 62 Air Te 53

Gps Area P61, P71, P63, P64

35W/Lake St./Orange Line

MINNESOTA DEPARTMENT OF TRANSPORTATION

Use reverse side for sketches

DAILY CONCRETE PAVING ACCOMPLISHMENT REPORT

Date 7/15/20	Report No #89	S.P. 2782-327	Inspector [signature]

PAVEMENT

			Alignment/Station
Alignment	Alley		
Station Start			
Station Stop			
Distance			
Width	VARI		
8" 9" 10" 12" Concrete Pav. (Base)			
Concrete Pav. (Special ~~10"~~)	271.2	Sq Yd	
High Early strength			
Bridge Appr. Panels (Sta.)			
Terminal Headers (Sta.)			

SUPPLEMENTAL REINFORCEMENT

Type	L.F	Size	Pounds
Epoxy- No. 4	X		
Epoxy- No. 5	X		

CONCRETE PRODUCTION DATA

Mix No.	Batches	CY Mixed	CY Waste
EMP3A113		71.5	

CY Req'd

Yield

FLEXURAL STRENGTH

Beam # / Cyl. #	Alignment	Sta. to Sta.	Yds Represented
102A-D	Alley		71.5

REINFORCING STEEL

Type	L.F./ Each	Size (dia)	Pounds
Drill & Grout (Epoxy)	X		
Drill & Grout (Special)	X		

JOINT ITEMS

INCLUDE DOWELS AND PROTECTION ANGLES

Type	Loc.	Lin. Ft.
Dowel Bar	X	
1.25" Dowel (High Perf)	X	

Remarks/Notes Hennepin Cty
108814 CAT 3

[signature]

Testing

	Shafer	MnDOT
Air	8.0	8.0
Slump	4½	4½
Conc Temp	74°	74°
Air Temp	68°	68°

Original - Project File
cc: Contractor

B3.5: Concrete: SAM

Date		10/10/2018	10/10/2018	4/21/2020	4/21/2020	4/21/2020	4/21/2020
Location		Lab	Field	638+50	638+50	635+00	635+00
Test No.		**Example**	**Example**	**1**	**2**	**3**	**4**
First Run	**14.5 psi**	9.93	9.27	5.85	6.42	5.62	6.09
	30 psi	23.38	22.30	15.90	16.80	14.88	16.37
	45 psi	37.65	36.37	26.84	28.95	26.18	27.99
Second Run	**14.5 psi**	10.43	9.49	5.95	6.54	5.73	6.21
	30 psi	23.50	22.55	15.96	16.77	14.97	16.59
	45 psi	38.40	36.61	26.95	28.82	26.51	28.46
Air Content (%)		2.5	3.1	8.1	6.9	8.7	8.1
SAM @ 14.5 psi		0.50	0.22	0.10	0.12	0.11	0.12
SAM @ 30 psi		0.12	0.25	0.06	-0.03	0.09	0.22
SAM @ 45 psi		0.75	0.24	0.11	-0.13	0.33	0.47
SAM's Chance		1.00	0.26	0.64	0.01	1.00	1.00
Result:		**Likely Correct**	*Ran Incorrect*	**Likely Correct**	*Ran Incorrect*	**Likely Correct**	**Likely Correct**

Fresh Prop.	**slump [in]**						
	temp. [F]			**67.00**	**67.0**	**62.0**	**62**
	Unit Weight [pcf]						
	w/c ratio						
Mix Design [lb/yd^3]	**Coarse 1**			1080	1080	1080	1080
	Coarse 2			679	679	679	679
	Fine			1322	1322	1322	1322
	Cement			400	400	400	400
	Fly Ash			170	170	170	170
	Water			222	222	222	222
	AEA			0.5-3	0.5-3	0.5-3	0.5-3
	WR			0-8	0-8	0-8	0-8
	SP						

Date		4/22/2020	4//22/2020	4/22/2020	4/22/2020	4/24/2020	4/24/2020
Location		614+50	614+50	633+75	633+75	650+35	650+35
Test No.		**5**	**6**	**7**	**8**	**9**	**10**
First Run	14.5 psi	5.33	5.99	6.19	6.52	5.78	6.02
	30 psi	14.68	15.82	16.14	16.88	15.99	16.78
	45 psi	25.84	27.40	28.05	29.05	27.34	28.12
Second Run	14.5 psi	5.32	6.05	6.23	6.60	5.79	6.09
	30 psi	14.44	15.70	16.21	16.89	16.24	16.30
	45 psi	25.62	27.30	28.19	29.00	27.44	28.22
Air Content (%)		8.8	7.8	8.1	7.4	7.1	6.7
SAM @ 14.5 psi		-0.01	0.06	0.04	0.08	0.01	0.07
SAM @ 30 psi		-0.24	-0.12	0.07	0.01	0.25	-0.48
SAM @ 45 psi		-0.22	-0.10	0.14	-0.05	0.10	0.10
SAM's Chance		0.27	0.29	0.83	0.06	0.03	1.00
Result:		*Ran Incorrect*	*Ran Incorrect*	**Likely Correct**	*Ran Incorrect*	*Ran Incorrect*	*Ran Incorrect*

Fresh Prop.	slump [in]						
	temp. [F]	59	59	57	57	58	58
	Unit Weight [pcf]						
	w/c ratio						
Mix Design [lb/yd^3]	Coarse 1	1080	1080	1087	1087	1080	1080
	Coarse 2	679	679	683	683	679	679
	Fine	1322	1322	1331	1331	1322	1322
	Cement	400	400	410	410	400	400
	Fly Ash	170	170	150	150	170	170
	Water	222	222	218	218	222	222
	AEA	0.5-3	0.5-3	0.5-3	0.5-3	0.5-3	0.5-3
	WR	0-8	0-8	0-8	0-8	0-8	0-8
	SP						

Date		4/24/2020	4/24/2020	4/25/2020	4//25/20	4/27/2020	4/27/2020
Location		609+25	609+25	602+00	602+00	76+69	76+69
Test No.		**11**	**12**	**13**	**14**	**15**	**16**
First Run	14.5 psi	5.64	6.10	5.85	6.03	6.18	5.93
	30 psi	14.75	15.23	14.39	15.76	16.63	15.45
	45 psi	26.22	27.74	26.89	27.81	28.03	26.32
Second Run	14.5 psi	5.74	6.13	5.86	6.07	6.24	5.99
	30 psi	14.83	15.29	14.66	15.89	16.75	15.58
	45 psi	26.35	27.82	27.12	28.02	28.21	26.40
Air Content (%)		7.3	6.2	7.6	6.6	8.9	7.0
SAM @ 14.5 psi		0.10	0.03	0.01	0.04	0.06	0.06
SAM @ 30 psi		0.08	0.06	0.27	0.13	0.12	0.13
SAM @ 45 psi		0.13	0.08	0.23	0.21	0.18	0.08
SAM's Chance		0.66	0.54	0.41	0.90	0.80	0.16
Result:		**Likely Correct**	**Likely Correct**	*Ran Incorrect*	**Likely Correct**	**Likely Correct**	*Ran Incorrect*

Fresh Prop.	slump [in]						
	temp. [F]	57	58	65	66	57	57
	Unit Weight [pcf]						
	w/c ratio						
Mix Design [lb/yd^3]	Coarse 1	1080	1080	1080	1080	1080	1080
	Coarse 2	679	679	679	679	679	679
	Fine	1322	1322	1322	1322	1322	1322
	Cement	400	400	400	400	400	400
	Fly Ash	170	170	170	170	170	170
	Water	222	222	222	222	222	222
	AEA	0.5-3	0.5-3	0.5-3	0.5-3	0.5-3	0.5-3
	WR	0-8	0-8	0-8	0-8	0-8	0-8
	SP						

Date		4/27/2020	4/27/2020	4/29/2020	4/29/2020	4/29/2020	4/29/2020
Location		596+65	596+65	612+85	612+85	598+90	598+90
Test No.		**17**	**18**	**19**	**20**	**21**	**22**
First Run	**14.5 psi**	6.58	6.23	6.22	5.86	5.33	5.98
	30 psi	16.25	16.01	16.74	15.33	14.10	15.59
	45 psi	27.86	27.59	27.93	25.89	24.85	27.14
Second Run	**14.5 psi**	6.59	6.27	6.28	5.89	5.23	5.97
	30 psi	16.36	16.09	16.81	15.46	13.92	15.61
	45 psi	27.99	27.62	28.02	26.01	24.26	27.15
Air Content (%)		8.9	7.8	8.9	7.0	8.8	7.8
SAM @ 14.5 psi		0.01	0.04	0.06	0.03	-0.10	-0.01
SAM @ 30 psi		0.11	0.08	0.07	0.13	-0.18	0.02
SAM @ 45 psi		0.13	0.03	0.09	0.12	-0.59	0.01
SAM's Chance		0.64	0.14	0.51	0.42	0.00	0.36
Result:		**Likely Correct**	*Ran Incorrect*	**Likely Correct**	*Ran Incorrect*	*Ran Incorrect*	*Ran Incorrect*

Fresh Prop.	**slump [in]**						
	temp. [F]	60	60	52	52	52	52
	Unit Weight [pcf]						
	w/c ratio						
Mix Design [lb/yd^3]	**Coarse 1**	1080	1080	1080	1080	1080	1080
	Coarse 2	679	679	679	679	679	679
	Fine	1322	1322	1322	1322	1322	1322
	Cement	400	400	400	400	400	400
	Fly Ash	170	170	170	170	170	170
	Water	222	222	222	222	222	222
	AEA	0.5-3	0.5-3	0.5-3	0.5-3	0.5-3	0.5-3
	WR	0-8	0-8	0-8	0-8	0-8	0-8
	SP						

Date		5/1/2020	5/1/2020	5/2/2020	5/2/2020	5/2/2020	5/2/2020
Location		750+00	750+00	728+75	728+75	746+50	746+50
Test No.		**23**	**24**	**25**	**26**	**27**	**28**
First Run	14.5 psi	6.03	6.12	6.10	6.54	6.33	5.99
	30 psi	16.22	16.41	15.80	16.81	15.99	16.12
	45 psi	27.96	28.89	27.41	28.89	28.43	27.83
Second Run	14.5 psi	6.09	6.16	6.18	6.59	6.41	6.03
	30 psi	16.24	16.49	15.96	16.93	16.02	16.16
	45 psi	27.98	29.04	27.59	29.07	28.56	28.01
Air Content (%)		8.1	7.4	7.6	6.7	7.2	6.8
SAM @ 14.5 psi		0.06	0.04	0.08	0.05	0.08	0.04
SAM @ 30 psi		0.02	0.08	0.16	0.12	0.03	0.04
SAM @ 45 psi		0.02	0.15	0.18	0.18	0.13	0.18
SAM's Chance		0.31	0.84	0.58	0.81	0.88	0.97
Result:		*Ran Incorrect*	**Likely Correct**	**Likely Correct**	**Likely Correct**	**Likely Correct**	**Likely Correct**

Fresh Prop.	slump [in]						
	temp. [F]	60	61	58	58	66	66
	Unit Weight [pcf]						
	w/c ratio						
Mix Design [lb/yd^3]	Coarse 1	1080	1080	1080	1080	1080	1080
	Coarse 2	679	679	679	679	679	679
	Fine	1322	1322	1322	1322	1322	1322
	Cement	400	400	400	400	400	400
	Fly Ash	170	170	170	170	170	170
	Water	222	222	222	222	222	222
	AEA	0.5-3	0.5-3	0.5-3	0.5-3	0.5-3	0.5-3
	WR	0-8	0-8	0-8	0-8	0-8	0-8
	SP						

Date		5/4/2020	5/4/2020	5/4/2020	5/4/2020	5/5/2020	5/5/2020
Location		26+25	26+25	74+80	74+80	740+75	740+75
Test No.		**29**	**30**	**31**	**32**	**33**	**34**
First Run	14.5 psi	6.07	6.25	5.94	6.31	5.89	6.68
	30 psi	15.45	15.90	15.45	16.26	15.37	17.21
	45 psi	26.78	27.54	26.92	28.15	26.79	29.27
Second Run	14.5 psi	6.17	6.36	6.03	6.44	5.92	6.78
	30 psi	15.66	16.10	15.62	16.48	15.48	17.29
	45 psi	27.09	27.72	27.11	28.34	26.95	29.51
Air Content (%)		7.6	7.2	7.9	7.1	8.0	7.4
SAM @ 14.5 psi		0.10	0.11	0.09	0.13	0.03	0.10
SAM @ 30 psi		0.21	0.20	0.17	0.22	0.11	0.08
SAM @ 45 psi		0.31	0.18	0.19	0.19	0.16	0.24
SAM's Chance		0.94	0.30	0.58	0.24	0.78	0.98
Result:		**Likely Correct**	*Ran Incorrect*	**Likely Correct**	*Ran Incorrect*	**Likely Correct**	**Likely Correct**
Fresh Prop.	slump [in]						
	temp. [F]	61	61	63	63	61	61
	Unit Weight [pcf]						
	w/c ratio						
Mix Design [lb/yd^3]	Coarse 1	1080	1080	1080	1080	1080	1080
	Coarse 2	679	679	679	679	679	679
	Fine	1322	1322	1322	1322	1322	1322
	Cement	400	400	400	400	400	400
	Fly Ash	170	170	170	170	170	170
	Water	222	222	222	222	222	222
	AEA	0.5-3	0.5-3	0.5-3	0.5-3	0.5-3	0.5-3
	WR	0-8	0-8	0-8	0-8	0-8	0-8
	SP						

Date		5/5/2020	5/5/2020				
Location		728+15	728+15				
Test No.		**35**	**36**				
First Run	14.5 psi	6.09	6.66				
	30 psi	15.84	17.00				
	45 psi	27.42	29.20				
Second Run	14.5 psi	6.17	6.78				
	30 psi	16.02	17.21				
	45 psi	27.67	29.42				
Air Content (%)		7.6	6.5				
SAM @ 14.5 psi		0.08	0.12				
SAM @ 30 psi		0.18	0.21				
SAM @ 45 psi		0.25	0.22				
SAM's Chance		0.86	0.50				
Result:		**Likely Correct**	**Likely Correct**	Insert Pressure Steps Above	Insert Pressure Steps Above	Insert Pressure Steps Above	Insert Pressure Steps Above
Fresh Prop.	slump [in]						
	temp. [F]	64	64				
	Unit Weight [pcf]						
	w/c ratio						
Mix Design [lb/yd^3]	Coarse 1	1080	1080				
	Coarse 2	679	679				
	Fine	1322	1322				
	Cement	400	400				
	Fly Ash	170	170				
	Water	222	222				
	AEA	0.5-3	0.5-3				
	WR	0-8	0-8				
	SP						

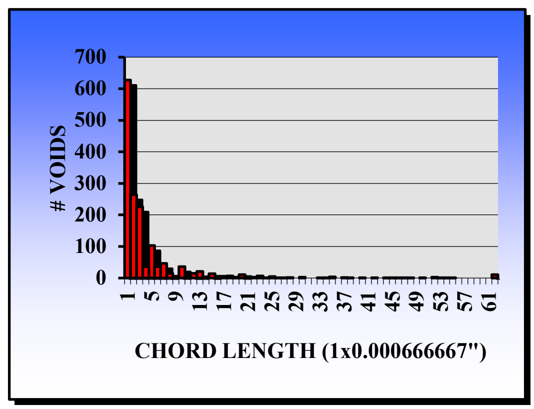
B4.1: Concrete: Hardened Air

AIR VOID ANALYSIS

PROJECT:	**REPORTED TO:**
I-35W AT LAKE ST HENNEPIN COUNTY S.P. 2782-327	MINNESOTA DEPT OF TRANSPORTATION CONSULTANT SERVICES UNIT 395 JOHN IRELAND BLVD ST. PAUL, MN 55155-1899
	ATTN: MARIA MASTEN
AET PROJECT NO: 29-20883	**DATE:** NOVEMBER 10, 2020

Sample ID: #12A

Conformance: The concrete contains an air void system which is consistent with current American Concrete Institute (ACI) recommendations for freeze-thaw resistance.



Sample Data

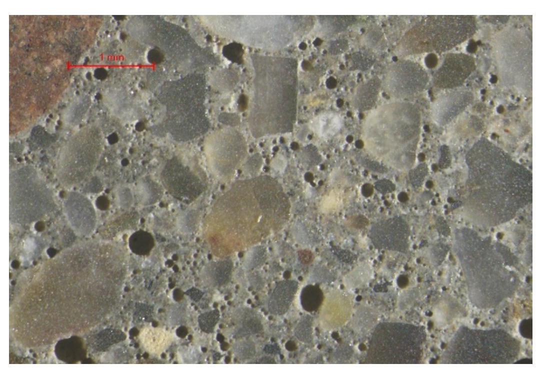
Description:	Hardened Concrete Cylinder
Dimensions:	152 mm (6") diameter by 305 mm (12") long

Test Data: By ASTM C457, Procedure A

Air Void Content %	6.3
Entrained, % < 0.040"(1mm)	4.9
Entrapped, %> 0.040"(1mm)	1.4
Air Voids/inch	17.2
Specific Surface, in^2/in^3	1090
Spacing Factor, inches	0.003
Paste Content, % estimated	22
Magnification	75x
Traverse Length, inches	90
Test Date	11/2/2020
Test Performed By	J. Duggan

Report Prepared By:
American Engineering Testing, Inc.

Blake M. Lemcke, PG
Senior Petrographer/Geologist
MN License #50337



Magnification: 30x
Description: Hardened air void system.

550 Cleveland Avenue North | Saint Paul, MN 55114
Phone (651) 659-9001 | (800) 972-6364 | Fax (651) 659-1379 | www.amengtest.com | AA/EEO

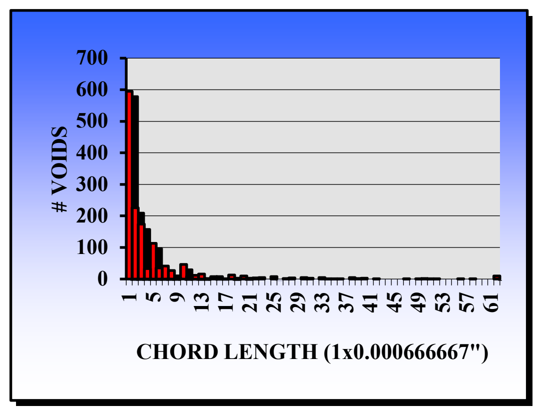
AMERICAN ENGINEERING TESTING, INC.

AIR VOID ANALYSIS

PROJECT:	**REPORTED TO:**
I-35W AT LAKE ST HENNEPIN COUNTY S.P. 2782-327	MINNESOTA DEPT OF TRANSPORTATION CONSULTANT SERVICES UNIT 395 JOHN IRELAND BLVD ST. PAUL, MN 55155-1899
	ATTN: MARIA MASTEN
AET PROJECT NO: 29-20883	**DATE:** NOVEMBER 10, 2020

Sample ID: #13

Conformance: The concrete contains an air void system which is consistent with current American Concrete Institute (ACI) recommendations for freeze-thaw resistance.



Sample Data

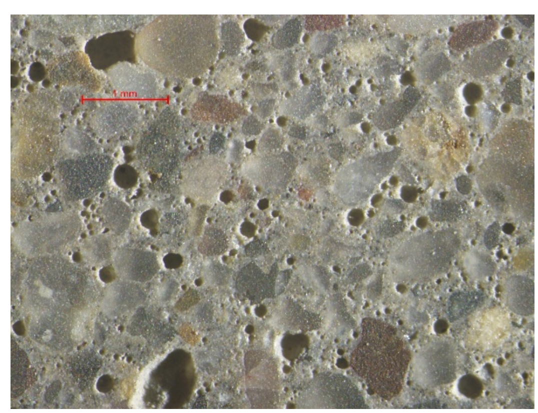
Description:	Hardened Concrete Cylinder
Dimensions:	152 mm (6") diameter by 305 mm (12") long

Test Data: By ASTM C457, Procedure A

Air Void Content %	5.6
Entrained, % < 0.040"(1mm)	4.7
Entrapped, %> 0.040"(1mm)	0.9
Air Voids/inch	15.1
Specific Surface, in^2/in^3	1090
Spacing Factor, inches	0.003
Paste Content, % estimated	19
Magnification	75x
Traverse Length, inches	96
Test Date	11/3/2020
Test Performed By	J. Duggan

Report Prepared By:
American Engineering Testing, Inc.

Blake M. Lemcke, PG
Senior Petrographer/Geologist
MN License #50337



Magnification: 30x
Description: Hardened air void system.

AIR VOID ANALYSIS

PROJECT:

I-35W AT LAKE ST
HENNEPIN COUNTY
S.P. 2782-327

REPORTED TO:

MINNESOTA DEPT OF TRANSPORTATION
CONSULTANT SERVICES UNIT
395 JOHN IRELAND BLVD
ST. PAUL, MN 55155-1899

ATTN: MARIA MASTEN

AET PROJECT NO: 29-20883

DATE: NOVEMBER 10, 2020

Sample ID: #14A

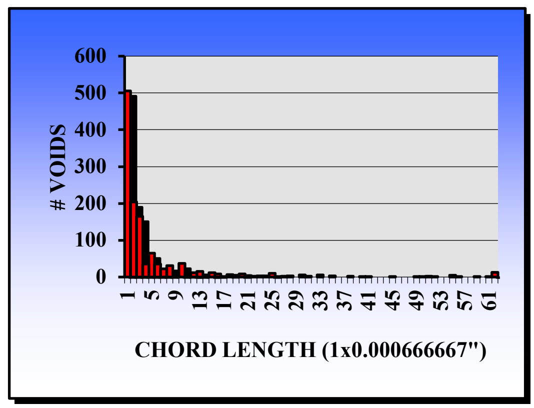
Conformance: The concrete contains an air void system which is consistent with current American Concrete Institute (ACI) recommendations for freeze-thaw resistance.

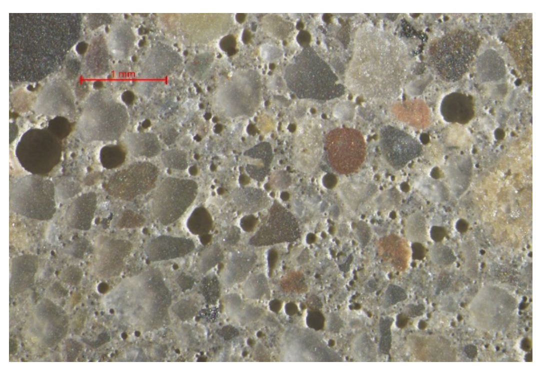
Sample Data

Description:	Hardened Concrete Cylinder
Dimensions:	152 mm (6") diameter by 305 mm (12") long

Test Data: By ASTM C457, Procedure A

Air Void Content %	5.4
Entrained, % < 0.040"(1mm)	4.1
Entrapped, %> 0.040"(1mm)	1.3
Air Voids/inch	12.4
Specific Surface, in^2/in^3	920
Spacing Factor, inches	0.004
Paste Content, % estimated	19
Magnification	75x
Traverse Length, inches	102
Test Date	11/3/2020
Test Performed By	J. Duggan





Magnification: 30x
Description: Hardened air void system.

Report Prepared By:
American Engineering Testing, Inc.

Blake M. Lemcke, PG
Senior Petrographer/Geologist
MN License #50337

AIR VOID ANALYSIS

PROJECT:

I-35W AT LAKE ST
HENNEPIN COUNTY
S.P. 2782-327

REPORTED TO:

MINNESOTA DEPT OF TRANSPORTATION
CONSULTANT SERVICES UNIT
395 JOHN IRELAND BLVD
ST. PAUL, MN 55155-1899

ATTN: MARIA MASTEN

AET PROJECT NO: 29-20883

DATE: NOVEMBER 10, 2020

Sample ID: #25

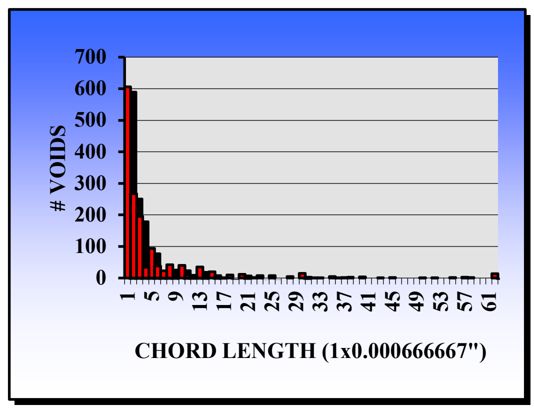
Conformance: The concrete contains an air void system which is consistent with current American Concrete Institute (ACI) recommendations for freeze-thaw resistance.

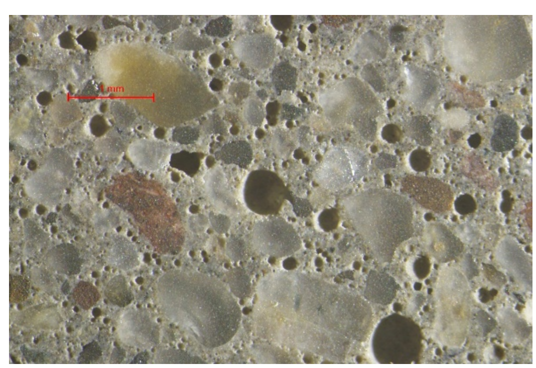
Sample Data

Description: Hardened Concrete Cylinder
Dimensions: 152 mm (6") diameter by 305 mm (12") long

Test Data: By ASTM C457, Procedure A

Air Void Content %	6.4
Entrained, % < 0.040"(1mm)	5.3
Entrapped, %> 0.040"(1mm)	1.1
Air Voids/inch	16.1
Specific Surface, in^2/in^3	1010
Spacing Factor, inches	0.003
Paste Content, % estimated	17
Magnification	75x
Traverse Length, inches	96
Test Date	10/29/2020
Test Performed By	J. Duggan





Magnification: 30x
Description: Hardened air void system.

Report Prepared By:
American Engineering Testing, Inc.

Blake M. Lemcke, PG
Senior Petrographer/Geologist
MN License #50337

AMERICAN ENGINEERING TESTING, INC.

AIR VOID ANALYSIS

PROJECT:

I-35W AT LAKE ST
HENNEPIN COUNTY
S.P. 2782-327

REPORTED TO:

MINNESOTA DEPT OF TRANSPORTATION
CONSULTANT SERVICES UNIT
395 JOHN IRELAND BLVD
ST. PAUL, MN 55155-1899

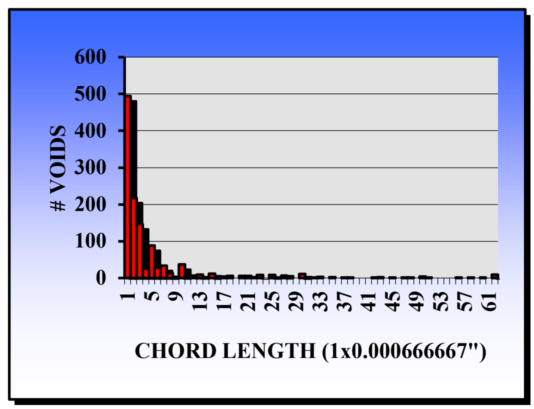
ATTN: MARIA MASTEN

AET PROJECT NO: 29-20883

DATE: NOVEMBER 10, 2020

Sample ID: #26

Conformance: The concrete contains an air void system which is consistent with current American Concrete Institute (ACI) recommendations for freeze-thaw resistance.



Sample Data

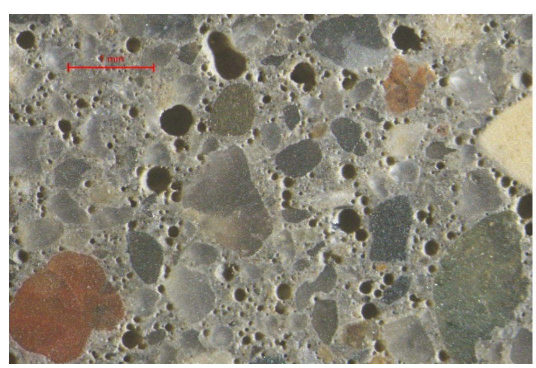
Description: Hardened Concrete Cylinder
Dimensions: 152 mm (6") diameter by 305 mm (12") long

Test Data: By ASTM C457, Procedure A

Air Void Content %	4.5
Entrained, % < 0.040"(1mm)	3.9
Entrapped, %> 0.040"(1mm)	0.6
Air Voids/inch	12.0
Specific Surface, in^2/in^3	1080
Spacing Factor, inches	0.004
Paste Content, % estimated	20
Magnification	75x
Traverse Length, inches	102
Test Date	10/30/2020
Test Performed By	J. Duggan

Report Prepared By:
American Engineering Testing, Inc.

Blake M. Lemcke, PG
Senior Petrographer/Geologist
MN License #50337



Magnification: 30x
Description: Hardened air void system.

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AIR VOID ANALYSIS

PROJECT:

I-35W AT LAKE ST
HENNEPIN COUNTY
S.P. 2782-327

REPORTED TO:

MINNESOTA DEPT OF TRANSPORTATION
CONSULTANT SERVICES UNIT
395 JOHN IRELAND BLVD
ST. PAUL, MN 55155-1899

ATTN: MARIA MASTEN

AET PROJECT NO: 29-20883

DATE: NOVEMBER 10, 2020

Sample ID: #27

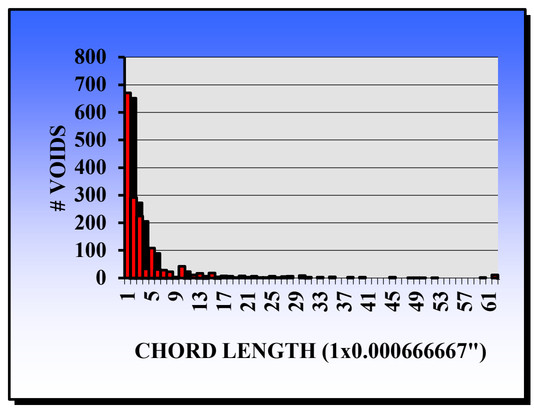
Conformance: The concrete contains an air void system which is consistent with current American Concrete Institute (ACI) recommendations for freeze-thaw resistance.

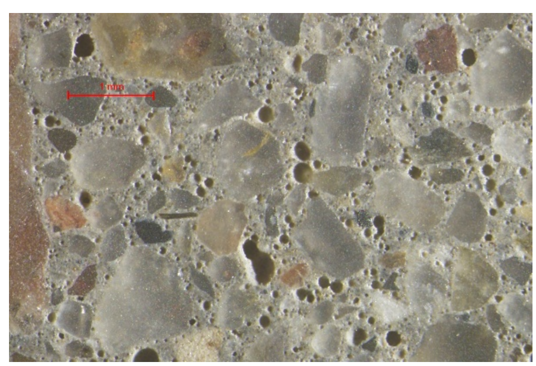
Sample Data

Description: Hardened Concrete Cylinder
Dimensions: 152 mm (6") diameter by 305 mm (12") long

Test Data: By ASTM C457, Procedure A

Air Void Content %	5.5
Entrained, % < 0.040"(1mm)	4.6
Entrapped, %> 0.040"(1mm)	0.9
Air Voids/inch	15.9
Specific Surface, in²/in³	1160
Spacing Factor, inches	0.003
Paste Content, % estimated	18
Magnification	75x
Traverse Length, inches	102
Test Date	11/2/2020
Test Performed By	J. Duggan





Magnification: 30x
Description: Hardened air void system.

Report Prepared By:
American Engineering Testing, Inc.

Blake M. Lemcke, PG
Senior Petrographer/Geologist
MN License #50337

AMERICAN ENGINEERING TESTING, INC.

AIR VOID ANALYSIS

PROJECT:

I-35W AT LAKE ST
HENNEPIN COUNTY
S.P. 2782-327

REPORTED TO:

MINNESOTA DEPT OF TRANSPORTATION
CONSULTANT SERVICES UNIT
395 JOHN IRELAND BLVD
ST. PAUL, MN 55155-1899

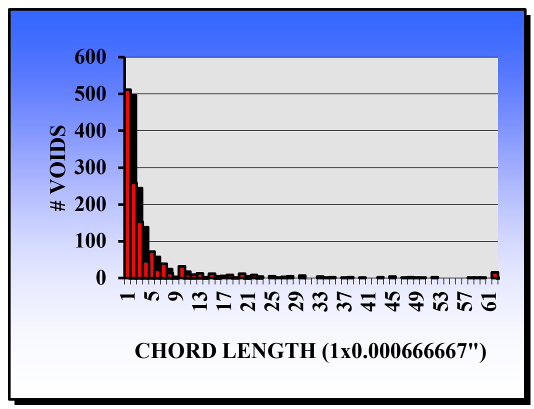
ATTN: MARIA MASTEN

AET PROJECT NO: 29-20883

DATE: NOVEMBER 10, 2020

Sample ID: #28

Conformance: The concrete contains an air void system which is consistent with current American Concrete Institute (ACI) recommendations for freeze-thaw resistance.



Sample Data

Description:	Hardened Concrete Cylinder
Dimensions:	152 mm (6") diameter by 305 mm (12") long

Test Data: By ASTM C457, Procedure A

Air Void Content %	4.9
Entrained, % < 0.040"(1mm)	4.1
Entrapped, %> 0.040"(1mm)	0.8
Air Voids/inch	12.8
Specific Surface, in^2/in^3	1060
Spacing Factor, inches	0.003
Paste Content, % estimated	17
Magnification	75x
Traverse Length, inches	102
Test Date	10/30/2020
Test Performed By	J. Duggan

Report Prepared By:
American Engineering Testing, Inc.

Blake M. Lemcke, PG
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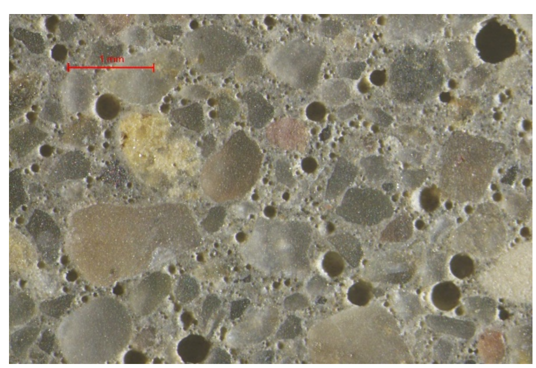
MN License #50337



Magnification: 30x
Description: Hardened air void system.

AMERICAN ENGINEERING TESTING, INC.

AIR VOID ANALYSIS

PROJECT:

I-35W AT LAKE ST
HENNEPIN COUNTY
S.P. 2782-327

REPORTED TO:

MINNESOTA DEPT OF TRANSPORTATION
CONSULTANT SERVICES UNIT
395 JOHN IRELAND BLVD
ST. PAUL, MN 55155-1899

ATTN: MARIA MASTEN

AET PROJECT NO: 29-20883

DATE: NOVEMBER 10, 2020

Sample ID: #29

Conformance: The concrete contains an air void system which is consistent with current American Concrete Institute (ACI) recommendations for freeze-thaw resistance.

Sample Data

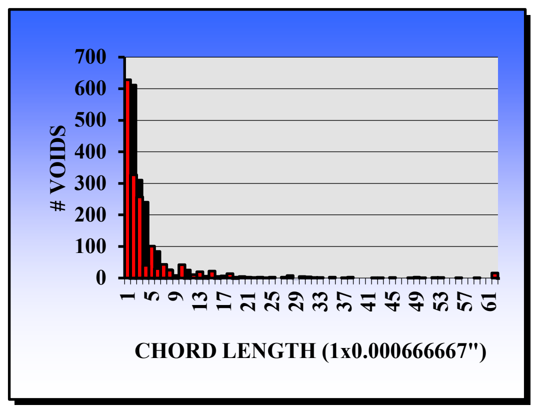
Description:	Hardened Concrete Cylinder
Dimensions:	152 mm (6") diameter by 305 mm (12") long

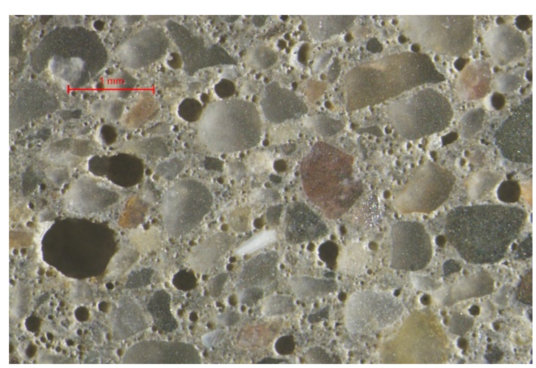
Test Data: By ASTM C457, Procedure A

Air Void Content %	6.2
Entrained, % < 0.040"(1mm)	4.7
Entrapped, %> 0.040"(1mm)	1.5
Air Voids/inch	16.3
Specific Surface, in^2/in^3	1050
Spacing Factor, inches	0.002
Paste Content, % estimated	16
Magnification	75x
Traverse Length, inches	102
Test Date	11/2/2020
Test Performed By	J. Duggan

Report Prepared By:
American Engineering Testing, Inc.

Blake M. Lemcke, PG
Senior Petrographer/Geologist
MN License #50337





Magnification: 30x
Description: Hardened air void system.

AMERICAN ENGINEERING TESTING, INC.

AIR VOID ANALYSIS

PROJECT:

I-35W AT LAKE ST
HENNEPIN COUNTY
S.P. 2782-327

REPORTED TO:

MINNESOTA DEPT OF TRANSPORTATION
CONSULTANT SERVICES UNIT
395 JOHN IRELAND BLVD
ST. PAUL, MN 55155-1899

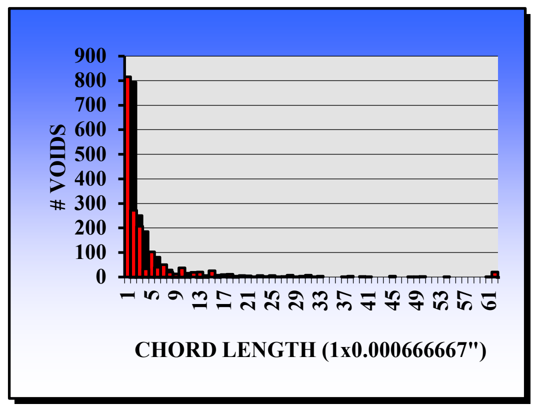
ATTN: MARIA MASTEN

AET PROJECT NO: 29-20883

DATE: NOVEMBER 10, 2020

Sample ID: #30

Conformance: The concrete contains an air void system which is consistent with current American Concrete Institute (ACI) recommendations for freeze-thaw resistance.



Sample Data

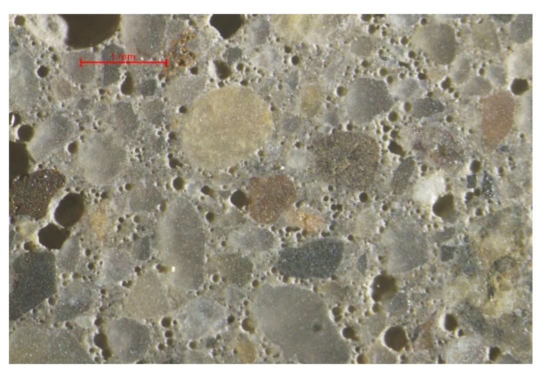
Description:	Hardened Concrete Cylinder
Dimensions:	152 mm (6") diameter by 305 mm (12") long

Test Data: By ASTM C457, Procedure A

Air Void Content %	6.8
Entrained, % < 0.040"(1mm)	5.2
Entrapped, %> 0.040"(1mm)	1.6
Air Voids/inch	18.6
Specific Surface, in^2/in^3	1090
Spacing Factor, inches	0.002
Paste Content, % estimated	17
Magnification	75x
Traverse Length, inches	96
Test Date	11/3/2020
Test Performed By	J. Duggan

Report Prepared By:
American Engineering Testing, Inc.

Blake M. Lemcke, PG
Senior Petrographer/Geologist
MN License #50337



Magnification: 30x
Description: Hardened air void system.

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