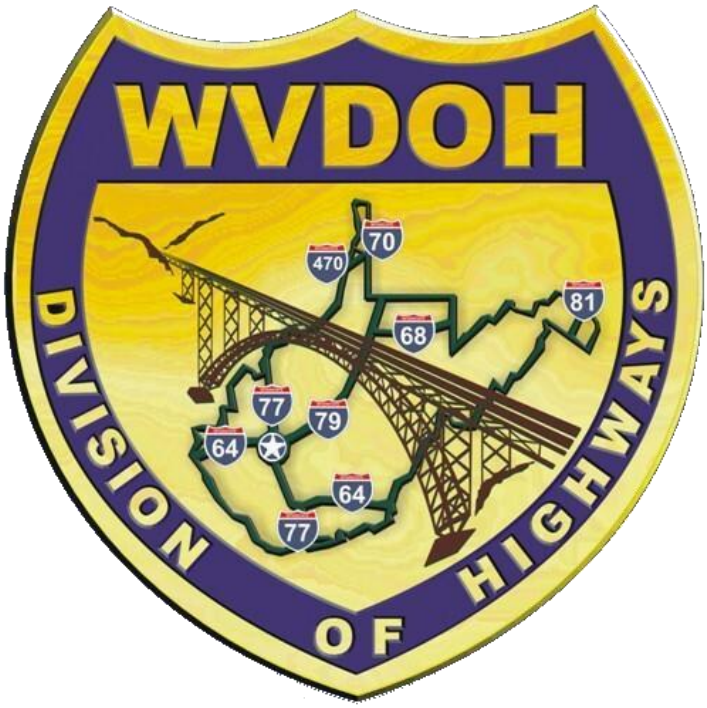
WVDOH PORTLAND CEMENT CONCRETE INSPECTOR AND TECHNICIAN

MATERIAL PROCEDURE MANUAL



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CONCRETE INSPECTOR AND

TECHNICIAN TRAINING PROGRAM

MATERIAL PROCEDURE MANUAL

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Informational Memorandum 18 (IM-18) Applicable Materials Procedures:

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

GUIDE FOR QUALITY CONTROL AND ACCEPTANCE REQUIREMENTS FOR PORTLAND CEMENT CONCRETE

1. PURPOSE

1.1 To establish minimum requirements for Contractor's Quality Control (QC) system and the Division's Acceptance Plan. It is intended that these minimum requirements be followed in detailing the inspection, sampling, and testing deemed necessary to maintain compliance with all Specification requirements.

2. SCOPE

2.1 This Materials Procedure (MP) is applicable to all Portland Cement Concrete (PCC) items, and it outlines the quality control procedures for both plant and field operations and includes procedures for approving and using Master and/or Project Specific QC Plans. This procedure also aids in documentation and retention of QC Plans in ProjectWise.

3. REFERENCED DOCUMENTS

3.1 AASHTO M 201 - Standard Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes.

3.2 AASHTO T 22 - Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens.

3.3 AASHTO T 231 - Standard Method of Test for Capping Cylindrical Concrete Specimens.

3.4 ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.

3.5 ASTM C1231 - Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Cylindrical Concrete Specimens.

3.6 ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

3.7 ASTM C511 - Standard Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes.

3.8 ASTM C617 - Standard Practice for Capping Cylindrical Concrete Specimens.

3.9 MP 109.00.21 - Basis for Charges for Non-Submittal of Sampling & Testing Documentation by the Established Deadline.

3.10 MP 300.00.51 - Procedural Guidelines for Maintaining Control Charts for Aggregate Gradation.

3.11 MP 601.03.52 – Procedural Guidelines for Maintaining Control Charts for Portland Cement Concrete.

3.12 MP 601.04.20 - Curing Concrete Test Specimens in The Field.

3.13 MP 601.05.50 - Quality Assurance Procedures for Portland Cement Concrete.

3.14 MP 700.00.54 - Procedure for Evaluating Quality Control Sample Test Results with Verification Sample Test Results.

4. GENERAL REQUIREMENTS

4.1 The Contractor shall provide and maintain a quality control system that will provide reasonable assurance that all materials and products submitted to the Division for acceptance will conform to the contract requirements whether manufactured or processed by the Contractor or procured from suppliers, subcontractors, or vendors. The Contractor shall perform or have performed the inspections and tests required to substantiate product conformance to contract document requirements and shall also perform or have performed all inspections and tests otherwise required by the contract. The Contractor's quality control inspections and tests shall be documented and shall be available for review by the Engineer throughout the life of the contract. The Contractor shall maintain standard equipment and qualified personnel as required by the Specifications to assure conformance to contract requirements. Procedures will be subject to the review of the Division before the work is started.

5. QUALITY CONTROL PLAN

5.1 The Contractor shall prepare a QC Plan detailing the type and frequency of inspection, sampling, and testing deemed necessary to measure and control the various properties of materials and construction governed by the Specifications. As a minimum, the sampling and testing plan should detail sampling location, sampling techniques, and test frequency to be utilized. Quality control sampling and testing performed by the Contractor may be utilized by the Division for acceptance.

5.1.1 A QC Plan must be developed by the Contractor and submitted to the Engineer prior to the start of construction on every project. Acceptance of the QC Plan by the Engineer will be contingent upon its concurrence with these guidelines.

5.1.2 As work progresses, an addendum(s) may be required to a QC Plan to keep the QC program current. Personnel may be required to show proof of certification for testing.

5.2 Quality Control Plan Guidelines

5.2.1 The Plan shall identify the personnel responsible for the Contractor's quality control. This should include the company official who will act as the liaison with Division personnel, as well as the Certified Portland Cement Concrete Technician who will direct the inspection program at the plant or in the field depending if it is a plant or field QC Plan. Their phone number and email address must also be included as a means for contact by the Division personnel.

5.2.2 All classes of concrete and corresponding mix design numbers, which may be used, shall be listed on the Plant QC Plan. All classes of concrete, which may be used, shall be listed on the Field QC Plan.

5.2.3 Process control sampling, testing, and inspection should be an integral part of the contractor's quality control system. In addition to the above requirements, the Contractor's QC Plan should document the process control requirements shown in Table 1 of Attachment 1. The process control activities shown in Table 1 are considered to be normal activities necessary to control the production and placement of a given product or material at an acceptable quality level. To facilitate the Division's activities, the Contractor, as per ML-25, shall retain all completed gradation samples until further disposition is designated by the Division.

5.2.4 All concrete producers shall provide an E-Ticket that meets the requirements of Section 109.20.1 of the Specifications.

5.2.5 All sampling and testing shall be in accordance with the methods and procedures required by the Specifications. Measuring and testing equipment shall be standard and properly calibrated as per the specified test procedures. If alternative sampling methods, procedures, and inspection equipment are to be used, they shall be detailed in the QC Plan. Any QC testing that is not performed in accordance with the methods and procedures required by the Specifications shall be considered an invalid test, and the applicable penalty for the cost associated with that test, in accordance with MP 109.00.20, will be assessed to the contractor, along with the applicable price adjustment in Section 105.3. The test specimen(s) represented by an invalid test shall be considered as not meeting Specifications and documented accordingly. The Division may, however, use the results of an invalid test to determine if material may be accepted and allowed to remain in place and if payment may be made for the material represented by the invalid test.

5.2.5.1 Any individual who samples or tests plastic concrete for quality control purposes shall be certified as a WVDOH PCC Inspector.

5.2.5.2 Any Laboratory which tests the hardened concrete cylinders for the Contractor, for quality control purposes, shall be listed in the Contractor’s QC Plan for field operations. This Laboratory shall provide evidence that it meets the applicable requirements in ASTM C1077, pertaining to testing hardened concrete cylinders, for a concrete testing laboratory, including curing facilities, testing equipment, technician proficiency, participation in the Cement and Concrete Reference Laboratory (CCRL) Concrete

Proficiency Sample Program (PSP), Quality Management System documentation, and recordkeeping. The only test required for these laboratories, in the CCRL Concrete PSP, is ASTM C39 (AASHTO T22), but it is recommended that the laboratory perform all the field test portions of these Proficiency Samples and maintain the results of these tests, in order to evaluate any root cause issues pertaining to compressive strength. Each Laboratory shall be inspected and evaluated initially, and at least once every regular inspection tour cycle (approximately 30 months) by the CCRL. The ASTM standards pertaining to testing concrete cylinders, with which the subject laboratory must comply, include ASTM C39 (AASHTO T22), ASTM C617 (AASHTO T231) or ASTM C1231, and ASTM C511 (AASHTO M201). The Personnel Qualification requirements in Section 6 of ASTM C1077 regarding PE direction, Laboratory Supervisors, and concrete laboratory personnel testing certifications also apply, except that a Laboratory Supervisor with at least five years' experience in construction materials testing shall be a permissible substitution for the licensed professional engineer. Subsequent documentation shall be provided to the Division showing that the subject Laboratory and personnel meet the applicable requirements of ASTM C1077, pertaining to testing concrete cylinders, for a concrete laboratory. In addition any laboratory conducting concrete surface resistivity testing must be evaluated by CCRL for AASHTO T358. Any Laboratory which desires to test Contractor hardened concrete QC specimens on WVDOH projects shall submit the evidence/documentation, required in Section 4.2.4.2, confirming compliance with ASTM C1077, with regards to testing concrete cylinders, to MCS&T Division at the following e-mail address: DOHMCSnTconcretelab@wv.gov. MCS&T Division will review this submittal. In this submittal, the subject Laboratory shall also explain how all deficiencies noted in the CCRL Laboratory Inspection Report have been addressed. All deficiencies noted in the CCRL Laboratory Inspection Report shall be resolved to the satisfaction of the Division within 90 days from the date of the CCRL Laboratory Inspection Report. Once MCS&T Division determines that the subject Laboratory is in compliance with the applicable requirements of ASTM C1077, and all deficiencies have been adequately resolved, that Laboratory will be placed on the Division's Approved List of Concrete Cylinder Testing Labs. All laboratories which test contractor hardened concrete QC specimens on WVDOH projects must be listed on the Division's Approved List of Concrete Cylinder Testing Labs. Laboratories that are certified to run AASHTO T358 will be indicated by an asterisk associated to the applicable footnote on the APL. A listing of these laboratories is available on the WVDOH MCS&T Webpage[1]. All Division Approved Laboratories shall provide the Division with the CCRL Lab Number for their laboratory and agree to allow DOH, CCRL, and AASHTO re:source to freely share information about assessment reports, proficiency samples, corrective actions, quality management system, and personnel competency and certification records.

[1] https://transportation.wv.gov/highways/mcst/Pages/APL_By_Number.aspx

5.2.6 When calculating the compressive strength of concrete cylinders in accordance with AASHTO T22, the following procedure shall be used:

$$CS = \frac{ML}{0.25 \times \pi \times D^2}$$

Where:

CS = Compressive Strength of the specimen
ML = Maximum load carried by the specimen during the test
π = Mathematical constant PI
D = Diameter of the cylinder being tested (in accordance with AASHTO T 22)

Note: The calculation for CS shall be performed in one continuous step (without any rounding), either by the testing machine, or by calculating device, and only the final value (CS) is permitted to be rounded (to the accuracy specified in AASHTO T 22). The value for π shall be the manufacturer's pre-programmed value in a calculating device or the testing machine.

5.2.7 Miscellaneous Concrete:

The contractor is not required to perform the process control testing required by Part C of Table 1 of the Attachment on miscellaneous concrete (as defined in section 5.2.7.1), provided that the concrete in question is being supplied by an A1 or A2 plant (as defined in MP 601.05.50, formerly numbered as IM-18), and provided that the requirements of section 5.2.7.2 are met for each project on which the reduced testing of miscellaneous concrete is applied.

5.2.7.1 Miscellaneous concrete shall be defined as relatively small quantities, not exceeding 25 yd^3 per day, incorporated into items that will not adversely affect the traffic carrying capacity of a completed facility. Such items would not include any concrete intended for major structures, permanent mainline or ramp pavements, or any other structurally critical items part of, or adjacent to the roadway.

The following items are suggested as a guideline in establishing items that may be categorized as miscellaneous concrete:
Note: Concrete testing for certain items below is waived, in some cases, by the referenced section of the specifications.

1 Sidewalks
2. Curb and Gutter
3. Slope walls for under drain outlet pipes
4. Temporary pavements and pipe crossings
5. Building floors
6. Slope paving and headers
7. Paved ditch or gutter

8. Small (less than 36" diameter) culvert headwalls
9. Catch basins, manhole bases, inlets, and junction boxes (and adjustments of such items) not located in the roadway
10. Foundations for breakaway supports
11. Utility trench fills
12. Cast-in-place survey markers

5.2.7.2 One sample per two days of production (for the same project) shall be tested (beginning on the first day of production) for compressive strength, air content, and consistency. On a minimum of ten percent of the samples outlined above, the Division will observe the batching operation at the plant (that is producing the concrete to be sampled) and check the operational control.

5.2.7.3 When placing miscellaneous concrete and no testing is required, an Approved Source Sample will be generated in SiteManager. The C###### representing the test from the previous day of production shall be entered in the intended use field. Miscellaneous Concrete will be entered in remarks. Miscellaneous Concrete will be written on all batch tickets for which testing is not required, per the miscellaneous concrete provisions of this MP, prior to scanning and placing in ProjectWise.

5.2.8 Documentation:

The Contractor shall maintain adequate records of all inspections and tests. The records shall indicate the nature and number of observations made, the number and type of deficiencies found, the quantities approved and rejected, and the nature of corrective action taken as appropriate. The Contractor's documentation procedures will be subject to the review and approval of the Division prior to the start of the work and to compliance checks during the progress of the work.

5.2.9 Charts and Forms:

All conforming and non-conforming inspections and test results shall be kept complete and shall be available at all times to the Division during the performance work. Forms shall be on a computer-acceptable medium where required. Batch ticket data shall be documented in accordance with the applicable section of MP 601.03.50, with a copy to be submitted to the District Materials Section within 72 hours of the concrete placement. Gradation data shall be documented on WVDOH form T300 using the material codes listed in the online computer systems user guide. The original gradation data shall be submitted to the District Materials Section within 72 hours of obtaining the gradation sample. Test data for (PCC) shall be charted in accordance with the applicable requirements of MP 601.03.52. Gradation test data shall be plotted in accordance with the applicable requirements of MP 300.00.51. The Contractor may use other types of control charts as deemed appropriate by the Division. It is normally expected that testing and charting will be completed within 48 hours after sampling.

The Contractor shall also ensure that all Material Suppliers prepare and submit the HL-441 form (weekly supplier report) in a timely manner

5.2.9.1 All charts and records documenting the Contractor's quality control inspections and tests shall become property of the Division upon completion of the work.

5.2.10 Batch Tickets

Each batch of Structural Concrete, including miscellaneous concrete (as defined in section 4.2.6.1), delivered at the project shall be accompanied by one batch ticket with all of the items of information listed in Section 4.2.9.1 pre-populated on the ticket. In the case of (PCC) Pavement, each batch of concrete delivered at the project on which a test in accordance with Table 1 of Attachment 1 is to be performed shall be accompanied by a batch ticket. This batch ticket shall have all of the items listed in section 4.2.9.1 pre-populated on the ticket unless non-agitator trucks or truck agitators are used. In this case, the batch ticket shall have all of the items listed in section 4.2.9.2 pre-populated on the ticket.

5.2.10.1 All batch tickets for Structural Concrete and (PCC) Pavement Concrete transported by truck mixers shall have all the following items pre-populated on the ticket:

1. Producer/Supplier Code
2. Producer/Supplier Name
3. Producer/Supplier Location
4. Mix Design Laboratory Reference Number
5. Date
6. Sequence Number
7. Volume (yd^3/m^3)
8. Time Batched
9. Contract Identification Number (CID #)
10. Federal Project Number (If applicable)
11. State Project Number
12. Material Code/Name
13. Water Allowed (gal/L)
14. Water at Plant (gal/L)
15. Weight of Ice at Plant (lb/kg)
16. Weight of Cement (lb/kg)
17. Supplementary Cementitious Material(s) (SCM) (lb/kg)
18. Weight of Fine Aggregate (lb/kg)
19. Weight of Coarse Aggregate (lb/kg)
20. *Admixture Name(s) and Dose (oz/L)
21. Cylinder I.D.
22. Initial Counter
23. Target Consistency (in/mm)
24. Target Air (%)
25. License Number of Haul Unit.

* If admixtures are added at the jobsite, these shall be entered by the project.

The following information shall be documented on the ticket by the project:

1. Contract Item Number
2. Contract Line Number
3. Time Unloaded
4. Water at Job (gal/L)
5. Concrete Temperature (^{o}F/^{o}C)
6. Final Counter
7. Actual Consistency (in/mm)
8. Actual Air (%)

5.2.10.2 All batch tickets for concrete delivered by means of non-agitator trucks or truck agitators shall have all of the following items pre-populated on the ticket:

1. Producer/Supplier Name
2. Mix Design Laboratory Reference Number
3. Date
4. Sequence Number
5. Volume (yd^3)
6. Time Batched
7. ~~7.~~ Contract Identification Number (CID #)
8. Federal Project Number (If applicable)
9. State Project Number
10. Material Code/Name
11. Water Allowed (gal/L)
12. Water at Plant (gal/L)
13. Weight of Ice at Plant (lb/kg)
14. Weight of Cement (lb/kg)
15. Weight of SCM (lb/kg)
16. Weight of Fine Aggregate (lb/kg)
17. Weight of Coarse Aggregate (lb/kg)
18. *Admixture Name(s) and Weight(s) (oz/L)
19. Target Consistency (in/mm)
20. Target Air (%)
21. License Number of Haul Unit.

* If admixtures are added at the jobsite, these shall be entered by the project

The following information shall be documented on the ticket by the project:

1. Item Number
2. Line Number
3. Time Unloaded
4. Temperature (°F/°C)
5. Actual Consistency (in/mm)
6. Actual Air (%)

5.2.10.3 The batch ticket in the case of either type of concrete shall be a batch ticket prepared by the plant. This ticket must be computer generated with blank fields provided in which all of the required data shall be recorded. The data items listed above that are completed in the field (such as Time Unloaded, Actual Consistency, etc.) must have a field on the batch ticket for completion. Volume is to be reported to the nearest 0.01 yd^3. Consistencies are to be reported to the nearest 0.25 inch. Target and Actual Air are to be reported to the nearest 0.1% (to the nearest 0.25% if the volumetric method is used).

5.2.10.4 As per the requirements of Section 109.20.1 of the Specifications, an E-Ticket shall be provided to meet these requirements.

5.2.11 Corrective Action:

The Contractor shall take prompt action to correct conditions, which have resulted, or could result, in the submission to the Division of materials and products, which do not conform to the requirements of the Contract documents.

5.2.12 Non-Conforming Materials:

5.2.12.1 The Contractor shall establish and maintain an effective and positive system for controlling non-conforming material, including procedures for its identification, isolation and disposition. Reclaiming or reworking of non-conforming materials shall be in accordance with procedures acceptable to the Division. All non- conforming materials and products shall be positively identified to prevent use, shipment, and intermingling with conforming materials and products. Holding areas, mutually agreeable to the Division and the Contractor shall be provided by the Contractor.

5.2.13 Types of QC Plans:

5.2.13.1 QC Plans which are intended for use on more than one project shall be defined as Master QC Plans. Section 4.3 outlines the procedures for Master QC Plan submittal and approval.

5.2.13.2 QC Plans which are intended for use on a single project shall be defined as Project Specific QC Plans. Project Specific QC Plans shall contain a cover letter which includes the following: project description, CID#, Federal and/or State Project Number.

5.2.13.3 A Contractor may submit a Master QC Plan for Plant and/or Field operations instead of a Project Specific QC Plan.

5.2.13.4 Once any QC Plan is approved for a project, the key date shall be entered in SiteManager by the appropriate District Materials personnel. The first date entered shall be the date the Project QC Plan letter is received. The second date shall be when the District approves the QC Plan for use on the project.

5.3 Master QC Plan

5.3.1 The intent of Master QC Plans is to facilitate the approval process in a more uniform manner. Master QC Plans can be submitted to the Division by the Contractor when their workload in a given District is routinely repetitive for the year.

5.3.2 The Contractor shall submit a Master Field QC Plan yearly to each District in which they have work (see Attachment 2). If the Contractor does not have work in a given District for the year, then a Master Field QC Plan does not need to be submitted to that District.

5.3.3 The Producer/Supplier shall submit a Master Plant QC Plan at the beginning of each year to the District in which their plant is located (see Attachment 3).

5.3.4 The District will review the submitted Master QC Plans to see if they meet the applicable requirements of Sections 4.2 thru 4.2.11.1 and assign a Laboratory Reference Number to each QC Plan upon approval, for future referencing. The District will acknowledge approval of each Master QC Plan to the Contractor and/or Producer/Supplier by letter (see Attachment 4), which will include the Laboratory Reference Number and a copy of the approved Master QC Plan. This will then be scanned and placed in ProjectWise under the appropriate District's Org for that Contractor and/or Producer/Supplier.

5.3.5 Once a project has been awarded, if a contractor elects to use the approved Master Plant and Master Field QC Plans on that project, the Contractor shall submit a letter requesting to use the Master QC Plans for that project. This letter must be on the Contractor's letterhead, be addressed to the District Engineer/Manager or their designee, and contain the following information: project number, CID#, project description, type of Quality Control Plan and the laboratory reference number for the Master QC Plan. See Attachment 5 for an example of a plant letter and Attachment 6 for an example of a field letter.

5.3.5.1 The District shall review the referenced Master QC Plans to ensure they cover all items in that project. If the referenced Master QC Plan is found to be insufficient for some items on that project, the District shall request the Contractor to submit additional information for quality control of those items as an addendum on a project specific basis. When the District is satisfied with the QC Plan for that project, a letter shall be sent to the Contractor acknowledging approval (see Attachment 7), with the following

attached: the contractor's project QC Plan request letter and the Master QC Plan approval letter. This shall then be placed in the project's incoming-mail mailbox in ProjectWise.

5.3.5.2 A Master QC Plan that has been approved for project use shall be good for the duration of that project.

5.3.5.3 For the use of Division Personnel, the District approval letter for this project must state the ProjectWise link to the referenced Master QC Plan for that Contractor (for example: WVDOT ORGS > District Organization #> Materials > Year > Master QC Plans).

5.3.6 The Master Field and Plant QC Plans shall be valid for the duration of one calendar year beginning on January 1st and ending on December 31st. The Master Plant QC Plan will also cover maintenance purchase order concrete for the year.

6. ACCEPTANCE SAMPLING AND TESTING

6.1 Acceptance sampling and testing is the responsibility of the Division. Quality control tests by the Contractor may be used for acceptance.

6.2 The Division shall sample and test for applicable items completely independent of the contractor at a frequency equal to approximately ten (10) percent of the frequency for testing given in the approved QC Plan. Witnessing the contractor's sampling and testing activities may also be a part of the acceptance procedure, but only to the extent that such tests are considered "in addition to" the ten (10) percent independent tests.

6.3 Results from independent tests conducted by the Division for gradation, entrained air, consistency, and strength will be plotted on the Contractor's quality control charts with a red circle but are not to be included in the moving average. When the Contractor's tests are witnessed, the results are circled on the control chart in red and are to be included in the moving average calculations.

6.4 Results from both independent tests and witnessed tests will be evaluated in accordance with MP 700.00.54. If a dissimilarity is detected, an investigation shall be immediately initiated to determine the cause of the dissimilarity.

7. ABSENT TESTING OF MATERIAL

7.1 If the Contractor fails to perform testing of the material in accordance with the Contractor's Division Approved Quality Control Plan, payment for the portion of the item represented by the absent test shall be withheld, pending the Engineer's decision whether or not to allow the material to remain in place. Testing includes both performing the test and submitting the results as per MP 109.00.21.

7.1.1 If the Engineer allows the material to remain in place, the Division shall not pay for the material represented by the absent test. However, the Division shall pay for the cost of the placement of the material, including labor and equipment. The invoice or material supplier cost (if applicable), determined at the time of shipment, shall be used to calculate the cost of material when evaluating the total cost of labor and equipment.

Michael Mance Digitally signed by Michael Mance
Date: 2024.08.23 10:03:05 -04'00'

Michael A. Mance, P.E.
Interim Director
Materials Control, Soils and Testing Division

MP 601.03.50 Steward – Cement and Concrete Section
MM:T
ATTACHMENTS

TABLE 1
CONTRACTORS PROCESS CONTROL REQUIREMENTS
STRUCTURAL CONCRETE AND
PORTLAND CEMENT CONCRETE PAVEMENT

	Minimum frequency*
A. PLANT AND TRUCKS	
1. Mixer Blades	Prior to Start of Job and Weekly
2. Scales	
a. Tared	Daily
b. Calibrate	Prior to start of Job
c. Check Calibration	Weekly
3. Gauges and Meters-Plant and Truck	
a. Calibrate	Yearly
b. Check Calibration	Weekly
4. Admixture Dispenser	
a. Calibrate	Prior to Start of Job
b. Check Operation and Calibration	Daily
B. AGGREGATES	
1. Fine Aggregate	
a. Gradation	Per section 601.3.2.4 of the Specifications
b. Moisture	Daily

2. Coarse Aggregates

a. Gradation	Per section 601.3.2.4 of the Specifications
b. Percent passing No. 75µm	Daily
c. Ā for Combined Coarse Aggregates Fine Aggregates and Cement	Per section 601.3.2.4 of the Specifications
d. Moisture	Daily

3. Optimized Aggregates

a. Gradation	Per section 601.3.2.4.1 of the Specifications
b. Moisture	Daily

C. PLASTIC CONCRETE

1. Entrained Air Content

Pavement Concrete	Two at the beginning of the paving operation, per Section 501.4.2, then one per 500 yd^3 (380 m^3) or fraction thereof, with a minimum of two per day
Structural Concrete (except Bridge Superstructure)	One per 100 yd^3 (75 m^3) or fraction thereof, with a minimum of one per ½ day of operation
Bridge Superstructure	One per batch

2. Consistency**

Pavement Concrete	One per 500 yd^3 (380 m^3) or fraction thereof, with a minimum of two per day
Structural Concrete (except Bridge Superstructure)	One per 100 yd^3 (75 m^3) or fraction thereof, with a minimum of one per ½ day of operation

Bridge Superstructure	One for first batch and one for every fifth batch thereafter
3. Temperature	Per Specification
4. Yield	
Pavement Concrete	Per Section 501.3 of the Specifications and one for each five days of operation after the first five days of operation
Structural Concrete	Per Section 601.3.2.3 of the Specifications and one for each ten sets of cylinders after the first ten
5. Compressive Strength***	
Pavement Concrete	One set of concrete cylinders for each 350 yd^3 (270 m^3) or fraction thereof
Structural Concrete	For each class concrete delivered and placed on a calendar day from a single supplier, one set of concrete cylinders for each 100 yd^3 (75 m^3) or fraction thereof
6. Permeability	
Pavement Concrete	N/A
Structural Concrete	Per Section 601.4.5 of the Specifications
Specialized Concrete Overlays	Per Section 679.2.2 of the Specifications

* Frequency for Process Control will vary with the size and type of aggregate or mixture and the batch-to-batch variability of the item.

** When superplasticizer is added to the concrete in the field, additional consistency testing is required as per Section 601.3.2.1 of the Specifications.

*** All cylinders shall be made, cured, and shipped to the Laboratory in accordance with AASHTO R 100 and MP 601.04.20. They shall be tested in accordance with AASHTO T 22 and the applicable section of the Specifications.

Example
COMPANY LETTERHEAD

Mr./Ms./Mrs. _____
West Virginia Department of Highways
District ___ Engineer/Manager
_____, WV #####

RE: Master PCC Field QC Plan

Dear _____,

We are submitting our PCC Field Quality Control Plan, developed in accordance with Sections 501 and 601 of the (year) WVDOH Standard Specifications, the (year) WVDOH Supplemental Specifications, and MP 601.03.50.

1. The Quality Control program is under the direction of_____, who can be contacted in Field/Office, by telephone number _____, cell#_____, and/or e-mail address _____.

2. Sampling and testing will be performed by qualified personnel as per WVDOH specifications Section 106.

3. Class(es) of Concrete to be controlled are listed as follows:

   - All types Class A - All types Class B - All types Class C

   - All types Class D - All types Class K - All types Class H

   - Etc.

4. All items in this QC Plan will be sampled at a minimum frequency as specified in Table 1 of Attachment 1. We acknowledge that additional sampling may be required by the Division in addition to the minimum frequency stated.

5. All sampling and testing will be in accordance with the methods and procedures required by the Specifications. All measuring and testing equipment shall be standard and properly calibrated as per the specified test procedure. *(If alternative sampling methods, procedures and inspection equipment are to be used please state in detail what they are and how they will be utilized.)*

6. Batch ticket data shall be documented in accordance with the applicable section of MP 601.03.50, with a copy to be submitted to the District Materials Section within 72 hours of the concrete placement.

7. Calculation of the compressive strength of concrete cylinders will be done as shown in Section 5.2.5 of MP 601.03.50.

8. Testing of Miscellaneous Concrete will be as specified in Section 5.2.6 and Sub-Sections 5.2.6.1 thru 5.2.6.3 of MP 601.03.50.

9. We will maintain adequate records of all inspection and tests. The records will indicate the type of test, number of observations made, the amount and type of deficiency's found, the quantities approved and rejected, and the nature of corrective actions taken as appropriate.
   Our documentation procedures will be subject to the review and approval of the Division prior to the start of the work and to compliance checks during the progression of the work.

10. Our company will take prompt action to correct conditions, which have resulted or could result, in the submission to the Division/District of materials and products, which do not conform to the requirements of the contract documents.

11. Non-Conforming Materials -- *State how you will establish an effective and positive system for controlling non-conforming material. This shall include the following:*

    - procedures for non-conforming material identification
    - isolation and disposition of this material

    Reclaiming or reworking of non-conforming materials shall be in accordance with procedures acceptable to the Division.
    Our company will specify and provide holding areas, which shall be mutually agreeable by the Division and Contractor.

Very Truly Yours,

_____
Company Official, Title

Example
COMPANY LETTERHEAD

Mr./Ms./Mrs. _____
West Virginia Department of Highways
District ___ Engineer/Manager
_____, WV #####

RE: Master PCC Plant QC Plan

Dear _____,

We are submitting our PCC PLANT Quality Control Plan, developed in accordance with Sections 501 and 601 of the (year) WVDOH Standard Specifications, the (year) WVDOH Supplemental Specifications, and MP 601.03.50.

1. The Quality Control program is under the direction of_____, who can be contacted in Field/Office, by telephone number _____, cell#_____, and/or e-mail address _____.

2. Sampling and testing will be performed by qualified personnel as per Specifications Section 106.

3. The PCC Mix Designs and class of concrete to be controlled are listed below:

	Mix Design Number	Class of Concrete
1.	#######	Class B
2.	_____	_____
3.	_____	_____
4.	_____	_____
Etc.		

4. All items in this QC Plan will be sampled at a minimum frequency as specified in Table 1 of Attachment. We acknowledge that additional sampling may be required by the Division in addition to the minimum frequency stated.

5. All sampling and testing will be in accordance with the methods and procedures required by the Specifications. All measuring and testing equipment shall be standard and properly calibrated as per the specified test procedure. *(If alternative sampling methods, procedures and inspection equipment are to be used please state in detail what they are and how they will be utilized.)*

6. Charts and forms
Our Company will make sure all conforming and non-conforming inspections and test results shall be kept complete and shall be available at all times to the Division during the performance work. Forms shall be on a computer-acceptable medium where required. Gradation data shall be documented on WVDOH form T300 using the material codes listed in the online computer systems user guide. The original gradation data shall be submitted to the District Materials Section within 72 hours of obtaining the gradation sample. Test data for Portland cement concrete shall be charted in accordance with the applicable requirements of MP 601.03.52. Gradation test data shall be plotted in accordance with the applicable requirements of MP 300.00.51. We may use other types of control charts as deemed appropriate by Division. It is normally expected that testing and charting will be completed within 48 hours after sampling. Our Company shall also ensure that all Material Suppliers prepare and submit the HL-441 form (weekly supplier report) in a timely manner. All charts and records will be turned over to the Division upon completion of work for a given WVDOH project.

7. *State that batch tickets will conform to requirements of MP 601.03.50 Section 5.3.9 and its applicable subsections.*

8. Our company will take prompt action to correct conditions, which have resulted or could result, in the submission to the Division of materials and products, which do not conform to the requirements of the contract documents.

9. Non-Conforming Materials - *State how you will establish an effective and positive system for controlling non-conforming material. This shall include the following:*

- procedures for non-conforming material identification
- isolation and disposition of this material

Reclaiming or reworking of non-conforming materials shall be in accordance with procedures acceptable to the Division.
Our company will specify and provide holding areas, which shall be mutually agreeable by the Division and Contractor.

Very Truly Yours,

_____
Company Official, Title

WVDOH District Master QCP Approval Letter
*** EXAMPLE ***
WVDOH LETTERHEAD

ACME Company
20 First St.
Somewhere, WV #####

RE: PCC Plant or PCC Field *(whichever is applicable)*
Master QC Plan
Description: (YEAR)
P/S code: (only if a plant QCP)

Dear Sir,

Your Quality Control Plan (M#-#####) for _____has been reviewed and found to be acceptable for the following items:

- All WVDOH approved Designs for PCC Classes of Concrete controlled by the referenced QC plan.

As work progresses throughout the season an addendum(s) may be required to this QCP to keep the QC program current. Also note that personnel may be required to show proof of certification for testing. Please use Lab Reference # M#-###### when corresponding about this QC plan. Please make sure that all appropriate personnel have a copy of this plan in their possession.

Very truly yours,

_____
Name, Title

Example
COMPANY LETTERHEAD

Mr./Ms./Mrs. _____
WV Department of Highways
District ___ Engineer/Manager
_____, WV #####

RE: PCC Quality Control Plan
for Plant ---- Project

Federal Project No. _____
State Project No. _____
Contract ID No. _____
Description _____

Dear Mr./Ms./Mrs. _____,

We would like to use our Producer/Supplier's name Master PCC Plant QC Plan, reference number _____ for the project referenced above. All PCC items on the referenced project are covered by the Master PCC Plant QC Plan. *(if needed state the Special Provision and that the addendum is attached for Quality Control of Special Provision Item)*

The Quality Control Plan is under the direction of _____, _____(title), and will be the company's contact representative to the Division of Highways District Materials and Construction Departments. They can be contacted in person at the plant, by telephone _____or at e-mail at _____.

Very truly yours,

_____

Company Representative

Example
COMPANY LETTERHEAD

Mr./Ms./Mrs. _____
WV Department of Highways
District ___ Engineer/Manager
_____, WV #####

Re: PCC Quality Control Plan
for Field ---- Project

Federal Project No. _____
State Project No. _____
Contract ID No. _____
Description _____

Dear Mr./Ms./Mrs. _____,

We would like to use our approved Master PCC Field QC Plan, reference number _____ for the project referenced above. All PCC items on the referenced project are covered by the Master PCC Field QC Plan. *(if needed state the Special Provision and that the addendum is attached for Quality Control of Special Provision Item)*

The Quality Control Plan is under the direction of _____, _____(title), and will be the company's contact representative to the Division of Highways District Materials and Construction Departments. They can be contacted in person at the plant, by telephone _____or at e-mail at _____.

Very truly yours,

_____

Company Representative

WVDOH District Master QCP Approval Letter
*** EXAMPLE ***
WVDOH LETTERHEAD

ACME Company
20 First St.
Somewhere, WV #####

RE: PCC Field or PCC Plant *(whichever is applicable)* QC Plan

Project CID#: ########
Fed/State Project #: NHPP- ## - ####-##
Description: Falling Slide
County: XXXXXXX
P/S Code: (If a Plant)

Dear Sir,

Your request to use Master Quality Control Plan (M# - ######) for PCC Plant or PCC Field (*whichever is applicable)* on the project referenced above, has been reviewed and found to be acceptable for the following items:

- All WVDOH approved designs and classes of PCC controlled by this QCP listed below:

- Class B - Class B modified - Class K -etc.

As work progresses throughout this project an addendum(s) may be required to this QCP to keep the QC program current. Please use M# - ###### when corresponding about this QC Plan. Also note that personnel may be required to show proof of certification for testing. Please make sure that all appropriate personnel have a copy of this plan in their possession.

For Division Reference: The Master Quality Control Plan can be reviewed in ProjectWise at the folder shown below:
WVDOH ORG>D0#>year>MASTER QC PLANS>Contractors or Plant>Company >folder>Name of file (i.e.: 2016 04 05 M#160001 PCC Plant QCP)

Very truly yours,

_____
Name, Title

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

STANDARD METHOD FOR DETERMINATION OF Ā OF THE TOTAL SOLIDS IN PORTLAND CEMENT CONCRETE

1. PURPOSE

1.1 To establish a procedure for determining the Ā of the total solids contained in portland cement concrete.

1.2 To establish a uniform definition of Ā.

2. SCOPE

2.1 This procedure shall apply in all cases where the specification requires the determination of Ā of the total solids in portland cement concrete.

3. DEFINITIONS

3.1 Ā (A-Bar) – A factor that characterizes the gradation of an aggregate. The size of the factor is very highly correlated with the aggregate surface area. The Ā factor is used as a control in concrete mix designs.

4. PROCEDURE

4.1 Since the solids contained in a portland cement concrete mix consist of coarse aggregate, fine aggregate, and portland cement, this procedure will address the determination of Ā of these solids in combination.

4.1.1 The mass of the solid materials used in the mix proportions shall be used to determine the percent of each constituent material in the total solids.

4.1.1.1 Determine the total mass of solids: $M_{ca} + M_{fa} + M_c = M_t$

Where:

M_{ca} = mass of coarse aggregate (SSD) used in one cubic yard (meter) of concrete.
M_{fa} = mass of fine aggregate (SSD) used in one cubic yard (meter) of concrete.
M_c = mass of cement used in one cubic yard (meter) of concrete.

M_t = total mass of solids in one cubic yard (meter) of concrete.

Determine the fractional part of each solid (solid fraction):

$\frac{M_{ca}}{M_t}$ = fractional part of coarse aggregate in the mix

$\frac{M_{fa}}{M_t}$ = fractional part of fine aggregate in the mix

$\frac{M_c}{M_t}$ = fractional part of cement in the mix

4.1.2 Determine the gradation of each of the individual materials using standard procedures with the following modifications.

4.1.2.1 When determining the fine aggregate gradation, include Standard Sieve sizes 3/8 inch (9.5 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (600 µm), No. 50 (300 µm), No. 100 (150 µm), and No. 200 (75 µm).

4.1.2.2 When determining the coarse aggregate gradation, all material passing the smallest specification sieve shall be sieved through either eight or twelve inch sieves. Only a minor amount of material will be retained on any sieves above the No. 200. This amount of material is considered to be insignificant and is added to the amount retained on the No. 200 sieve.

4.1.3 Determine the Solid Ā's. The Solid Ā of each constituent shall be determined by adding the cumulative percentages by mass of material passing each of Standard Sieve sizes 1 1/2 inch (37.5 mm), 3/4 inch (19 mm), 3/8 inch (9.5 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (600 µm), No. 50 (300 µm), No. 100 (150 µm), and No. 200 (75 µm) and dividing by 100.

4.1.4 Determine the Ā of each of the solids using the fractional parts (solid fractions) from 4.1.1.2 and the Solid Ā of each constituent from 4.1.3.

$\bar{A}_{ca}$ = fractional part of coarse aggregate x Solid Ā of coarse aggregate

$\bar{A}_{fa}$ = fractional part of fine aggregate x Solid Ā of fine aggregate

$\bar{A}_{c}$ = fractional part of cement x Solid Ā of cement

Where:

$\bar{A}_{ca}$ = Ā of coarse aggregate
$\bar{A}_{fa}$ = Ā of fine aggregate
$\bar{A}_{c}$ = Ā of cement

4.1.5 Determine the Ā of the Total Solids:

Ā Total Solids = $\bar{A}_{ca} + \bar{A}_{fa} + \bar{A}_{c}$

08/31/2022

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 601.03.51 Steward – Cement and Concrete Section
RLS:T
ATTACHMENT

EXAMPLE OF CALCULATIONS
Ā TOTAL SOLIDS

1. Total mass of solids in one cubic yard (meter) of concrete:

M_{ca} = Mass of SSD Coarse Aggregate = 1800 lb. (816kg) M_{fa} =

Mass of SSD Fine Aggregate = 1100 lb. (499 kg) M_c = Mass of

cement =600 lb. (272 kg)

M_t = Total mass of Solids

$M_t = M_{ca} + M_{fa} + M_c$

M_t = 1800 lb. (816 kg) + 1100 lb. (499 kg) + 600 lb. (272 kg) = 3500 lb. (1587 kg)

2. Fractional part of each solid:

$$\frac{M_{ca}}{M_t} = \frac{1800 \text{ lb. } (816 \text{ kg})}{3500 \text{ lb. } (1587 \text{ kg})} = 0.514$$

$$\frac{M_{fa}}{M_t} = \frac{1100 \text{ lb. } (499 \text{ kg})}{3500 \text{ lb. } (1587 \text{ kg})} = 0.314$$

$$\frac{M_c}{M_t} = \frac{600 \text{ lb. } (272 \text{ kg})}{3500 \text{ lb. } (1587 \text{ kg})} = 0.171$$

3. Determination of the Solid Ā of each constituent:

PERCENT PASSING

Sieve Size	Coarse Aggregate	Fine Aggregate	Cement
1 1/2 in. (37.5 mm)	100	100	100
3/4 in. (19.0 mm)	84	100	100
3/8 in. (9.5 mm)	21	100	100
No. 4 (4.75 mm)	2	98	100
No. 8 (2.36 mm)	1	83	100
No. 16 (1.18 mm)	0	65	100
No. 30 (600 µm)	0	48	100
No. 50 (300 µm)	0	13	100
No. 100 (150 µm)	0	3	100
No. 200 (75 µm)	0.5	1.5	100
Totals	208.5	611.5	1000
Solid Ā's	2.08	6.12	10

4. Determine the Ā of each of the solids:

$\bar{A}_{ca} = 0.514 \times 2.08 = 1.07$
$\bar{A}_{fa} = 0.314 \times 6.12 = 1.92$
$\bar{A}_{c} = 0.171 \times 10 = 1.71$

5. Determine the Ā of the Total Solids:

$\bar{A}$ Total Solids $= 1.07 + 1.92 + 1.71 = 4.70$

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PROCEDURAL GUIDELINES FOR MAINTAINING CONTROL CHARTS FOR PORTLAND CEMENT CONCRETE

1.0 PURPOSE

1.1 To establish guidelines for developing and maintaining control charts to evaluate consistency, percent entrained air, strength characteristics, and the total solids A of portland cement concrete.

2.0 SCOPE

2.1 These procedures shall be applicable in all instances in which they can be reasonably and logically applied. For consistency, air, and strength, the applicability will normally depend on the quantity of material used, the continuity of delivery, etc. Control charts for total solids A shall be maintained for all concrete designs used on state work by a concrete producer.

3.0 GENERAL PROCEDURE

3.1 Control charts will be maintained at locations where the test samples are taken.

3.2 Control charts will be prepared on a 10 x 10 cross section paper with a width of approximately 560 mm for the sheet presenting the charts for consistency, percent entrained air, and strength characteristics. A separate sheet of sufficient width shall be used to accommodate the control charts for the total solids A for concrete mix designs. A chart length of approximately 760 mm should be displayed at all times. When standard cross section sheets are used, the most recent sheet will be displayed and the previous sheets will be placed chronologically in a holder.

3.3 Charts for consistency, air, and strength shall have the item number and/or description of the material noted on the top of the chart and will be visible at all times. charts will have the design number and class of concrete visible at all times.

4.0 CHART PREPARATION

4.1 At the beginning and end of each sheet (or the length of the displayed portion), vertical red lines will be drawn between the limits of the specification or tolerance; an arrow will be placed at the end of the vertical lines; the specification limits will be written above and below the arrows and the name of the property being graphed and the scale will be indicated between the limits on the left edge of the chart. See Appendix 1 and 2 for typical arrangements.

4.2 Scale

4.2.1 Consistency - One division of vertical scale will represent 5.0 mm of slump, or 5.0 mm of ball penetration (25 mm - 50 mm).

4.2.2 Air Content - One division of vertical scale will represent one-tenth of a percentage point of entrained air (25 mm - 1%).

4.2.3 Strength - One division of vertical scale will represent 1 MPa (25 mm = 10 MPa) compressive or 69 KPa (25 mm = 1 MPa) flexural strength.

4.2.4 Total solids A - One division of vertical scale will represent .01 (25 mm = 0.1) when the coarse aggregate size is 57, 7, 78, or 8 and .02 (25 mm = 0.2) when the coarse aggregate size is Number 3.

4.3 Plotting Test Data

4.3.1 Symbols and Color Code - Individual test values will be plotted in blue using the symbol " O ", with the circle being approximately 2.5 mm in diameter. Average test values for consistency, percent air, and strength as well as the averages of consecutive five test values for total

solids A shall be plotted in red using the symbol " □ ", with the square being approximately 2.5 mm on each side. Independent Assurance test values developed by the Division, including record samples, will be plotted in green using the symbol " r " with the sides of the triangle being approximately 2.5 mm.

4.3.2 Arrangement of Data - All data developed on a production day will be plotted on one heavy, vertical line, however, when two or more individual test values developed on the same production day have the same magnitude, the symbols may be plotted side-by-side on the same horizontal division line. All test data for a characteristic developed on a production day, exclusive of any independent testing conducted by the Division, will be averaged, and the average value plotted on the same vertical line as the individual test values. When an average value and an individual test value have the same magnitude, the plotted symbols may be superimposed.

4.3.3 When individual test values fall outside the specification limits, an arrow will be placed on the plotted symbol pointing in the direction of the specification limit.

4.3.4 As test data are developed on following production days, it will be plotted on successive heavy vertical lines, 25 mm apart, progressing from left to right across the control chart. As successive averages for consistency, percent air, and strength characteristic are plotted, the symbol " □ " will be connected with a heavy red solid line. For total solidsA control chart the moving average is the average of five consecutive test values and is determined by starting with the fifth test value and averaging it with the four preceding test values. The moving average of five symbol " □ " will be connected with a heavy red solid line. Individual test values will have the symbol " O " connected with a dashed blue line.

4.3.5 At the bottom of the cross section paper and immediately to the left of the heavy vertical line on which the test data are plotted, the date of sampling and initials of the individual plotting the test data will be recorded.

5.0 FAILING TESTS

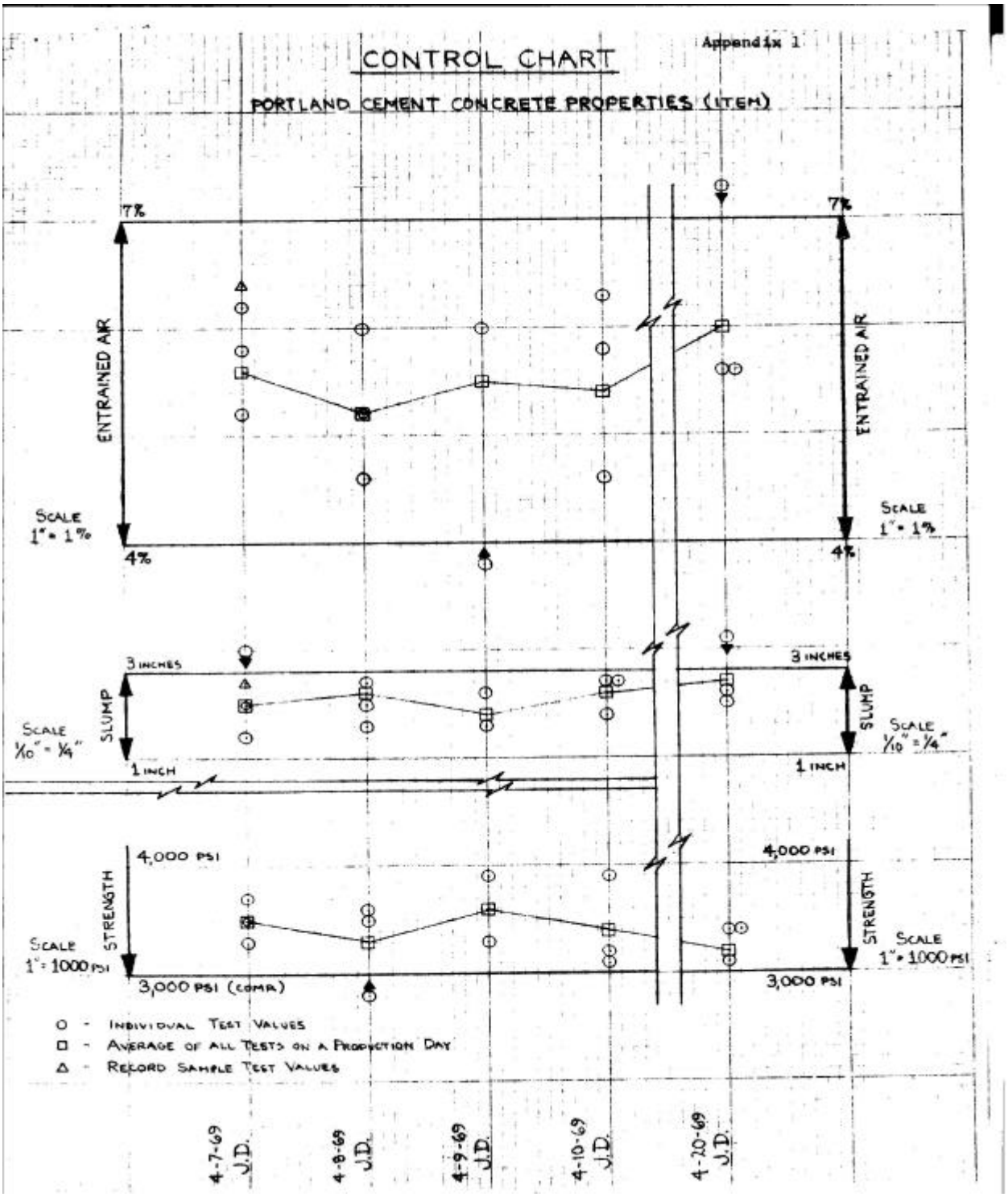
5.1 When individual test values fall outside the specification limits, this information will immediately be made available to the supervisory personnel of both the Contractor and the Division.

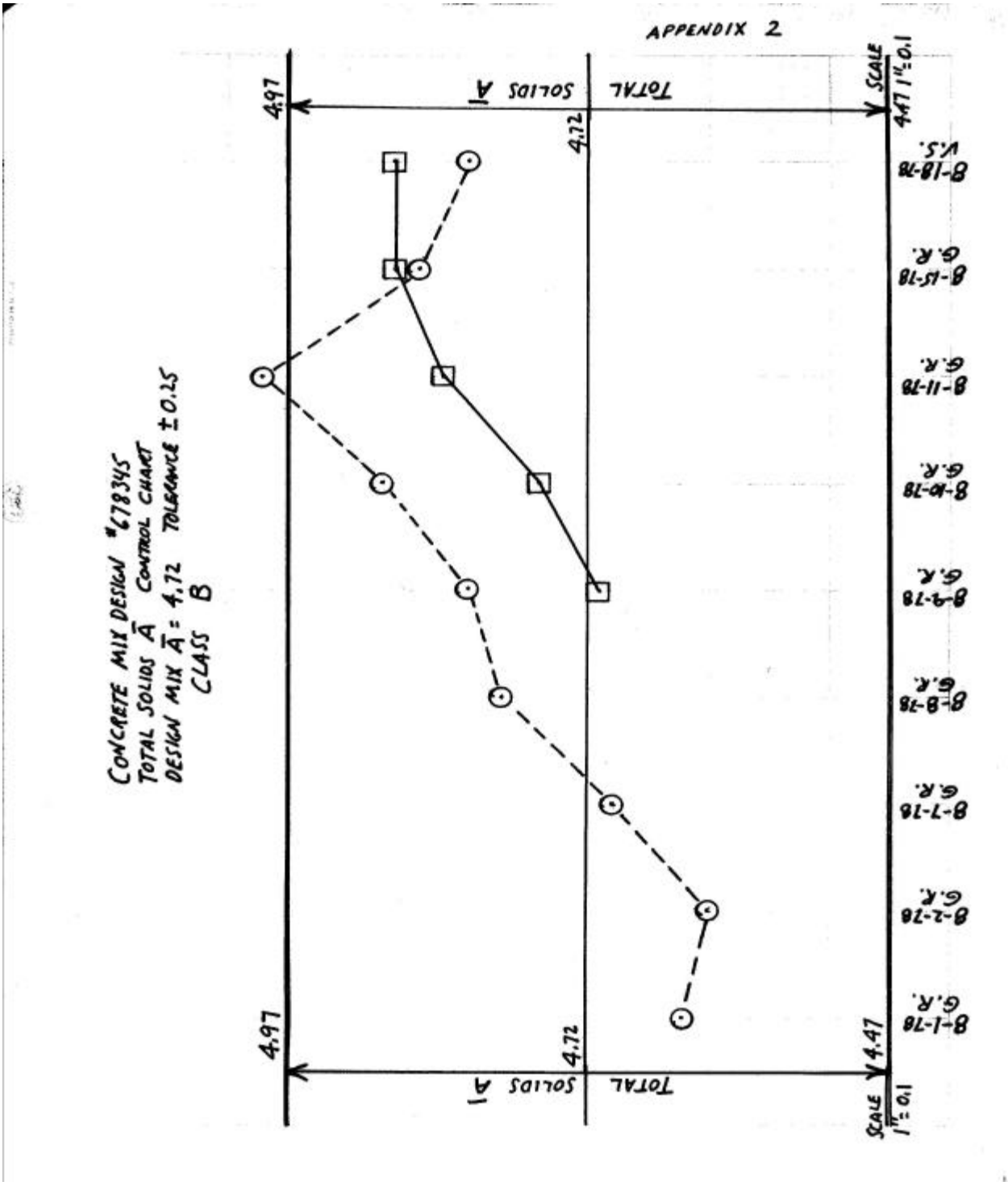
5.2 Should the moving average of five fall outside the design mixA tolerance, action required by the Specification will be taken. When appropriate action has been taken to bring theA back within tolerance the first individual production sample that is within tolerance shall be used to start a new moving average.

Gary L. Robson, Director
Materials Control, Soils
and Testing Division

GLR:w

Attachments


Appendix 1
CONTROL CHART
PORTLAND CEMENT CONCRETE PROPERTIES (ITEM)
7%
4%
ENTRAINED AIR
SCALE 1" = 1%
3 INCHES
1 INCH
SLUMP
SCALE 1/10" = 1/4"
4,000 PSI
3,000 PSI (COMP.)
STRENGTH
SCALE 1" = 1000 PSI
○ - INDIVIDUAL TEST VALUES
□ - AVERAGE OF ALL TESTS ON A PRODUCTION DAY
△ - RECORD SAMPLE TEST VALUES
4-7-69 J.D.
4-8-69 J.D.
4-9-69 J.D.
4-10-69 J.D.
4-20-69 J.D.


APPENDIX 2
CONCRETE MIX DESIGN #678345
TOTAL SOLIDS $\bar{A}$ CONTROL CHART
DESIGN MIX $\bar{A}$ = 4.72 TOLERANCE ±0.25
CLASS B
4.97
TOTAL SOLIDS Ai
4.72
4.47
SCALE 1"=0.1
B-18-78 V.S.
B-15-78 G.R.
B-11-78 G.R.
B-10-78 G.R.
B-9-78 G.R.
B-8-78 G.R.
B-7-78 G.R.
B-2-78 G.R.
B-1-78 G.R.

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

CURING CONCRETE TEST SPECIMENS IN THE FIELD

1. PURPOSE

1.1 The purpose of this procedure is to modify the curing requirements for cylindrical and prismatic specimens that have been made in the field.

2. BACKGROUND

2.1 The WVDOH Standard Specifications for Roads and Bridges and/or Supplemental Specifications (501.4, 511.3.6.1, 514.4.,601.4, 603.6.4, 620.5.5, and 679.2.2) require that the making and curing of concrete test specimens in the field be done in accordance with AASHTO Designation R100.

2.2 Section 10 of AASHTO Designation R100 covers curing of the test specimens until time of test.

3. APPLICABLE DOCUMENT

3.1 *WVDOH Standard Specifications for Roads and Bridges and/or Supplemental Specifications*

3.2 *AASHTO Designation R100*

4. PROCEDURE

4.1 Curing of cylindrical and prismatic specimens made in the field shall be in accordance with Section 10 of AASHTO Designation R100 with modifications as follows.

4.1.1 Delete the section that covers initial curing (10.1.2 in R100-21) and substitute the following:

10.1.2 Initial Curing - Immediately after molding and finishing, the specimens shall be stored for a period of 24 $\pm$ 8 hours in a temperature range from 60 to 80˚F, and in an environment preventing moisture loss from the specimens. For concrete mixtures with a specified strength of 6000 psi or greater, the initial curing temperature shall be between 68 and 78˚F . Various procedures are capable of being used during the initial curing period to maintain the specified moisture and temperature conditions. An appropriate procedure or combination of procedures shall be used (Note 8). Shield all specimens from direct sunlight and, if used, radiant heating devices. The storage temperature shall be controlled by the use of heating and cooling devices, as necessary. Record the temperature using a maximum-minimum thermometer.

4.2 Delete the section that covers transportation of specimens to the laboratory (11.1 in R100-21) and substitute the following:

11.1 Prior to transporting, cure and protect specimens as required in Section 10. When standard curing is used, specimens shall be transported within 24 ± 8 hours after molding. When field curing is used, specimens shall not be transported to the laboratory until just prior to testing. During transporting, protect the specimens with suitable cushioning material to prevent damage from jarring. During cold weather, protect the specimens from freezing with suitable insulation material. Prevent moisture loss during transportation by wrapping the specimens in plastic, wet burlap, by surrounding them with wet sand or tight-fitting plastic caps on plastic molds. Transportation time shall not exceed 4 hours.

02/16/2023

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 601.04.20 Steward – Cement and Concrete Section
RLS:Tp

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

ACCEPTANCE USE OF THE MATURITY METHOD FOR THE ESTIMATION OF CONCRETE STRENGTH ON WVDOH PROJECTS

1. PURPOSE

1.1 To establish a procedure to estimate the compressive strength of concrete, used on West Virginia Division of Highways (WVDOH) projects, with the Maturity Method.

2. SCOPE

2.1 This procedure shall apply to all Contractors, Sub-contractors, Consultants, and WVDOH Personnel who test concrete on WVDOH projects.

2.2 This procedure may be used in place of compressive strength cylinders, for the determination of the compressive strength of concrete, when allowed by the WVDOH Specifications. The Maturity Method shall not be permitted as a substitute for 28-day acceptance cylinders.

3. REFERENCED DOCUMENTS

3.1 *ASTM CI074 - Standard Practice for Estimating Concrete Strength by the Maturity Method*

4. PROCEDURE

4.1 The procedure outlined in the following sections shall be applied to each WVDOH approved concrete mix design for which the Maturity Method is desired to be used in place of concrete cylinders for the estimation of the concrete strength in the field. A separate strength-maturity relationship must be developed for each approved concrete mix design.

4.2 DEVELOPMENT OF STRENGTH-MATURITY RELATIONSHIP

4.2.1 Fabricate a minimum of fifteen concrete cylinders, in accordance with ASTM C192, from each WVDOH approved concrete mix design for which it is desired to establish a strength-maturity relationship. The mixes used to cast these cylinders shall be batched as closely as possible to the anticipated target air content, slump value, and chemical admixture dosage rate which will be used in the field. The mixes shall also be batched at a temperature as close as possible to the temperature that is anticipated in the field during concrete placement.

4.2.2 Either 6-inch x 12-inch cylinders or 4-inch x 8-inch cylinders may be used to develop the strength-maturity relationship, but if 4-inch x 8-inch cylinders are going to be used, then 4-inch x 8-inch cylinders must be approved to be used, in

accordance with MP 711.03.23, with the mix design for which the strength-maturity relationship is being developed

4.2.3 Follow the procedure outlined in Section 8 of ASTM C1074-19, and establish a strength-maturity relationship and corresponding Strength-Maturity Curve. The maturity of the subject cylinders shall be recorded to the nearest degree-hour. The axes used to plot this Strength-Maturity Curve shall be Strength, expressed in pounds per square inch on the Y-axis, and Temperature-Time Factor, expressed in °C-hours on the X-axis.

4.2.4 When concrete mixes designed for rapid strength gain are used, the compression tests shall be conducted at ages approved by the Engineer based on the strength development characteristics of that mix. However, a minimum of five test ages shall be used.

4.3 APPLICATION OF STRENGTH-MATURITY RELATIONSHIP

4.3.1 The Strength-Maturity Curve may be used in the field at the Project, in place of compressive strength cylinders, to estimate the compressive strength of the concrete in question.

4.3.2 The strength-maturity relationship and Strength-Maturity Curve shall not be permitted to be used in place of 28-day acceptance cylinders. The strength-maturity relationship and Strength-Maturity Curve shall only be used for the purposes of opening structures to traffic (i.e. Section 501.4.4, Section 506, etc.) and for form removal and construction of superimposed elements (i.e. Section 601.8.7).

4.3.3 When using the Strength-Maturity Curve for these purposes, the procedure outlined in Section 9 of ASTM C1074-19 shall be used for installing temperature sensors within the concrete of which the Strength-Maturity Curve is being used to estimate the compressive strength.

4.4 VALIDATION OF STRENGTH-MATURITY RELATIONSHIP

4.4.1 After five days of production, and every ten days of production after that, seven "Maturity Validation Cylinders" shall be fabricated. One of these cylinders shall have a maturity sensor installed in it within ± 5/8" (15 mm) of the center of the cylinder. Three of these cylinders shall be tested at an age of three days, and three of these cylinders shall be tested at an age of seven days. The average of each of these sets of three cylinders shall be the average compressive strength at that age.

4.4.2 The Maturity Validation Cylinders shall be the same size as the cylinders which were used to develop the original Strength-Maturity Curve.

4.4.3 If the average of either the three-day or seven-day compressive strength results, obtained in Section 4.4.1, fall at a point more than 5.0% less than the corresponding compressive strength, at the same Temperature-Time Factor point on the Strength-Maturity Curve, additional maturity validations at three and seven days, as outlined in Section 4.4.1, shall be conducted on the next three concrete placements.

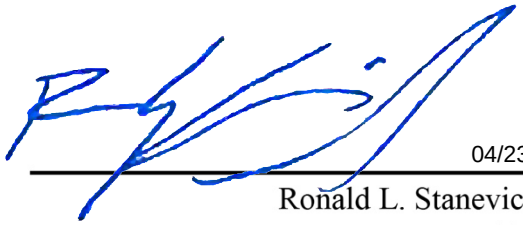
4.4.4 The Contractor shall continue to conduct these maturity validations until the average result of the three cylinders in each individual compressive strength test in three consecutive validations (consisting of both three-day and seven-day results) is not more than 10.0% less than the corresponding compressive strength at the same Temperature-Time Factor point on the Strength-Maturity Curve, and the average of all thee-day and all seven-day results in those three consecutive validations is not more than 5.0% less than the corresponding compressive strength at the same Temperature-Time Factor point on the Strength-Maturity Curve.

4.4.5 If, after five maturity validations, the Contractor has not obtained three consecutive validations for which the criteria in Section 4.4.4 has been met, then a new Strength-Maturity curve shall be established, as outlined in Section 4.5.

4.5 ESTABLISHMENT OF NEW STRENGTH-MATURITY CURVE

4.5.1 The new average three-day strength shall be established by averaging the five three-day strength results from the five maturity validations conducted in Section 4.4.5. The new average seven-day strength shall be established by averaging the five seven-day strength results from the five maturity validations conducted in Section 4.4.5.

4.5.2 The percentages by which the average three-day and average seven-day compressive strength results in Section 4.5.1 are below the corresponding compressive strengths at the same Temperature-Time Factor point on the Strength-Maturity Curve shall be calculated. The greater of these two percentages shall be the percent by which the Strength-Maturity Curve is lowered. This new "lowered" Strength-Maturity Curve shall be used from that point forward for estimating the compressive strength of the concrete from that approved mix design in the field



04/23/2020

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

RLS:Ms

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURES

QUALITY ASSURANCE PROCEDURES FOR PORTLAND CEMENT CONCRETE

1. PLANT AND EQUIPMENT INSPECTION STICKERS

1.1 Physical plants and equipment, which prepare materials for, or deliver materials to, applicable projects shall be regularly inspected and approved by an authorized representative of the Division. The process for this inspection is shown in the Plant Inspection Flow Chart in Attachment 1.

1.2 The inspections and approval shall be documented on the MC-4 Form (sample show in Attachment 2 and live form available on the MCS&T webpage) and confirmed by an inspection sticker supplied by the Materials Control, Soils & Testing Division (MCS&T). The inspection sticker will indicate the following:

1. Name of inspector
2. Plant or portion thereof, or singular piece of equipment inspected.
3. Date of inspection
4. Date of expiration of approval
5. Lab Number

1.3 Inspections may be made at any time at the discretion of the Division, and the status of the inspected facility shall be determined by the latest inspection. The date of expiration of approval, as noted on latest inspection sticker, shall be the last day on which the facility is considered to be approved by Division, and such facility must have an approved status at time of preparing materials for or delivering materials to applicable projects.

1.4 The sole purpose of the inspection sticker is to inform all concerned that a plant, or portion thereof, or a singular piece of equipment has been inspected. The sticker indicates that it has been found to substantially meet all requirements of the specifications and is approved to supply materials to applicable projects. Said inspection sticker shall therefore be affixed to the equipment or displayed in other manners so that the purpose as above stated will be fulfilled.

1.5 The stickers shall be applied and each District shall maintain records of these inspections in ProjectWise. The records shall include all the items listed in 1.2.

1.6 A plant or portion thereof, or a singular piece of equipment, shall be approved for a period not to exceed six (6) months. The period of approval shall be determined, in general, by the age, physical condition, or durability of the plant or equipment, and the inspection interval shall be such that the Division will have reasonable assurance that the plant or equipment is maintained in an acceptable manner.

1.6.1 During the plant inspection, the plant must demonstrate their capability to produce an E-Ticket as defined in Section 109.20.1 of the Specifications. A sample ticket shall be provided to the inspector, and compliance with this requirement shall be documented on the MC-4 form.

1.6.2 After each time a plant has been inspected, the District shall notify the Director of MCS&T, or their designee. MCS&T will generate a list of approved plants and post these on the Division Webpage[1].

1.7 Additional information regarding inspections and a sample of an inspection sticker is contained in Attachment 3.

2. QUALITY ASSURANCE IN PORTLAND CEMENT CONCRETE

2.1 PURPOSE

The purpose of this procedure is to establish guidelines which will aid Division personnel in implementing in a prescribed and uniform manner the Division's Quality Assurance Program for portland cement concrete, said program being directed primarily to maintaining a predetermined and acceptable level of assurance that portland cement concretes do conform to their governing specification.

2.2 DEFINITION OF TERMS

2.2.1 QUALITY ASSURANCE

Quality Assurance is an expression of confidence which the Division has in its program of acceptance testing and inspection which determines conformance of materials and construction to governing specification. A Quality Assurance Program is a planned program of acceptance testing and inspection which is conducted by the Division for the express purpose of maintaining a predetermined and acceptable level of assurance that construction materials do conform to governing specifications. Part of any Quality Assurance Program, is an awareness and knowledge of the Producer's Quality Control Program and the level of Quality Control maintained by that Producer.

2.2.2 QUALITY CONTROL

Quality Control is a planned program of testing, inspection and related activities conducted by a concrete Producer for the purpose of measuring the various properties of concrete and its component materials which are governed by the specification and controlling these properties within the limits of the specification.

[1] https://transportation.wv.gov/highways/mcst/pages/default.aspx

2.3 GENERAL DISCUSSION

The Division and the Contractor-Supplier industry have jointly participated in a program whose primary objective is to improve the quality of concrete in highway construction. One of the outcomes of this program is that the Division will run a smaller risk of having non-conforming materials incorporated into the work, and the Contractor-Supplier industry will run a smaller risk of having suitable materials rejected.

The following major developments are outgrowths of the program just mentioned:

2.3.1 Portland cement concrete technician's certification is available in the Contractor-Supplier industry to implement a program of Quality Control.

2.3.2 The requirement for a Contractor (or his authorized representative, a subcontractor or a commercial supplier) to do Quality Control of portland cement concrete and to have in his service a Certified Portland Cement Concrete Technician is specified in Sub-articles 501.4.2 and 601.4.2 of the Standard Specifications.

2.3.3 The requirement for a Contractor (or his authorized representative, a subcontractor or a commercial supplier) to have a field laboratory which is equipped and maintained in specified manner so as to aid in the conduct of a Quality Control Program is specified in Sub-articles 501.5.1 and 601.5.1 of the Standard Specifications.

2.3.4 Concrete batch plants and hauling equipment are regularly inspected by the Division, and their approval as conforming to requirements of governing specification is attested to by an inspection sticker (See Section 1 of this MP for details).

2.3.5 The requirement to do concrete design, using the particular sources of materials that are to be used in the work, is specified in articles 501.3 and 601.3.1 of the Standard Specifications. This requirement allows commercial concrete suppliers to have laboratory design work done for the various classes of concrete to be supplied, and it guards against the possibility of source materials changing appreciably and affecting the quality of subsequent concrete work.

Although all producers should maintain an acceptable level of Quality Control, it is reasonable to assume that a number of producers will maintain a level of Quality Control well above the minimum accepted level.

It is generally agreed that an acceptable level of Quality Assurance may be maintained with less acceptance testing and inspection when the level of Quality Control is increased.

The capability to perform a positive and sustained level of Quality Control in practically all producer plants today is now well established. Also, the Division has the means for measuring the level of Quality Control maintained by each producing plant. Accordingly, it would be desirable to pursue a Quality Assurance Program which takes into account the level of Quality Control in a Producer's plant so that an acceptable level of Quality Assurance could be maintained with a minimum cost (man-hours and dollars) to the Department. As previously stated the purpose of this procedure is to establish guidelines which will aid Department

personnel in implementing, in a prescribed and uniform manner, such a Quality Assurance Program.

2.4 DIRECTIVE

Concrete plants will be inspected in accordance with Section 1 of this MP and the condition of conformance will be determined. Those plants which are found to conform to the specifications will be identified as Class A plants, and those which do not conform will be identified as Class B plants. The level of Quality Control at each concrete plant will also be evaluated.

Those plants which have a high level of Quality Control will be considered to have a Level 1 Quality Control, and those plants which have a lower level of Quality Control will be considered to have a Level 2. All concrete plants will then be rated with one of the following classification numbers Al, A2 or B.

2.4.1 LEVEL 1 QUALITY CONTROL

All plants producing concrete which reasonably conforms to the specification requirements, and which satisfies the following additional requirements, will be considered to have LEVEL 1 Quality Control:

2.4.1.1 The compressive strength of the concrete produced by the plant shall have a coefficient of variation of 0.15 or less and the average compressive strength shall be equal to or greater than the specified requirement plus 2 1/2 standard deviations.

2.4.1.2 The air content of the concrete produced by the plant shall have a coefficient of variation of 0.18 or less, and the average air content shall not differ from the specified optimum value by more than one standard deviation.

2.4.1.3 The consistency of the concrete produced by the plant shall have a coefficient of variation of 0.20 or less, and the average consistency shall not differ from the specified optimum value by more than two standard deviations.

2.4.1.4 The plant shall maintain an adequate Quality Control Program for aggregate gradation.

2.4.2 LEVEL 2 QUALITY CONTROL

All plants which fail to meet one or more of the requirements specified in 2.4.1 will be considered to have LEVEL 2 Quality Control.

2.4.3 PHYSICAL PLANT-EVALUATION

District personnel will inspect and evaluate concrete plants in conformance with Section 1 of this MP. A copy of the inspection data, which is specified in Subsection 1.5, will be transmitted to the Materials Division immediately after the inspection is completed.

2.4.4 LEVEL OF QUALITY CONTROL - EVALUATION

The evaluation of the level of Quality Control maintained by concrete plants will be performed and maintained current by the Materials Division. The initial evaluation of the level of Quality Control will be based on an analysis of historical data. There after, tests for strength, entrained air, and consistency will be made by certified personnel on random samples taken from plant production. This test data will be used by the Materials Division to update the statistical parameters and maintain a current and valid evaluation of each plant's Quality Control level. The Materials Division will publish a list of concrete plants with their rating numbers, said publication to be updated monthly.

2.4.5 CLASS Al PLANTS - TEST AND INSPECTION REQUIREMENTS

Concrete from Class Al concrete plant shall be sampled and tested by certified personnel on a project-by-project basis, at random, with the frequency specified in Table 1 of MP 601.03.50.

Plant inspection and monitoring of batching operations at Class Al concrete plants shall be performed by District personnel on a random basis during production for Division Projects.

A concrete batch ticket, as defined in Section 5.2.9 of MP 601.03.50, shall be initiated and signed at the plant and accompany each delivery to the project.

2.4.6 CLASS A2 PLANTS - TEST AND INSPECTION REQUIREMENTS

Concrete from Class A2 concrete plants shall be sampled and tested by certified personnel on a project- by-project basis, at random, with the frequency specified in Table 1 of MP 601.03.50.

Plant inspection and monitoring of batching operations at Class A2 concrete plants shall be performed by District personnel on a continual basis during the time that concrete for items other than miscellaneous concrete are being produced for Division projects.

2.4.7 CLASS B PLANTS

Concrete purchased by a Contractor for use on Division projects shall be supplied from Class Al or A2 plants. Concrete purchased through competitive bidding with Purchase order contracts shall be supplied from Class Al or A2 plants. Class B plants are not considered to be eligible to compete with Class A plants in the furnishing of concrete to applicable projects.

In the event it is not practical to obtain small quantities of concrete for miscellaneous items (See 2.4.8) from a Class Al or A2 plant and a survey reveals that a Class B plant is conveniently situated with respect to the construction site, then a direct purchase of concrete by the Division from the Class B plant may be accomplished in conformance with the applicable Division procedures. The direct purchase of concrete from Class B plants shall also be made to conform to the requirements set out in Subsection 2.5 entitled QUALITY ASSURANCE OF DIRECT PURCHASE CONCRETES FROM CLASS B PLANTS. Plant

inspection at Class B plants and the sampling, testing and documentation of concrete from Class B plants shall also conform to the requirements set out in Subsection 2.5.

2.4.8 SMALL QUANTITIES FOR MISCELLANEOUS ITEMS

Miscellaneous concrete shall be defined as relatively small quantities incorporated into items that will not adversely affect the traffic carrying capacity of a completed facility. Such items would not include any concrete intended for major structures permanent mainline or ramp pavements, or other structurally critical items.

The following items are suggested as a guideline in establishing miscellaneous concrete:

1. Sidewalks
2. Curb and gutter
3. Slope walls for under drain outlet pipes
4. Temporary pavements and pipe crossings
5. Building floors
6. Slope paving and headers
7. Paved ditch or gutter
8. Small (less than 36” diameter) culvert headwalls
9. Catch basins, manhole bases, inlets, and junction boxes (and adjustments of such items) not located in the roadway
10. Foundations for breakaway supports
11. Utility trench fills
12. Cast-in-place survey markers

2.5 QUALITY ASSURANCE OF DIRECT PURCHASE CONCRETE FROM CLASS B PLANTS

2.5.1 PURPOSE

The purpose of this instruction is to provide guidance in specifying direct purchase of concrete and for inspection and testing of direct purchase concrete from Class B plants, so that a predetermined and acceptable level of Quality Assurance may be maintained by Division personnel. This instruction is set apart from the main directive in Subsection 2.4 because it is the intent to have concrete from Class B plants used in highway work only when it is not practical or economical to obtain concretes from Class A1 or A2 plants.

2.5.2 DEFINITION OF TERMS

2.5.2.1 Direct Purchase - Direct purchase is a formal procedure used to purchase materials for government agencies, including the Division of Highways) when it is not practical or economical to use the procedure of competitive bidding. Direct purchase requisitions will always specify the name of the proposed supplier as well as product name, quantity, specifications, etc.

2.5.3 GENERAL DISCUSSION

When highway work requiring portland cement concrete is being done by Division forces, and it is found to be impractical or uneconomical to obtain concrete from a Class Al or A2

plant but that it would be practical to obtain it from a Class B plant, then the purchase of concrete from a Class B plant shall be made to conform to the requirements of article 2.5.4.

2.5.4 INSTRUCTION

The purchase of portland cement concrete from a Class B plant will be permitted only after a field condition survey has been conducted and properly documented which indicates that it would be impractical and uneconomical to obtain concrete from a Class Al or A2 plant, and that a Class B plant does exist from which a direct purchase of concrete could practically and economically be made.

Procedures for making direct purchases of concrete shall be as prescribed by the appropriate State Agency. The method of specifying direct purchase concrete shall be as follows:

1. Specify the class of concrete.
2. Specify that the concrete mix design will be approved by the Division.
3. Specify that a Division inspector will be at the plant during the full time that concrete is being batched to direct the batching operation, and that batching shall not commence until the inspector is present.

In addition to the Quality Assurance activity performed at the plant, the Division will sample and test as deemed necessary all direct purchase order LOTS of concrete used in highway maintenance work.

3. PLANT APPROVAL STATUS

3.1 PLANT CERTIFICATION

3.1.1 When District Personnel determine that a Concrete Plant, which is not already listed as a Class A1, A2, or B plant on the Division's Approved Source Page, has met the requirements of this Materials Procedure, the Specifications, and all other applicable Materials Procedures, they shall notify MCS&T Division and provide all applicable documentation and information to MCS&T Division.

3.1.2 MCS&T Division shall then notify the subject Concrete Plant that they are approved to begin production for WVDOH projects. MCS&T Division shall also add that Concrete Plant to the Division's Approved Source Page and begin monthly evaluations of that Concrete Plant as outlined in this MP and MP 711.03.26.

3.2 PLANT DE-CERTIFICATION

3.2.1 When District Personnel determine that a Concrete Plant, which is listed as a Class A1, A2, or B plant on the Division's Approved Source Page, is not complying with the requirements of this MP, the Specifications, or any other applicable Materials Procedure, they shall immediately notify MCS&T Division and provide all applicable documentation and information to MCS&T Division. This information shall include a summary of the reason(s) for the de-certification of the subject Concrete Plant.

3.2.2 MCS&T Division shall then immediately notify the subject Concrete Plant and all applicable WVDOH District and Divisions that the subject Concrete Plant is no longer approved to supply concrete for WVDOH projects.

3.2.3 If the subject Concrete Plant, which has been de-certified and removed from approved status, desires re-approval, they shall initiate the re-approval process by submitting a plan of corrective action, which addresses all of the reasons for which that Plant was de-certified. This plan of corrective action shall be submitted to the District in which the Concrete Plant is located and to MCS&T Division.

Michael Mance
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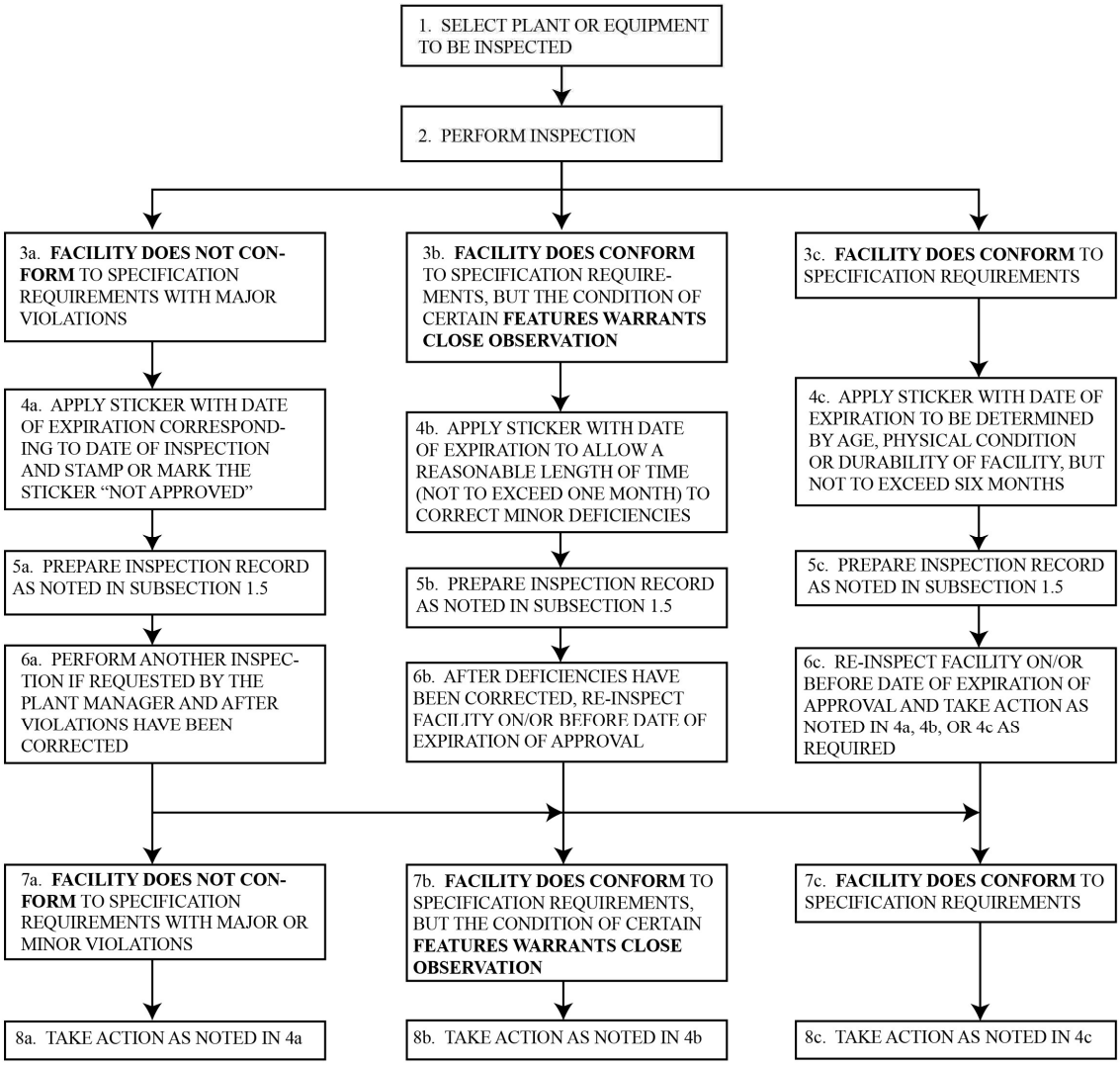
Michael Mance, P.E.
Director
Materials Control, Soils & Testing Division

MP 601.05.50 Steward – Cement and Concrete Section
MAM:T
ATTACHMENT

Plant Inspection Flow Chart



MC-4 Plant Inspection Form

Form MC-4
Rev 4/24/23

Page 1

West Virginia Division of Highways
Materials Control, Soils and Testing Division
Checklist For Inspection of Transit Mix & Central Mix Concrete Plants

Plant Inspected:	Date:	Date Sticker Expires:
Location:	Facility Code:	Sticker No. Assigned:
Plant Officials:		
E-Ticketing Requirements Met: Yes: ☐ No: ☐		

I. Plant Type:	Transit Mix: ☐	Central Mix: ☐	Combination: ☐

II. Aggregates:

Are the Stockpiles Segregated:	Yes ☐	No ☐	Any Foreign Matter in the Stockpiles:	Yes ☐	No ☐
Stockpiles Properly Separated:	Yes ☐	No ☐	Type of Base:		
Method of Handling Aggregates:					
Does Concrete Plant Stockpile Non-specification Materials:				Yes ☐	No ☐
If Yes, Are These Materials Properly Segregated From Specification Materials:				Yes ☐	No ☐
Source of Supply of Fine Aggregate:					
Source of Supply of Coarse Aggregate:					
Are all materials ordered to comply with West Virginia Division of Highways Specifications:				Yes ☐	No ☐

III. Scales:

Cement:				
Dial ☐	Capacity:	Increments:		
Load Cell ☐	Capacity:	Increments:		
Do Scales Comply With Specifications:			Yes ☐	No ☐
Aggregates:				
Dial ☐	Capacity:	Increments:		
Load Cell ☐	Capacity:	Increments:		
Do Scales Comply With Specifications:			Yes ☐	No ☐
Separate Scales for Cement and Aggregates:			Yes ☐	No ☐
Overall Condition of Scales:				
Date Sealed By Dept. of Weights & Measures:	Cement:	Aggregate:		

IV. Bins and Hoppers:

Number of Bin Compartments for Fine Aggregate:		Number of Bin Compartments for Coarse Aggregate:		
Maximum Size Batch:	Is the Cement Hopper Equipped with a Vibrator:		Yes ☐	No ☐
Is the Aggregate Hopper Equipped with a Vibrator:			Yes ☐	No ☐
Operation of the Hoppers Satisfactory: Yes ☐	No ☐	If "No", Why?		
Type of Cement Bin:		Number of Bins:	Capacity of Each Bin:	

V. Water:

Type of Water Measuring Device:	Scales ☐	Meter ☐	Truck Mixer Tanks ☐	
Automatic ☐	Manual ☐	Does Device Meet Specifications:	Yes ☐	No ☐
Date Sealed by Dept. of Weights & Measures:	Scales:	Meter:		

VI. Admixtures:

Brands Used:			
Air Entrainment:	Automatic Dispenser:	Yes ☐	No ☐
Retarder:	Automatic Dispenser:	Yes ☐	No ☐
Other Admixtures (Name & Type):	Automatic Dispenser:	Yes ☐	No ☐

VII. Central Mixer:

Condition of Drum:	Condition of Blades:	
Does Automatic Timing Device Meets Specifications:	Yes ☐	No ☐
Remarks:		

VIII. Truck Mixers:

Trucks Equipped with Electronic Counters:	Yes ☐	No ☐	Number of Trucks Added to Fleet Since Last Inspection:
Number of Trucks Deleted From Fleet Since Last Inspection:			
Truck Mixers Now Failing to Meet Specifications:			

TRUCK NUMBER	REASON FOR FAILURE

IX. Testing of Materials:

Tests of Aggregates Performed at Plant by:	Qualified:	Yes ☐	No ☐
Does Testing Equipment Comply with Specifications:		Yes ☐	No ☐
If "No", What Equipment Fails:			
Approved Test Weights Available in the Plant:	Yes ☐	No ☐	Date Last Checked:

X. General Condition of Plant:

XI. Any Further Remarks:

XII. Rating Assigned:	A ☐	B ☐	Plant Inspected By:

Sample Plant Inspection Sticker

West Virginia Division of Highways
CHECKED & ACCEPTED
INSPECTOR: _____ **DATE:** _____ **LAB NUMBER:** _____ **DISTRICT:** _____
DATE OF EXPIRATION **MONTH/DAY/YEAR** _____/_____/_____
PLANT / TRUCK

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

SAMPLING AND TESTING OF MATERIALS AT THE SOURCE (COVERAGE)

1. PURPOSE

1.1 To provide definitions and general guidelines of source sampling and testing to minimize non specification material arriving at the project site.

2. SCOPE

2.1 This procedure applies to materials sampled at the source (or some intermediate storage area) on a lot-by-lot basis.

3. DEFINITIONS

3.1 Pre-sampling - The sampling operation that is completed while the material is at the source, or other intermediate storage area, prior to shipment to the project site. Pre-sampled material cannot be used until authorization of approval is received from Materials Control, Soil and Testing Division.

3.2 Pretesting - The testing of pre-sampled material. A pretested material is that which has been sampled, tested, and evaluated prior to shipment to the project site. Such material may be used upon arrival at the project site.

3.3 Directive - Applicable Materials Procedures and/or Specifications.

4. PROCEDURE

4.1 Sampling Frequency

4.1.1 Frequency of sampling shall be in accordance with applicable directives for specific items.

4.2 Sampling

4.2.1 All material will be sampled by an authorized representative of the Division. Sampling will be conducted in accordance with the applicable directives.

4.3 Identifying Pre-sampled Material

4.3.1 When a specific quantity (lot) of material has been sampled, the material shall be set aside (isolated) and marked, sealed, tagged, or otherwise identified during storage as being pre-sampled. The material shall be stored with reasonable assurance that it will not be contaminated, included, or mixed with other materials that have not been represented in the sampling plan.

4.3.2 Identifying records shall include the following, and must accompany the sample to the laboratory:

a) Name of Producer/Supplier
b) Date of Fabrication
c) Batch or Lot Identification (Coverage Number)
d) Quantity of Material Represented by Inspection
e) Date Sampled
f) Test(s) Required
g) Sampler/Inspector
h) Project Number (If known at the time of testing)
i) Any other information necessary to identify the material.

4.4 Identifying Pre-tested Material

4.4.1 Packaged Material - When tests indicate packaged material has met the specification requirements they may be tagged, sealed, stamped, or otherwise identified by the state representative as having been pretested and approved.

4.4.2 Bulk or Miscellaneous Materials - When tests indicate bulk or miscellaneous materials have met specification requirements they may be stored in suitable enclosures until shipped. These enclosures may be tagged, sealed, stamped, or otherwise identified by the state's representative as having been pretested and approved. If appropriate, miscellaneous materials may be individually identified by tag, seal, or stamp as being pretested and approved. When closed conveyances are used to ship pretested materials, these conveyances may be tagged, sealed, stamped, or similarly treated to identify the contents as being pretested and approved for shipment to the project site.

5. DOCUMENTATION

5.1 Documentation of Samples - Samples must be documented setting forth all information necessary for proper identification of the materials in accordance with section 4.3.2.

5.2 Sample Document Distribution - Original documentation shall be transmitted with the sample to the testing laboratory. The sampler will retain a copy of this documentation.

5.3 Documentation of Test Results - The testing laboratory will perform all required tests and document the results on the appropriate form. A concluding statement on the form shall indicate that the material does or does not meet the requirements of the controlling specifications. This form shall also contain all applicable identifying information described in Section 4.3.2.

5.4 Testing Document Distribution

5.4.1 When testing is done by a Division approved laboratory, a copy of the test report will be furnished to Materials Control, Soil and Testing Division.

5.4.2 Test reports will be reviewed, assigned a laboratory number, and distributed by Materials Control, Soil and Testing Division as required.

5.5 Shipping Documentation - When test results indicate the material has met the specification requirements, authorization is given for shipment to the project site. The supplier shall prepare a shipping document and shall include as a minimum the following:

1. All information applicable in Section 4.3.2
   a) Information applicable for the shipment of aggregate, asphalt, and concrete includes all items except c, e, f, and g of the above referenced section.
   b) Information applicable to shipment of paint includes all items except e, g, and h of the above referenced section.
2. Date of shipment
3. The laboratory number assigned to the approval document.

When the material is from stock identified by a Coverage Number, a copy of the shipping document will be transmitted to the Materials Control Section of MCS&T. A copy of the shipping document will always accompany the shipment and be included in the project file.

5.6 Final Acceptance of Pre-tested Material - Tests completed on materials at the source may be used by the Division for acceptance. However, the Division reserves the right to inspect, resample and/or retest the materials at the source or after the materials have arrived at the project.

05/31/2023

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 700.00.01 Steward – Materials Control Section
RLS:B

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

AGGREGATE SAMPLING PROCEDURES

1. PURPOSE

1.1 To provide a uniform procedure for obtaining aggregate samples.

2. SCOPE

2.1 This procedure shall apply to the following:

(a) Process Control sampling by the Contractor.
(b) Acceptance Sampling by the Division.
(c) Independent Assurance Sampling by the Division.
(d) Record Sampling by the Division.

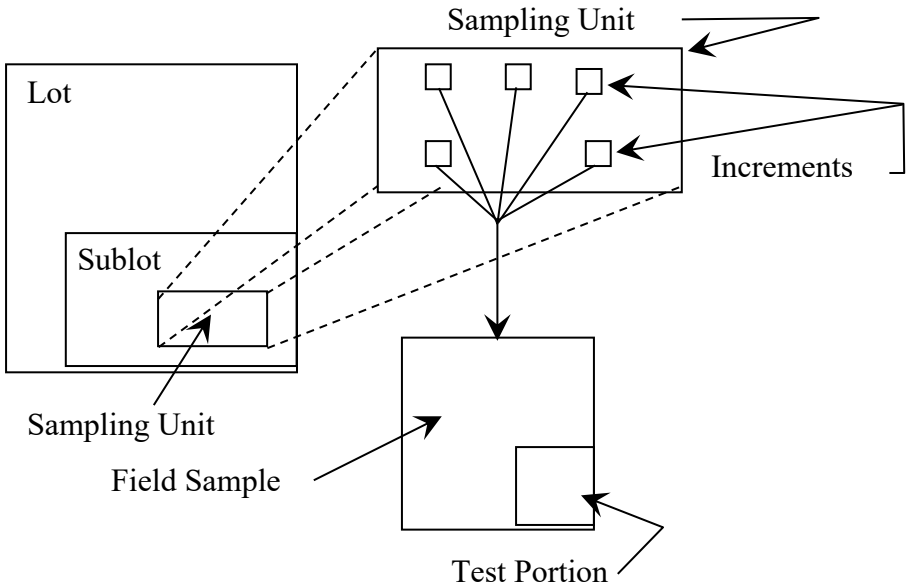
3. GENERAL

3.1 Taking a good sample is just as important as conducting a good test. The sampler must use every precaution to obtain samples that will show the true nature and condition of the material they represent.

3.2 Most aggregates are mixtures of various particle sizes, which tend to separate, or segregate, during transporting or stockpiling. For this reason, aggregate samples should be obtained at the last practical point before the material is incorporated into the finished product or before compaction.

3.3 Frequency of sampling will be in accordance with the applicable directives for the type sample being procured.

4. DEFINITION OF TERMS



4.1 Lot: The quantity of material represented by an average test value, not to exceed five individual test values, calculated in accordance with MP 300.00.51.

4.2 Sublot: The quantity of material represented by a single test value. In the case where only one sample is needed for the total plan quantity, the sublot may be considered the Lot.

4.3 Sampling Unit: The quantity of material within the sublot from which increments are obtained to be combined into a field sample.

4.4 Increment: The portion of material removed from the sampling unit to be combined into a field sample.

4.5 Field Sample: A composite of increments.

4.6 Test Portion: The material split from the field sample to be used in performing a specific test.

4.7 Random Location: A location whose position depends entirely on chance. In other words, one location has as good a chance being selected as any other.

5. CONTRACTOR RESPONSIBILITY

5.1 The Contractor shall provide all reasonable facilities and furnish the Division the information, assistance and samples required by the Engineer and Inspector for proper inspecting or testing of materials and workmanship.

5.2 All materials and each part or detail of the work shall be subject to inspection by the Engineer. The Engineer or a representative shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the

Contractor as is required to make a complete and detailed inspection. To facilitate the inspection of materials, all delivery tickets shall contain as a minimum the information required in MP 700.00.01.

6. SAMPLING PROCEDURES

6.1 There are four general areas from which aggregate samples are usually obtained. These include (1) Sampling from the roadway after the aggregate has been placed, but prior to compaction, (2) Sampling from a conveyor belt, (3) Sampling from a flowing stream of aggregate, and (4) Sampling from stockpiles.

6.1.1 Sampling from the roadway (e.g., bases and subbases)

6.1.1.1 The first step in obtaining a roadway sample is to locate the sublot. This is usually the quantity of material that will be represented by the one sample and is defined as a section of roadway of given width and length.

6.1.1.2 The next step is to randomly locate a sampling unit within the sublot. A sampling unit is defined as an area having dimensions of approximately12 feet by 12 feet, or an area of approximately 144 square feet in locations having any dimension less than 12 feet. Locating the sampling unit is accomplished by use of random numbers contained in Attachment I. Any pair of numbers (decimals) may be used to locate a sampling unit within the sublot. To locate the sampling unit in a sublot defined by area, the length of the area, in feet, is multiplied by one decimal of the pair, and width is multiplied by the other decimal. The resulting distances are to be measured from one end and one side of the area.

6.1.1.3 For example, a sublot of material consists of base course aggregate 26 feet wide from Station 956+00 to 965+00. The total length in feet is thus 96,500 minus 95,600, or 900 feet. A pencil tossed on Attachment I points to the pair of decimals 0.115 and 0.447. To locate the sampling unit, the first decimal is multiplied by the length of the sublot, and the companion decimal is multiplied by the width. The length value will be measured from Station 956+00 and the width value from the left-hand edge of the base. Thus, 900 multiplied 0.115 equals 104, and 26 multiplied by 0.447 equals 12, so the sampling unit would be located at Station 956+00 plus 1+04, or 957+04 at 12 feet from the left edge. This point could define the center or any corner of the sampling unit. If we use the center, a 12-foot by 12-foot sampling unit would fall between Stations 956+98 and 957+l0 with longitudinal boundaries at 6 feet and 18 feet from the left edge of the base.

6.1.1.4 Five approximately equal increments are then located within the sampling unit. This is also best accomplished by means of the random numbers in Attachment 1. Procedures to follow are essentially the same as those set forth for locating the sample unit. The five increments are taken from the sampling unit and combined to form a field sample whose weight equals or exceeds the minimum recommended in Table I. All increments shall be taken from the roadway for the full depth of the material being sampled, care being taken to exclude any foreign material which may have been incorporated during the normal construction process. The specific areas from which each increment is to be removed shall be

clearly marked; a metal template placed over the area is a definite aid in securing approximately equal increment weights.

6.1.2 Sampling from a Conveyor Belt

6.1.2.1 The first step in obtaining a sample from the conveyor belt is to define the sublot. This is generally defined as a unit of time, i.e., a half-day or a day's production. The next step is to randomly locate a sampling unit within the sublot. A sampling unit in this case is generally considered to be the material contained within the length of the conveyor. Locating the sampling unit is accomplished by use of the random numbers contained in Attachment I. Any number may be used to locate a sampling unit within the sublot. To locate the sampling unit in a sublot defined by time, the length of time, usually in minutes, is multiplied by the random decimal obtained from Attachment I.

6.1.2.2 For example, a sublot of material consists of concrete aggregate used in a half-day's production estimated to be between 8:00 a.m. and 12:00 noon. A pencil tossed on Attachment I points to decimal 0.279. Thus, the sampling unit would be located somewhere within the four-hour period (8:00 a.m. to 12:00 noon). Four (hours) multiplied by 60 (minutes per hour) multiplied by 0.279 equals 67 minutes. The sampling unit would be located 67 minutes after the 8:00 a.m. startup; or at 9:07 a.m. (or as soon thereafter as practical).

6.1.2.3 Five randomly located, approximately equal increments are obtained from the sampling unit and combined to form a field sample whose weight equals or exceeds the minimum recommended in Table I. The location of the five increments is determined by multiplying the length of the belt by five random numbers. The conveyor belt is stopped while the increments are being obtained. Two templates, conforming to the shape of the belt and spaced such that the material contained between them will yield an increment of the required size, are inserted into the aggregate stream on the belt. All material between the templates is carefully scooped into a suitable container, including all fines on the belt collected with a brush and dustpan.

6.1.3 Sampling from a Flowing Aggregate Stream (bin or belt discharge)

6.1.3.1 Definition of the sublot and location of the sampling unit is generally identical with sampling from a conveyor belt, with the exception that the sampling unit in this case is defined as that material which will flow during a five-minute period. Once the sampling unit is located, five approximately equal increments, randomly spaced, are obtained and combined to form a field sample whose weight equals or exceeds the minimum recommended in Table I. Each increment is taken from the entire cross-section of the material as it is being discharged. It is usually necessary to have a special device constructed for use at each individual plant. This device will consist of a pan of sufficient size to intercept the entire cross-section of the discharge stream and hold the required quantity of material. A set of rails may be necessary to support the pan as it is passed under the discharge stream. If the sampling pan overflows, it should be struck level so that only material that is within the pan is retained.

6.1.4 Sampling from a Stockpile

6.1.4.1 If possible, stockpile sampling should be avoided when sampling to determine the gradation of an aggregate. However, circumstances sometimes make it necessary, and when this occurs a sampling plan and the number of samples to be taken must be considered for each specific case. Stockpiled aggregates tend to segregate with the coarser particles rolling to the outside base of the pile, which makes gradation representation difficult. Because of this, every effort should be made to enlist the services of power equipment (such as a front-end loader) to develop a separate small sampling pile composed of material taken from various levels and depths in the main stockpile. Increments from this pile may be combined, thoroughly mixed, and reduced by quartering and/or sample splitter to obtain the field sample. Methods for quartering and splitting samples are given in AASHTO R76. If power equipment is not available, hand sampling may be employed to obtain at least three increments per sample: One increment taken from the top one third of the pile, one from the middle and one from the bottom third. When hand sampling, the outer layer of the pile should be removed (scraped away with the shovel) at the point prior to sampling.

7. WEIGHTS REQUIRED

7.1 Field Sample Weights

7.1.1 Field sample weights as listed in Table I are minimum values. Actual weights required must be predicated on the type and number of tests to which the material is to be subjected. The amounts specified in Table I will provide adequate material for routine gradation and quality analysis.

7.2 Test Portion Weight

7.2.1 The weight of the test portion to be obtained from the field sample for a specific test will be defined in the Standard Procedures of the test involved. Reduction of the field sample into test portions is done with a sample splitter. The weight of test portion recommended for gradation testing is given in Table II.

8. TRANSPORTING SAMPLES

8.1 Testing at Site of Sampling

8.1.1 Samples taken for testing in the field may be placed in any suitable clean container of appropriate size which is secure enough to prevent loss of material when transporting the sample to the testing location.

8.2 Samples to be Shipped from Site of Sampling

8.2.1 Samples to be shipped should be placed in standard sampling sacks. If the sample contains an appreciable quantity of fine material, a plastic liner should be put in the sack to prevent loss of the fines. Each sack must be securely tied to prevent loss of material in transit. It is also essential that sample identification be maintained from the field to the testing site. Each sack must have appropriate

indelible identification attached and enclosed so that field reporting, laboratory logging, and test reporting may be facilitated.

12/08/2021

RLS:Ms
Attachments

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

TABLE I

WEIGHT OF SAMPLES

NOMINAL MAXIMUM SIZE OF PARTICLES*	MINIMUM WEIGHT OF FIELD SAMPLES	
Sieve Size	Kilo	lb
No. 8	10	25
No. 4	10	25
3/8 in.	10	25
1/2 in.	15	35
3/4 in.	25	55
1 in.	50	110
1 1/2 in.	75	165
2 in.	100	220
2 1/2 in.	125	275
3 in.	150	330
3 1/2 in.	175	385

*The nominal maximum size of particles is defined as the largest sieve size listed in the applicable specifications upon which any material is permitted to be retained. Exception: If the specification tolerances are such that no sieve listed has a range of X-100 percent passing, then the next smallest standard sieve, as listed in Table I, and below that sieve which 100 percent must past will be considered the nominal maximum size.

TABLE II

TEST PORTION FOR GRADATION

NOMINAL MAXIMUM SIZE OF PARTICLES	MINIMUM WEIGHT OF TEST PORTION	
Sieve Size	Kilo	lb
No. 8	0.1	0.3
No. 4	0.5	1.0
3/8 in.	1.0	2.0
1/2 in.	2.0	4.0
3/4 in.	5.0	11.0
1 in.	10.0	22.0
1 1/2 in.	15.0	33.0
2 in.	20.0	44.0
2 1/2 in.	35.0	77.0
3 in.	60.0	130.0
3 1/2 in.	100.0	220.0

ATTACHMENT I

RANDOM NUMBERS

.858	.082	.886	.125	.263	.176	.551	.711	.355	.698
.576	.417	.242	.316	.960	.879	.444	.323	.331	.179
.587	.288	.835	.636	.596	.174	.866	.685	.066	.170
.068	.391	.139	.002	.159	.423	.629	.631	.979	.399
.140	.324	.215	.358	.663	.193	.215	.667	.627	.595
.574	.601	.623	.855	.339	.486	.065	.627	.458	.137
.966	.589	.751	.308	.025	.836	.200	.055	.510	.656
.608	.910	.944	.281	.539	.371	.217	.882	.324	.284
.215	.355	.645	.450	.719	.057	.287	.146	.135	.903
.761	.883	.711	.388	.928	.654	.815	.570	.539	.600
.869	.222	.115	.447	.658	.989	.921	.924	.560	.447
.562	.036	.302	.673	.911	.512	.972	.576	.838	.014
.481	.791	.454	.731	.770	.500	.980	.183	.385	.012
.599	.966	.356	.183	.797	.503	.180	.657	.077	.165
.464	.747	.299	.530	.675	.646	.385	.109	.780	.699
.675	.654	.221	.777	.172	.738	.324	.669	.079	.587
.269	.707	.372	.486	.340	.680	.928	.397	.337	.564
.338	.917	.942	.985	.838	.805	.278	.898	.906	.939
.130	.575	.195	.887	.142	.488	.316	.935	.403	.629
.011	.283	.762	.988	.102	.068	.902	.850	.569	.977
.683	.441	.572	.486	.732	.721	.275	.023	.088	.402
.493	.155	.530	.125	.841	.171	.794	.850	.797	.367
.059	.502	.963	.055	.128	.655	.043	.293	.792	.739
.996	.729	.370	.139	.306	.858	.183	.464	.457	.863
.240	.972	.495	.696	.350	.642	.188	.135	.470	.765

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

CERTIFICATION OF BATCH SCALES AND CALIBRATION OF STANDARD 50 POUND TEST WEIGHTS

1. PURPOSE

1.1 To provide instructions and establish frequency for having batch scales checked and approved.

1.2 To provide procedural instructions for having standard 50-pound test weights checked and approved.

2. SCOPE

2.1 This procedure will apply to all batch plants furnishing portland cement concrete or asphalt concrete to projects.

3. INSTRUCTIONS

3.1 Batch scales shall be checked and approved by the West Virginia Division of Labor at least once a year.

3.2 Standard, 50-pound, test weights shall be certified as correct by the Division of Labor at the time and location designated by their directives.

3.3 Certification of standard test weights by the West Virginia Division of Labor will be evidenced by the letters WV and a two-digit number stamped on the lead plug in each of the standard weights, the two digits representing the year in which certification is made.

3.4 Standard test weights should be treated in the following manner prior to delivery to the calibration station.

3.4.1 Wire brush to remove all dirt and rust, and paint with a light coat of aluminum paint.

4. FACILITIES LOCATED OUTSIDE OF WEST VIRGINIA

4.1 The Division may, at its option, accept inspection and sealing by out-of-state agencies.

4.2 The frequency of such inspection shall conform to West Virginia's Division of Labor requirements.

Michael Mance Digitally signed by Michael Mance Date: 2024.08.23 14:38:12 -04'00'

Michael A. Mance, PE
Interim Director
Materials Control, Soils & Testing Division

MP 700.00.30 Steward – Lab Support Section
MM:B

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

PORTLAND CEMENT AND BLENDED HYDRAULIC CEMENT MILL CERTIFICATION

1. PURPOSE

1.1 To provide the Division's acceptance procedures for portland cement and blended hydraulic cements.

2. SCOPE

2.1 This procedure shall apply to all portland cement and blended hydraulic cement production mills which furnish cement to projects, except that the Division may elect to use other control procedures when special conditions dictate the need for more stringent control.

3. APPLICABLE SPECIFICATIONS

3.1 All items under this procedure shall meet the requirements of Section 701.1 and 701.3 of Specifications. This section specifically includes ASTM C150 for portland cement and ASTM C595 for blended hydraulic cements. In addition, samples will be obtained in accordance with ASTM C183.

4. PROCEDURE

Cement mills which produce cement for use in projects shall be identified as Certified or Non-Certified, as outlined below.

4.1 CERTIFIED

To be considered for certification, the manufacturer shall do the following:

4.1.1 Submit a certified statement to Materials Control, Soils and Testing (MCS&T) Division that all cement shipped to projects will conform to the specification requirements. The certified statement shall be signed by a representative of the manufacturer having legal authority to bind the company.

4.1.2 Maintain records of production control tests, for each type of cement which may be supplied to projects, for a period of at least five years and make them available to the Division upon request.

4.1.3 Have mill laboratory facilities inspected by the Cement and Concrete Reference Laboratory (CCRL). A copy of the CCRL report on the mill laboratory inspection shall be provided to the Division, accompanied by documentation of resolution of any discrepancies noted in the CCRL report.

4.1.3.1 Each mill shall continue to participate in the CCRL inspection program at the normal inspection frequency scheduled by CCRL, typically 24-36 months. Each mill shall submit a copy of that inspection report to this Division accompanied by documentation of resolution of any discrepancies noted in the CCRL report.

4.1.4 Submit to the MCS&T Division test data developed on the type(s) of cement to be certified. This data must consist of test results developed from each day's production over the most recent fifty production days. The required tests are for all the standard chemical and physical requirements listed in ASTM C150 and/or ASTM C595. Each complete battery of tests shall represent not more than twenty-four hours of continuous production per finish mill.

4.1.4.1 In the case of Type III cement, blended hydraulic cement, or other cement, which is not produced on a regular basis, if there are not fifty production days for that type of cement in the previous two-year period, then the data for that type of cement shall consist of test results from at least the last twenty-six production days, unless otherwise approved by the Division.

4.1.5 The quality history of a cement plant seeking certification will be determined using the data submitted by the manufacturer as specified in 4.1.4 or 4.1.4.1. Statistical limits, as defined in ASTM C183, will be developed from this data. When an acceptable quality history has been determined, the Division will compare test data developed on production grab samples taken by Division representatives, to the statistical limits established by the mill's production data.

4.1.6 When a cement mill has met the above criteria and has been designated by the Division as Certified, the manufacturer will be required to submit test data on a monthly basis in the same manner as described in 4.1.4.

4.1.6.1 As required in Section 4.1.4, all Certified cement mills shall submit test results, for all tests, developed from each day’s production, to MCS&T Division, except for the results for the Insoluble Residue test. Once a cement mill has been Certified, and if, during the previous three-month period, none of the Insoluble Residue test results from that Certified cement mill exceed 0.75%, then that Certified cement mill may reduce the frequency of Insoluble Residue test result submittal to one test per week of production, instead of one test per day of production. If any Insoluble Residue test result from that Certified cement mill (including results from samples obtained by the Division), is greater than 0.75%, then the frequency of Insoluble Residue test result submittal from that Certified cement mill shall immediately be increased back to one test per day of production, until another three-month period has elapsed, with no Insoluble Residue test results greater than 0.75% from that Certified cement mill.

4.1.6.2 When ASTM C1038 testing is performed due to higher SO_s content, as outlined in Table 1 of ASTM C150 and/or Table 1 of ASTM C595, the Certified cement mill performing that testing shall perform a minimum of one test per month on the sample with the highest SO_s content for that month.

4.1.6.3 In the case of Type III cement, blended hydraulic cement, or other cement, which is not produced on a regular basis, if no cement of this type was produced in a particular

month(s), then the Cement Manufacturer shall submit a written statement noting this to MCS&T Division.

4.1.7 The Division will take paired samples from a certified plant's production at a frequency dependent upon the variability of test data. The frequency will generally be such that the sampling is accomplished every four months.

4.1.7.1 In the case of Type III cement, blended hydraulic cement, or other cement, which is not produced on a regular basis, if no cement of this type was produced in a four-month period, then the Cement Manufacturer shall submit a written statement noting this to MCS&T Division, and the Division will not be required to take paired samples for that four-month period.

4.1.7.2 The paired samples will be obtained, tested, and evaluated in accordance with applicable ASTM procedures.

4.1.7.3 Two consecutive pairs of test values failing to meet the statistical control criteria may be considered cause to remove the mill from the certified group.

4.1.7.4 If any individual sample fails to meet the requirements of the applicable ASTM Specification, the mill may be removed from the certified group.

4.1.7.5 If a certification is removed, it may be reinstated at the discretion of the Division when sufficient sampling and testing has been conducted to ensure statistical control.

4.1.8 When all requirements for certification have been met, the manufacturer may ship cement of the type certified to projects. Records of quantities of cement shipped to projects must be maintained by the manufacturer for a minimum of three years and made available to the Division upon request.

4.1.9 The manufacturer and the District Materials offices will be notified of all changes in the status of a mill's certification.

4.1.10 Once each month, or anytime the list is updated, the MCS&T Division will provide the District with a list of all currently certified cement mills.

4.2 NON-CERTIFIED

A cement mill defined as non-certified may supply cement to the projects from approved LOTs.

4.2.1 The Division will sample, test, approve, and seal LOTs of cement for use in projects. Samples will be obtained in accordance with ASTM C183 except that one grab sample shall be secured for each 400 tons (360 Mg) in the sampling of bulk storage at points of discharge, while the cement is flowing through the openings. All of the applicable chemical and physical tests noted in ASTM C150 and/or ASTM C595 will be conducted by the Division laboratories.

4.2.1.1 Any individual sample failing to meet all of the applicable ASTM requirements will result in rejection of the entire LOT of cement.

4.2.2 When a LOT of cement has been sampled, tested, and found to meet all specification requirements, the Division will notify the manufacturer of approval and a Division approval number will be assigned to the LOT.

4.2.3 A manufacturer may make shipments from approved LOTs upon notification of Division approval. When such shipments are made, the manufacturer shall provide documentation as follows:

1. Project to which material is shipped (if available)
2. Silo number from which material drawn
3. Location of shipping origin
4. Contractor (i.e. consignee)
5. Division approval number assigned to silo
6. Identification of carrier
7. Quantity of material in shipment
8. Type of material

4.2.3.1 This documentation may be provided in the form of bills of lading and shall have the following distribution:

1. 1 copy sent to MCS&T Division
2. 1 copy sent to accompany shipment and to be left at the destination to become the property of the Division

4.2.3.2 Records of quantities of cement shipped to projects must be maintained by the manufacturer for a minimum of three years and made available to the Division upon request.

4.2.3.3 A balance sheet shall be maintained by the manufacturer for each LOT of cement approved for shipment to projects. This balance sheet shall provide the following information:

1. The silo number
2. The Division approval number assigned to the silo
3. The test quantity
4. Separate entries for each shipment made from the silo showing bill of lading number and quantity.
5. The balance left in the test quantity after each shipment

The manufacturer may not ship material in excess of the test quantity plus five percent (5%).

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Michael A. Mance,
Interim Director
Materials Control, Soils & Testing Division

MP 701.01.10 Steward – Cement and Concrete Section
MM:Td

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

GUIDE FOR APPROVAL OF SUPPLEMENTARY CEMENTITIOUS MATERIALS (SCMs)

1. PURPOSE

1.1 To set forth the Division's approval procedures for Supplementary Cementitious Materials (SCMs) used in portland cement concrete.

2. SCOPE

2.1 This procedure will apply to all SCMs used in portland cement concrete that are used on West Virginia Division of Highways projects.

3. INITIAL APPROVAL

3.1 In order for a SCM to be initially approved for use, the producer of the SCM shall first submit a certified statement to the Materials Control, Soils and Testing (MCS&T) Division that all SCMs shipped to Division projects will conform to the applicable specification requirements. The certified statement shall be signed by a representative of the producer having legal authority to bind the company.

3.2 The producer shall also submit, to MCS&T Division, quality control test data on the SCM to be certified. This data shall consist of test results developed from production samples during the last six months. There shall be at least one set of quality control test data for each month in that six-month period. These test results shall include results of all tests that are required by the specifications.

3.3 After the Producer has completed Sections 3.1 and 3.2, and if all test data submitted in Section 3.2 meet the applicable specification requirements, a representative of MCS&T Division shall obtain a sample of the SCM from the source of production. The MCS&T Division shall test this sample, and if it meets specification requirements, a representative of the MCS&T Division shall obtain a second sample of the SCM from the source of production or distribution (i.e. terminal). The MCS&T Division shall then test this second sample.

3.3.1 If either of the two samples obtained in Section 3.3 does not meet specification requirements, the SCM will not be approved. If, at this time, the producer still seeks Division approval of the subject SCM, a minimum of ninety calendar days (from the date the non-conforming sample was obtained) must elapse before the approval process may begin again (starting with Section 3.1).

3.4 If the second sample obtained in Section 3.3 also meets specification requirements, the SCMs will be placed on the Division's approved list and the producer may begin to supply the subject material for use on Division projects.

4. APPROVED LIST

4.1 Once each quarter, or any time the list is updated, the MCS&T Division shall provide a list of all currently approved SCMs.

4.2 The producer and the District Materials Sections will be notified of any changes in the approved status of a SCM.

4.3 No SCM may be used in portland cement concrete that is supplied to West Virginia Division of Highways projects unless it is on the Division's approved list of SCMs.

5. MAINTAINING APPROVED STATUS

5.1 In order to maintain approved status of the subject SCM, the producer shall submit test data on a monthly basis in the same manner as described in Section 3.2.

5.2 Also, Division representatives from each District Materials Section shall obtain samples of the subject SCM at every point of use (i.e. ready-mix plants, etc.) that is located within their District. A minimum of one sample shall be obtained from each particular location every six (6) months. Within one week of obtaining these samples, the District personnel shall forward them to the MCS&T Division, where they shall be tested.

5.2.1 If any of the samples, obtained by District Personnel as outlined in Section 5.2, fail to meet the specification requirements, personnel from the MCS&T Division shall immediately obtain a sample of the subject material at the source of production or distribution (i.e. terminal). The MCS&T Division shall then test this sample.

5.2.2 If the sample obtained in Section 5.2.1 meets specification requirements, personnel from the MCS&T Division shall obtain a second sample at the source of production or distribution (i.e. terminal). If this second sample meets specification requirements, no further action is required, and the subject source may remain on the Division’s approved list.

5.2.3 If either of the samples obtained in Sections 5.2.1 or 5.2.2 do not meet specification requirements, the subject material shall be removed from the Division’s approved list.

5.2.4 If, within a twelve-month period, two or more samples obtained as outlined in Section 5.2 (of the same material from the same approved source) fail to meet specification requirements, personnel from the MCS&T Division shall conduct an investigation into the possible reasons for the non-specification material. If the outcome of this investigation indicates a problem with material from the subject approved source, removal of that source from the approved list shall be permitted.

5.2.5 If a SCM is removed from the approved list, it may be reinstated at the discretion of the Division when sufficient sampling and testing (at the source of production or

distribution) has been conducted to ensure that material being produced is once again within the limits of the specifications.

5.3 If, in a two-year period, no samples from an approved source of a SCM, as outlined in Section 5.2, are received by MCS&T from the Districts, then that source of SCM shall be considered as inactive, and it may be removed from the Division's approved list of SCMs.

5.3.1 If the Division elects to keep an inactive source of SCM on the approved list of SCMs, then MCS&T shall obtain additional samples at that source, as outlined in Sections 3.3 and 3.4.

10/28/2021

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

RLS:M

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

MIX DESIGN FOR PORTLAND CEMENT CONCRETE

1. PURPOSE

1.1 To establish a procedure for testing the physical properties of a proposed mix design.

1.2 To establish criteria for evaluating the test data to arrive at acceptable batch proportions for an approved mix design.

2. SCOPE

2.1 This procedure shall apply to the design of all portland cement concrete which is required by the specifications to be batched in accordance with an approved mix design. This procedure shall also apply to the design of self-consolidating concrete (SCC) specified in Section 603, but not to normal (non-SCC) concrete specified in Section 603.

3. REFERENCED DOCUMENTS

3.1 AASHTO Standards:

1. M 201, Standard Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
2. R 18, Standard Practice for Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
3. R 39, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
4. R 76, Standard Practice for Reducing Samples of Aggregate to Testing Size
5. T 11, Standard Method of Test for Materials Finer Than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
6. T 19, Standard Method of Test for Bulk Density (Unit Weight) and Voids in Aggregate
7. T 22, Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens
8. T 27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
9. T 84, Standard Method of Test for Specific Gravity and Absorption of Fine Aggregate
10. T 85, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate
11. T 119, Standard Method of Test for Slump of Hydraulic Cement Concrete
12. T 121, Standard Method of Test for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete

13. T 152, Standard Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method
14. T 196, Standard Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method
15. T 197, Standard Method of Test for Time of Setting of Concrete Mixtures by Penetration Resistance.
16. T 231, Standard Practice for Capping Cylindrical Concrete Specimens
17. T 358, Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration T309, Standard Method of Test for Temperature of Freshly Mixed Portland Cement Concrete
18. T 395, Standard Method of Test for Characterization of the Air-Void System of Freshly Mixed Concrete by the Sequential Pressure Method

3.2 ASTM Standards:

1. C 1231, Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Cylindrical Concrete Specimens
2. C 1567, Standard Test Method for Determining the Potential Alkali Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)

3.3 WVDOH Materials Procedures[1]:

1. MP 700.00.06, Aggregate Sampling Procedures
2. MP 603.06.20, Test Method for the Determination of Bond Strength Between Prestressing Steel Strand and Self-Consolidating Concrete (SCC)

3.4 WVDOH Forms:

1. WVDOH Form T 301E, A-Bar Calculation Worksheet
2. Optimized Aggregate Gradation (OAG) Worksheet
3. Excel Spreadsheet for MP 711.03.23

4. TEST PROCEDURE

4.1 With the exception of SCC produced in accordance with Section 603, mix designs shall be performed in accordance with the applicable requirements of AASHTO R39 (ASTM C192) by a Division Approved Laboratory. To obtain Division approval, a laboratory must be accredited by the AASHTO Accreditation Program for AASHTO R18 for the following Standards: AASHTO M201 (ASTM C511), AASHTO R39 (ASTM C192), AASHTO T22 (ASTM C39), AASHTO T119 (ASTM C143), AASHTO T121 (ASTM C138), AASHTO T152 (ASTM C231), AASHTO T196 (ASTM C173), AASHTO T197 (ASTM C403), AASHTO T231 (ASTM C617) or ASTM C1231, , AASHTO T309 (ASTM C1064), AASHTO T11 (ASTM C117), AASHTO T19 (ASTM C29), AASHTO T27 (ASTM C136), AASHTO T84 (ASTM C128), AASHTO T85 (ASTM C127), AASHTO R76 (ASTM C702), AASHTO T358. In addition, all personnel performing the Sequential Air Meter (SAM) test must be

[1] https://transportation.wv.gov/highways/mcst/Pages/WVDOH-Materials-Procedures.aspx

certified by the Division for AASHTO T395. A listing of these laboratories, that are approved to develop concrete mix designs for the Division, is available on the WVDOH, MCS&T Web Page[2]. Requests to be placed on that list of Division Approved Concrete Mix Design Labs shall be sent to the following e-mail address: DOHMCSnTconcretelab@wv.gov. To be placed on that list, all Division Approved Laboratories shall agree to allow the WVDOH, CCRL, and AASHTO re:source to freely share information about assessment reports, proficiency samples, corrective actions, quality management system, and personnel competency and certification records.

4.2 The following information for each of the materials listed below that are to be used in the proposed mix design shall be listed in Attachments 1 and 6-ASR. For mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1, the following information for each of the materials listed below that are to be used in the proposed mix design shall be listed in Attachments 1 OAG and 6-ASR OAG. The Ā requirements will not apply for those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1. Attachments 1 S-P and 6-ASR shall be used for SCC produced in accordance with Section 603.

4.2.1 Mix Design Component Materials

Cement:	Type, Materials Code, SiteManager Materials Code, Source and Location, Source Code, Producer/Supplier Code, Specific Gravity, Alkali Content
Supplementary Cementitious Material (SCM):	Type, Materials Code, SiteManager Materials Code, Source and Location, Source Code, Producer/Supplier Code, Specific Gravity, Alkali Content
Chemical Admixtures:	Type, Materials Code, SiteManager Materials Code, Source and Location, Source Code, Producer/Supplier Code
Coarse Aggregate:	Type, Materials Code, SiteManager Materials Code, Size, Source and Location, Source Code, Producer/Supplier Code, Specific Gravity, Absorption, A-Bar, Unit Weight, ASR Aggregate Reactivity Class
Fine Aggregate:	Type, Materials Code, SiteManager Materials Code, Source and Location, Source Code, Producer/Supplier Code, Specific Gravity, Absorption, A-Bar, Fineness Modulus, ASR Aggregate Reactivity Class

The mass and volume of each material that is to be used in each batch shall be listed in Attachment 2. Attachment 2 OAG shall be used for those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1. Attachment 2 S-P shall be used for SCC produced in accordance with Section 603.

[2] https://transportation.wv.gov/highways/mcst/Pages/APL_By_Number.aspx.

4.2.2 The aggregate correction factor, as defined in AASHTO T152, shall be listed in Attachment 3. Attachment 3 OAG shall be used for those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1. Attachment 3 S-P shall be used for SCC produced in accordance with Section 603.

4.2.3 The completed WVDOH form T301E, A-Bar calculation worksheet, used to establish the target A-Bar, shall be included in the mix design submittal package. An A-Bar calculation worksheet is not required to be included with the mix design submittal package for SCC produced in accordance with Section 603 and those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1. The completed optimized aggregate gradation (OAG) worksheet shall be included in the mix design submittal package.

4.2.4 Information (i.e. raw data) pertaining to the compressive strength test results of each cylinder shall be included in the mix design submittal package. This raw data shall include the specimen test age, date tested, cylinder ID, average cylinder diameter, maximum load applied to the cylinder, type of fracture, and compressive strength of the cylinder.

4.3 All classes of concrete (except Class H, concrete for specialized overlays, and SCC produced in accordance with Section 603) for the proposed mix design shall be batched in at least five separate batches. Two of the batches shall be proportioned to produce a mix having a minimum cement factor. Two of the batches shall be proportioned to produce a mix having a minimum cement factor equal to the specified minimum cement factor plus one bag of cement [94 lb. (42.6 kg)]. These batches at the minimum cement factor plus one bag of cement shall be proportioned at a different water-cement ratio (w/c) that the batches at the minimum cement factor. A fifth batch shall also be proportioned to produce a mix at the minimum cement factor, but this batch shall be proportioned at a different water-cement ratio than the previous four batches. The slump tolerance in Section 4.4 shall not apply to this fifth batch. All batches described above shall maintain the same replacement percentage of SCMs including plus one bag.

4.3.1 The Sequential Air Meter (SAM) test shall be performed for each trial batch of any mix design used on bridge decks. The average SAM number shall be recorded on Attachment 3 and must be less than or equal to 0.20 psi for establishment of the mixture proportions in accordance with AASHTO T 395 for mix design approval.

Class H concrete, concrete for Specialized Overlays, as set forth in Section 679 of the specifications, and SCC produced in accordance with Section 603 for the proposed mix design shall be batched in at least two separate batches.

The batches for Class H concrete shall be produced at the cement factor for Class H concrete that is required in the specifications. The surface resistivity tests shall be performed in accordance with AASHTO T 358, specified in Section 601.3 shall be performed, at the same test age, on each of these batches, and the same method of curing shall be used for all the test specimens.

The batches for specialized concrete overlays shall be produced at or above the minimum cement factor specified in Section 679.2.2.1 or 679.2.2.2. The surface resistivity test shall be performed, at the same test age, on each of these batches, and the same method of curing shall be used for all the test specimens.

The information (i.e. raw data), from which each surface resistivity test result was derived, shall also be included in the mix design submittal package.

The batches for SCC for prestressed concrete members shall be produced as outlined in Section 603.6.2.1 and at the cement factor required in Section 603.6.3.1.

4.4 Each batch of concrete shall be tested in the plastic state for air, consistency and yield. Each batch shall be adjusted as necessary to produce a plastic concrete having an air content, consistency, and yield equal to the specified value plus or minus a reasonable laboratory working tolerance. The following tolerances shall be used as a guide for all classes of concrete except SCC produced in accordance with Section 603: Air Content, ± ½ percent; Consistency, ± ½ in. (± 12 mm) of slump; Yield, ± 2 percent.

4.4.1 For SCC produced in accordance with Section 603, testing shall begin at the time immediately after the mixing sequence is completed. This time shall be designated as T_0. Temperature, air content, consistency, T_{50}, VSI (Visual Stability Index), passing ability, rapid assessment of static segregation resistance, segregation resistance, unit weight, and yield tests shall be conducted on these batches and shall be within the tolerances set forth in Table 603.6.2.1A.

Air content, consistency, and passing ability tests shall be conducted every thirty minutes until either the air content falls below the target value by more than 1.5%, the slump flow falls below the target spread by more than 2.0 inches (50 mm), or the J-Ring value falls below the target value by more than 1.5 inches (38 mm). For each time of testing, these values shall be plotted versus time after batching. Linear interpolation shall be used to determine the exact time when either the air content falls below the target value by more than 1.5%, the slump flow falls below the target spread by more than 2.0 inches (50 mm), or the J-Ring value falls below the target value by more than 1.5 inches (38 mm). The elapsed time, after T_0, when this occurs shall be noted as the "Workable Period" and shall be recorded in Attachment 2 S-P. This workable period shall be used as the time frame in which the entire member shall be construction, reference Section 603.6.7.

4.5 When the properties of a concrete batch have been established within acceptable limits, seven 4 by 8 in. (100 by 200 mm) cylinders shall be made from each batch produced in Section 4.3 (or 4.3.1) and tested in compression at the following ages: one cylinder at age 24 hours ± 2 hours (the exact age to the nearest hour at time of test shall be noted on the report); one cylinder at age 3 days; one cylinder at age 7 days; one cylinder at age 14 days; and three cylinders at age 28 days. The values of the physical properties of each mix produced in Section 4.3 (or 4.3.1) shall be the average of the physical properties established in the first two mixes produced at the minimum cement factor, the average of the physical properties established in the two mixes produced at the

minimum cement factor plus one bag of cement, and the physical properties of the fifth batch at the minimum cement factor and different water-cement ratio. These values shall be listed in Attachment 3. 4 by 8 in. (100 by 200 mm) cylinders shall be permitted for SCC produced in accordance with Section 603. The results of these tests shall be listed in Attachment 3 S-P.

4.5.1 The following properties of each batch of concrete produced in Sections 4.3 (or 4.3.1) shall be listed in Attachment 2: A-bar of total solids, consistency, air content, unit weight and yield, water-cement ratio, and temperature. The following properties of each batch of concrete produced in Sections 4.3 (or 4.3.1) shall be listed in Attachment 2 OAG, for those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1: optimized aggregate gradation (OAG) worksheet, consistency, air content, unit weight and yield, water-cement ratio, and temperature.

4.5.2 For SCC produced in accordance with Section 603, from one of the SCC trial batches required in 603.6.2.1, six more cylinders shall be fabricated for modulus of elasticity testing, eight more cylinders shall be fabricated for creep testing, three specimens shall be fabricated for length change testing, three specimens shall be fabricated for surface resistivity testing , and three specimens shall be fabricated for freeze-thaw resistance testing. Casting of all Class S-P specimens to be used for hardened concrete property testing shall be done in one lift without rodding or vibration. Curing and testing parameters for these specimens are noted in Section 603.6.2.1. These results of these tests shall be listed in Attachment 2 S-P.

Also, from one of the SCC trial batches required in 603.6.2.1, a prestressing strand bond strength test, in accordance with MP 603.06.20, shall be conducted, and the result shall be recorded in Attachment 3 S-P.

4.6 Mix design submittal packages including Attachments 1, 2, 3 and 6-ASR, A-bar worksheet(s), and raw data pertaining to the compressive strength and surface resistivity tests shall be submitted to the WVDOH District Materials Section in which the Source (i.e. Concrete Batch Plant) is located. Mix design submittal packages, for those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1 including Attachments 1 OAG, 2 OAG, 3 OAG and 6-ASR OAG, optimized aggregate gradation worksheet, and raw data pertaining to the compressive strength and surface resistivity tests shall be submitted to the WVDOH District Materials Section in which the Source (i.e. Concrete Batch Plant) is located. These submittal packages may be submitted to the District electronically, and MCS&T Division may be copied on the electronic submittal also, as this may expedite the process. All mix concrete mix designs, except SCC mix designs, that are sent to MCS&T Division shall be submitted electronically to the following e-mail address: DOHConcreteMixDesign@wv.gov.

SCC mix designs, produced in accordance with Section 603, shall be submitted directly to MCS&T Division and shall include Attachments 1 S-P, 2 S-P, 3 S-P and 6-ASR.

4.6.1 In the case of mix design submittals for a single mix design which is used at multiple concrete plants, one submittal package (for the same design) may be used for multiple

concrete plants. All the concrete plants at which the mix design is being used shall be noted on Attachment 1, and each WVDOH Materials Section in which the concrete plants are located shall be included on the submittal. Attachment 1 OAG shall be used in lieu of Attachment 1, for those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1. This submittal will be reviewed by MCS&T Division, and if the mix design is approved, a separate lab number will be assigned to the mix design for each location at which it is approved.

5. ACCEPTANCE CRITERIA

5.1 If the standard deviation of the concrete plant production has been established, the mix design must have an average laboratory compressive strength, based on the 4 by 8 in. (100 by 200 mm) cylinder results equal to or greater than the "Design 28-Day Compressive Strength" required by the specifications plus two times the standard deviation. Data used to establish the standard deviation shall be taken from the Division's data bank and shall consist of at least 30 individual test results obtained from recent plant production of concrete with proportions similar to the design mix. Information relative to the statistics for a particular plant will be furnished to the Contractor upon request.

5.2 If the standard deviation of the concrete plant production has not been established, or in the case of mobile mixer units, the mix design must have an average laboratory compressive strength equal to or greater than the "Design 28-Day Compressive Strength" plus 1,300 psi (9 MPa). The Division shall note the Plant Compressive Strength Standard Deviation, at the time of the mix design approval, in Attachment 3.

5.2.1 Note that the "Design 28-Day Compressive Strength" required by the Specifications is the minimum field strength sought in 4 by 8 in. (100 by 200 mm) cylinders representing the concrete being placed in the field and should not be confused with the laboratory compressive strengths required for design. The compressive strength, required in Section 5.1 or 5.2 for mix design approval, shall be noted as the “Mix Design Approval Strength”.

5.3 SCC mix designs, produced in accordance with Section 603, shall meet the mix design requirements as set forth in this MP and not the ACI mix requirements as specified in Section 603.6.2, except for the compressive strength “overdesign” requirements. SCC mix designs, produced in accordance with Section 603, shall meet the compressive strength “overdesign” requirements of ACI 301 Chapter 4.

6. PROPORTIONING DESIGN MIX

6.1 If the average of the batches produced in Section 4.3 (or 4.3.1), with the specified minimum cement factor, satisfies the acceptance criteria of Section 5, then it will be considered acceptable as the mix design for the class of concrete being designed.

6.2 If the average of the batches produced in Section 4.3 with the specified minimum cement factor does not satisfy the acceptance criteria of Section 5, then a linear compressive strength-cement factor relationship will be established using the average

28-day compressive strength, based on the 4 by 8 in. (100 by 200 mm) cylinder results, of the batches with the minimum cement factor and the average 28-day compressive strength of the batches with the minimum cement factor plus one bag of cement. This relationship will be interpolated to determine a cement factor [to the nearest 1 lb. (0.45 kg)] which would cause the acceptance criteria to be satisfied. This interpolated cement factor will be considered acceptable for proportioning the mix design for the class of concrete being designed.

6.2.1 If neither of the averages of the batches produced in Section 4.3 satisfies the acceptance criteria of Section 5, then that proposed mix design cannot be considered as acceptable, and a new mix design will be required.

6.2.2 Section 6.2 does not apply to Class H concrete, specialized overlay concrete, and SCC produced in accordance with Section 603. Therefore, if the average compressive strength of the Class H, specialized overlay concrete batches, or SCC produced in accordance with Section 603, in Section 4.3.1 does not satisfy the acceptance criteria of Section 4, then that proposed mix design cannot be considered as acceptable, and a new mix design will be required.

6.3 The submittal for a proposed mix design shall include completed copies of Attachments 1 and 3. It shall also include a completed copy of Attachment 2 for each of the batches at the minimum cement factor. It shall also include a completed copy of Attachment 2 for each of the batches at the minimum cement factor plus one bag of cement, and a completed copy of Attachment 2 for the batch at the minimum cement factor with a different water-cement ratio (i.e. fifth batch), when applicable. Attachments 1 OAG, 2 OAG, and 3 OAG shall be used in lieu of Attachments 1, 2, and 3 respectively, for those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1. All pertinent information supporting these attachments and pertaining to the information in them shall be submitted also. Upon approval of the subject mix design, the Division shall include a copy of Attachment 4 or 5 in ProjectWise, along with the approved mix design.

SCC mix design submittals, produced in accordance with Section 603, shall include completed copies of Attachments 1 S-P and 3 S-P. They shall also include a completed copy of Attachment 2 S-P for both batches produced in the mix design. All pertinent information supporting these attachments and pertaining to the information in them, including the test results pertaining to the workable period as outlined in Section 4.4.1, shall be submitted also.

6.4 Although the Contractor has satisfied all requirements for concrete design and a mix design has been approved by the Engineer, the Contractor may still be required to adjust the approved mix design in the field as necessary to maintain all properties within the limits of the specification. These field adjustments shall include increasing the cement factor above the value specified in the approved mix design if such an adjustment would be necessary to cause the strength of the field placed concrete to conform to the requirements of the specification. These field adjustments shall also include the addition of water in the field for slump adjustment. The procedure for determining the

maximum amount of water, which may be added to an approved concrete mix in the field, is outlined in the following sections.

6.4.1 Using the three different water-cement ratios from the batches produced in Section 4.3 and the corresponding 28-day compressive strengths from Section 4.5, the Excel file in Attachment 4 of this MP shall be used to create a best-fit line through these three points.

6.4.2 The water-cement ratio that corresponds to the Mix Design Approval Strength, as outlined in Section 5.1 or 5.2, shall be determined from the Excel file in Attachment 4 of this MP. The maximum water that is allowed to be added to an approved concrete mix in the field, shall be the amount of water, which corresponds to that water-cement ratio (i.e. the water-cement ratio that corresponds to the Mix Design Approval Strength). This maximum water amount shall be shown in Attachment 4. However, under no circumstance, shall the total amount of water in a mix, including field additions, exceed the amount of water corresponding to the maximum water content noted in Table 601.3.1A (i.e. under no circumstances shall the water-cement ratio in Table 601.3.1A be exceeded).

6.4.3 For existing approved mix designs, for which there are only two different water-cement ratios, Attachment 5 shall be used to determine the maximum water, that is allowed to be added to that approved concrete mix in the field. Attachment 4 shall be used to determine the maximum water, that can be added in the field, for all other mixes.

6.4.4 For Class H mixes and concrete mixes for specialized overlays, as set forth in Section 679 of the specifications, no additional water beyond what was used in the approved mix designs shall be added in the field.

7. MIX DESIGN RE-APPROVAL

7.1 Each mix design shall remain approved for a period of three years from the date of approval, after which the mix design may be re-approved for an additional three years based on re-qualification tests outlined in Section 7.2 and conducted at the Concrete Producer or a Division Approved Laboratory, meeting the requirements of Section 4.1. If a mix design is used often enough (at least fifteen air content, slump, and compressive strength tests for the previous three-year period), the re-qualification tests shall not be required, and the mix design may be re-approved based on the actual field tests performed during the previous three-year period.

Re-approval of SCC mix designs, produced in accordance with Section 603, shall be re-approved as outlined in Section 603.6.2.

The mix design shall meet the ASR requirements in Section 601.3.1.1 according to the most recent aggregate reactivity, alkali content of cement and SCM, and CaO content of fly ash from the Division Approved Products Lists APLs. A mix design using an SCM replacement level below that required in Table 601.3.1.1.1.4.2b of the Specifications may evaluate the effectiveness of SCM to prevent deleterious expansion as described in Section 601.3.1.1.1.6 to meet the ASR requirements.

7.1.1 When a Concrete Producer desires to have a mix design re-approved, he shall submit a written request to the WVDOH District Materials Section in which that plant is located noting such and including the current mix design lab numbers to be evaluated. The WVDOH District Materials personnel shall verify if there are a minimum of fifteen air content, slump, and compressive strength tests for that mix design in the previous three-year period.

7.1.2 If there are at least fifteen air content, slump, and compressive strength tests for that mix design in the previous three-year period, then the WVDOH District Materials personnel shall notify MCS&T Division that the subject mix design may be re-approved based on the criteria in Section 7.1. MCS&T Division shall then update the approval date of the subject mix design.

7.1.3 If there are not at least fifteen air content, slump, and compressive strength tests for that mix design in the previous three-year period, then the WVDOH District Materials personnel shall notify the Concrete Producer that the subject mix design must be re-approved as outlined in Section 7.2.

7.2 The following procedures shall be used to re-approve concrete mix designs that do not meet the criteria in Section 7.1.

7.2.1 The Concrete Producer shall provide a statement to the Engineer verifying that all sources of materials used in the approved mix designs are unchanged and the same as used in the original approved mix design. All materials shall meet the applicable sections of the specifications. The original mix design shall meet the ASR requirements in Section 601.3.1.1 according to most recent aggregate reactivity, alkali content of cement and SCM, and CaO of fly ash from the Division APLs.

7.2.2 Coarse and fine aggregate samples shall be obtained at the Concrete Producer's facility in accordance with MP 700.00.06, and the following tests shall be conducted on those aggregate samples by a WVDOH certified Aggregate Inspector: specific gravity (both coarse and fine aggregate), combined A-bar of total solids, absorption (both coarse and fine aggregate), fineness modulus (fine aggregate), and unit weight (coarse aggregate). The results of these tests shall be used by a WVDOH certified PCC Technician at the Concrete Producer or a Division Approved Laboratory, to establish a new target A-bar for the mix design and, if necessary, to adjust any batch volumes. Combined aggregate gradation shall be conducted in lieu of combined A-bar of total solids for those mix designs with the optimized aggregate gradation. The working range on each sieve from cumulative combined percent retained from aggregate gradation shall be in accordance with Table 601.3.2.4.1B from Section 601.3.2.4.1.

7.2.3 The Concrete Producer shall then, at the Producer's facility and in the presence of WVDOH District Materials personnel, produce a representative batch (acceptable to both the Producer and the WVDOH personnel) in accordance with Sections 601.6 and 601.7 of no less than 6 yd^3 (4.6 m^3) of the concrete mix subject for re-approval. This batch shall be tested for air content, slump, unit weight and yield. Also, three 4 by 8 in.(100 by 200 mm) 28-day compressive strength specimens, and if applicable, two

surface resistivity specimens (each to be tested at an age of 28 days and the average result used) shall be fabricated and tested from this batch.

7.2.3.1 In lieu of the batch produced at the Producer's facility, as outlined in Section 6.2.3, a batch may be produced at a Division Approved Laboratory. This batch does not need to be witnessed by WVDOH personnel. The size of this batch shall be the same as the size of the batches produced for new laboratory mix designs. If there are any changes to either the coarse or fine aggregate, certified laboratory personnel may perform the testing and mix adjustments as stated in Section 7.2.2.

7.3 The Concrete Producer or Division Approved Laboratory Personnel shall record the results of all tests required and the proportions used in the batch outlined in Section 7.2 in the applicable sections of Attachments 1, 2, and 3. Attachments 1 OAG, 2 OAG, and 3 OAG shall be used in lieu of Attachments 1, 2, and 3 respectively, for those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1. The Concrete Producer or Division Approved Laboratory Personnel shall then submit those attachments, along with the test data required in Section 7.2.2 to the WVDOH District Materials section, who will then forward them to MCS&T Division for evaluation. Based on these results, the existing mix design will either be re-approved (possibly with slight adjustments), or the current mix design will be considered to have expired, and a new mix design will be required. When a mix design is re-approved by MCS&T Division, the laboratory approval number for that mix shall not be changed, but the approval date (the "Date Sampled") shall be revised.

7.3.1 For mix design re-approval purposes, the compressive strength of the representative batch produced at the Producer, as outlined in Section 7.2.3, must meet or exceed the "Design 28-day Compressive Strength" in Section 601.3, but it does not have to meet the "overdesign" acceptance criteria outlined in Section 5.

7.3.1.1 If a laboratory batch is produced in lieu of a batch at the Producer, as outlined in Section 7.2.3.1, then the compressive strength of that batch must have a compressive strength which exceeds the "Design 28-Day Compressive Strength" required by the specifications by the value (f'_{cr}) obtained from the formula below. The criteria used to establish the standard deviation is outlined in Section 5.1.

$$f'_{cr} = f'_c + \sigma$$

Where:
f'_{cr} = Required compressive strength of the batch produced in Section 7.2.3.1 (expressed in psi)
f'_c = Design 28-Day Compressive Strength (expressed in psi)
σ = Concrete Plant Standard Deviation (outlined in Section 5.1)

7.3.2 For mix design re-approval purposes the surface resistivity test results from the representative batch produced in Section 7.2.3 or 7.2.3.1 must be equal to or greater than 30 kΩ-cm in order for the mix design to be re-approved.

7.3.3 If a mix design has expired, it may still be used on projects which have started before the mix design expired. However, after its date of expiration, a mix design may not be used on any new projects; a new mix design shall be required for these projects.

8. CHANGING A COMPONENT MATERIAL USED IN A MIX DESIGN

8.1 Whenever more than one component material in an approved mix design is changed simultaneously, a new laboratory mix design, in accordance with Section 4 shall be required. This option is not permitted for SCC mix designs produced in accordance with Section 603.

8.1.1 There are circumstances when one component material in an approved mix design may be changed to another WVDOH approved component material without requiring a new laboratory mix design. Those circumstances, and the subsequent steps which must be taken for that component material change to be approved, are outlined in the following sections.

8.2 The changes, outlined below, to any of the following component materials are permitted provided the requirements in Section 8.3 are met. Only one component material may be changed at a time, otherwise a new laboratory mix design in accordance with Section 4 shall be required. When changing the type and/or source of any one component material, minor adjustments to the quantities of other component materials in the mix design are permitted, to maintain desired mix properties. When changing the type and/or source of any one component material, the mix design shall meet the ASR requirements in Section 601.3.1.1 according to the most recent aggregate reactivity, alkali content of cement and SCM, and CaO of fly ash from the APLs. ASTM C1567 testing in accordance with Section 601.3.1.1.1.6 may be used to evaluate the effectiveness of SCM to prevent deleterious expansion if the SCM minimum replacement requirements of Table 601.3.1.1.1.4.2b are not met.

8.2.1 Cement: The source of cement may be changed provided the requirements of Section 8.3 are met. A change from a Type I cement to a Type IL cement (or from a Type IL cement to a Type I cement) may also be considered a single component material change.

8.2.2 Supplementary Cementitious Material (SCM): The source and/or type of SCM may be changed provided the requirements of Section 8.3 are met.

8.2.3 Chemical Admixture: The source and/or type of any individual admixture (*i.e*., air entraining, water reducing, or water-reducing and retarding, *etc*.) may be changed provided the requirements of Section 8.3 are met. If more than one admixture is used in a mix design, a change to an individual component material means a change in only one of those admixtures. If more than one admixture is used in a mix design, and a change to one of these admixtures is desired (a change to an individual component material), then the source of the new admixture must still be the same as the source of the rest of the admixtures in the mix (*i.e*., water-reducing admixture A from Source X may be changed to water-reducing admixture B from Source X.)

8.2.4 Latex Admixture: The source of latex admixture may be changed provided the requirements of Section 8.3 are met.

8.2.5 Fine Aggregate: The source of fine aggregate may be changed provided the requirements of Section 8.3 are met. However, if the type of fine aggregate changes (*i.e.*, silica sand to limestone sand or natural sand to manufactured sand), a new laboratory mix design in accordance with Section 3 shall be required.

8.2.6 Coarse Aggregate: The source of coarse aggregate may be changed provided the requirements of Section 8.3 are met. However, if the type or size of coarse aggregate changes (*i.e.,* river gravel to limestone or #57 limestone to #67 limestone), a new laboratory mix design in accordance with Section 4 shall be required.

8.3 When a change to any individual component material in an approved mix design, as outlined in Sections 8.1.1 and 8.2, is desired, the Concrete Producer shall, at the Producer's facility and in the presence of WVDOH District Materials personnel, produce two separate representative batches (acceptable to both the Producer and the WVDOH personnel) in accordance with Sections 601.6 and 601.7. Each of these batches shall be no less than 3 yd^3 (2.3 m^3), shall be batched at the target cement factor, and shall consist of the concrete mix with the proposed material change. The proportions for these batches shall be determined by a WVDOH certified PCC Technician.

8.3.1 If there is a change to either the coarse or fine aggregate, then a sample of the new material shall be obtained at the Concrete Producer's facility in accordance with MP 700.00.06, and the following tests shall be conducted by a WVDOH certified Aggregate Inspector on that aggregate sample: specific gravity, solid A-bar of the new material and A-bar of total solids, absorption, fineness modulus (fine aggregate), and unit weight (coarse aggregate). The results of these tests shall be used by a WVDOH certified PCC Technician at the Concrete Producer to establish a new target A-bar for the mix and, if necessary, to adjust any batch volumes. Combined aggregate gradation shall be conducted in lieu of solid A-bar of the new material and A-bar of total solids for those mix designs with the optimized aggregate gradation. The results of these tests shall be used by a WVDOH certified PCC Technician at the Concrete Producer to establish a new target Combined % Retained for the mix, if necessary, to adjust any batch volumes.

8.3.2 In lieu of the two batches produced at the Producer's facility, as outlined in Section 8.3, two batches may be produced at a Division Approved Laboratory, meeting the requirements of Section 4.1. These batches do not need to be witnessed by WVDOH personnel. The sizes of these batches shall be the same as the size of the batches produced for new laboratory mix designs, and their proportions shall be determined by certified laboratory personnel. If there are any changes to either the coarse or fine aggregate, certified laboratory personnel may perform the testing and mix adjustments as stated in Section 8.3.1.

8.3.3 All of the information pertaining to the materials used in these batches shall be listed in Attachments 1, 2, 3 and 6-ASR as outlined in Section 4.2. Attachments 1 OAG, 2

OAG, and 3 OAG shall be used in lieu of Attachments 1, 2, and 3 respectively, for those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1.

8.3.4 Both batches of concrete shall be tested in the plastic state for air, consistency, and yield. Each batch shall be adjusted as necessary to produce a plastic concrete having an air content, consistency, and yield equal to the specified value plus or minus the following tolerances: Air content, ± 1 percent; Consistency, ± 1 in. (± 25 mm) of slump; Yield, ± 2 percent.

8.3.4.1 If laboratory batches are produced in lieu of batches at the Producer, as outlined in Section 8.3.2, then the batch tolerances specified in Section 4.4 shall apply.

8.3.5 When the properties of a concrete batch have been established within acceptable limits, 3 - 4 in by 8 in. (100 by 200 mm) cylinders shall be made from each batch produced in Section 8.3 and 28 days. Cylinders may also be tested at 7, 14, and 21 days, and those results may be used as the basis of acceptance as long as the average compressive strength requirements outlined in Section 8.5 are met. The values of the physical properties of this new mix design (with the component material change) shall be the average of the physical properties established in the two batches produced in Section 8.3. These values shall be listed in the column for the mix with the "Minimum Cement Factor" in Attachment 3. Attachment 3 OAG shall be used in lieu of Attachment 3, for those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1.

The following properties of each batch of concrete produced in Section 8.3 shall be listed in Attachment 2: A-bar of total solids, consistency, air content, unit weight and yield, water-cement ratio, and temperature. For those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1, the following properties of each batch of concrete produced in Section 8.3 shall be listed in Attachment 2 OAG: optimized aggregate gradation (OAG) worksheet, consistency, air content, unit weight and yield, water-cement ratio, and temperature.

8.4 When it is desired to change a component material in a mix which requires the surface resistivity test, (Class H, and K concrete and specialized concrete overlays as outlined in Section 679), specimens shall be fabricated from each of the batches produced in Section 8.3. The specimens may be tested for Surface Resistivity at an age of 28 days. Specimens may also be tested at 7, 14, and 21 days, and those results may be used as the basis of acceptance if the requirements in Sections 8.4 and 8.5 are met. The average value of these surface resistivity specimens shall be no less than ten percent of the mix designs surface resistivity value, required in the applicable specification, when tested at the time frame specified in the applicable specification.

8.4.1 If laboratory batches are produced in lieu of batches at the Producer, as outlined in Section 8.3.2, then the average value of these surface resistivity specimens shall be less than or equal to the mix design surface resistivity value required in the applicable specification, when tested at the time frame specified in the applicable specification.

8.5 The average compressive strength of the two batches produced at the Producer in Section 8.3 must have an average compressive strength which exceeds the "Design 28-Day Compressive Strength" required by the specifications by the value (f'_{cr}) obtained from the formula below. The criteria used to establish the standard deviation is outlined in Section 5.1.

$$f'_{cr} = f'_c + 2.33\sigma - 500$$

Where:
f'_{cr} = Required average compressive strength of the batches produced in Section 8.3 (expressed in psi)
f'_c = Design 28-Day Compressive Strength (expressed in psi)
σ = Concrete Plant Standard Deviation (outlined in Section 4.1)

8.5.1 If laboratory batches are produced in lieu of batches at the Producer, as outlined in Section 8.3.2, then the average compressive strength of these batches must have an average compressive strength which exceeds the "Design 28-Day Compressive Strength" required by the specifications by the value (f'_{cr}) obtained from the formula below. The criteria used to establish the standard deviation is outlined in Section 5.1.

$$f'_{cr} = f'_c + 2\sigma$$

8.5.2 If the average compressive strength of the two batches produced in Section 8.3 (f'_{cr}) is less than the "Design 28-Day Compressive Strength" (f'_c) required by the specifications, the new mix (with the component material change) cannot be considered as acceptable, unless the requirements of Section 8.7 are met.

8.6 It is not required, but if the Concrete Producer desires, two additional separate batches may be produced, at the same time that the two batches in Section 8.3 are being produced. These two additional batches shall be acceptable to both the Producer and the WVDOH personnel and shall be produced in accordance with Sections 601.6 and 601.7. Each of these batches shall be no less than 3 yd^3 (2.3 m^3), shall be batched at the target cement factor plus one bag of cement [94 lb. (42.6 kg)], and shall consist of the concrete mix with the proposed material change.

8.6.1 In lieu of the two batches produced at the Producer's facility, as outlined in Section 8.7, two batches at the target cement factor plus one bag of cement [94 lb. (42.6 kg)] may be produced at a Division Approved Laboratory, meeting the requirements of Section 4.1. These batches, produced at a Division Approved Laboratory, do not need to be witnessed by WVDOH personnel. The sizes of these batches shall be the same as the size of the batches produced for new laboratory mix designs, and their proportions shall be determined by certified laboratory personnel.

8.6.2 Production of these two additional batches is not an option for Class H concrete or specialized overlay concrete.

8.6.3 Both batches of concrete shall be tested in the plastic state for air, consistency, and yield. Each batch shall be adjusted as necessary to produce a plastic concrete having

an air content, consistency, and yield equal to the specified value plus or minus the following tolerances: Air Content, ± 1 percent; Consistency, ± 1 in. (± 25 mm) of slump; Yield, ± 2 percent.

8.6.3.1 If laboratory batches are produced in lieu of batches at the Producer, as outlined in Section 8.7.1, then the batch tolerances specified in Section 4.4 shall apply.

8.6.4 When the properties of a concrete batch have been established within acceptable limits, three 4 by 8 in. (100 by 200 mm) cylinders shall be made from each batch produced in Section 8.7 and tested in compression at an age of 28 days. The values of the physical properties of this new mix design (with the component material change) shall be the average of the physical properties established in the two batches produced in Section 8.7. These values shall be listed in the column for the mix with the "Minimum Cement Factor + 1 Bag" in Attachment 3. Attachment 3 OAG shall be used in lieu of Attachment 3, for those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1.

The following properties of each batch of concrete produced in Section 8.7 shall be listed in Attachment 2: A-bar of total solids, consistency, air content, unit weight and yield, water-cement ratio, and temperature. For those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1, the following properties of each batch of concrete produced in Section 8.7 shall be listed in Attachment 2 OAG: optimized aggregate gradation (OAG) worksheet, consistency, air content, unit weight and yield, water-cement ratio, and temperature.

8.6.5 If the average of the batches produced in Section 8.3, with the specified target cement factor, does not satisfy the acceptance criteria set forth in Section 8.6, then a linear compressive strength-cement factor relationship will be established using the average 28-day compressive strength [based on the 4 by 8 in. (100 by 200 mm) cylinder results] of the batches with the target cement factor (Section 8.3) and the average 28-day compressive strength of the batches with the target cement factor plus one bag of cement (Section 8.7). This relationship will be interpolated to determine a cement factor [to the nearest 1 lb. (0.45 kg)] which would cause the acceptance criteria to be satisfied. This interpolated cement factor will be considered acceptable for proportioning the design mix for the class of concrete being designed.

8.6.6 If neither of the averages of the batches produced in Sections 8.3 or 8.7 satisfy the acceptance criteria in Section 8.6, then that proposed component material change cannot be considered as acceptable, and a new laboratory mix design will be required to make a change in component materials.

8.7 The submittal for a proposed mix design change, as outlined in Section 8, shall include completed copies of Attachments 1 and 3. It shall also include a completed copy of Attachment 2 for each of the batches produced in Section 8. Attachments 1 OAG, 2 OAG, and 3 OAG shall be used in lieu of Attachments 1, 2, and 3 respectively, for those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1. All pertinent information supporting these attachments and pertaining to the information in them shall be submitted also. The lab numbers of the

original mix design shall be included in the submittal. This new mix design shall be submitted to the District in the same manner as a normal mix design, and it shall then be forwarded to MCS&T Division for review and approval. If approved, a new lab number will be assigned to this mix design, and it shall, from that point forward be treated as a new mix design.

8.8 No additional component material changes are permitted to this mix design (without a new laboratory mix design) until there are a minimum of 20 consecutive field test results, from this new mix design, which meet or exceed the design compressive strength requirements. Once there are 20 consecutive field test results, from this new mix design, which meet or exceed the design compressive strength requirements, this mix design is eligible for another component material change in accordance with Section 8.

9. REPLACEMENT OF FLY ASH WITH CEMENT OR ANOTHER APPROVED SOURCE OF FLY ASH IN A MIX DESIGN

9.1 When an issue arises with a fly ash source or any other circumstance arises which causes a Concrete Producer to discontinue the use of a source of fly ash in an approved mix design, an equal volume of cement, or an equal volume of fly ash from a different WVDOH approved fly ash source, may be substituted for the fly ash in that mix. This option is not permitted for SCC mix designs produced in accordance with Section 603.

9.1.1 This option of replacing fly ash with cement, or fly ash from a different approved source, does not apply to Class H concrete and concrete for specialized overlays, as set forth in Section 679 of the specifications.

9.2 The Concrete Producer shall notify the WVDOH District Materials personnel that it is desired to replace the fly ash in an approved concrete mix design with an equal volume of cement or fly ash from a different approved source. The WVDOH District Materials personnel may then approve this change on a temporary basis. Field test data, as outlined in the following sections, shall be used to approve this mix design change as a permanent new mix design. The change on a temporary basis and permanent new mix design shall meet the ASR requirements in Section 601.3.1.1 according to the most recent aggregate reactivity, alkali content of cement and SCM, CaO of fly ash from the APLs. Evaluation of the effectiveness of SCM in accordance with 601.3.1.1.1.6 may be used if SCM replacement level does not meet the minimum replacement level described in Table 601.3.1.1.1.4.2b.

9.2.1 When fly ash from a different approved source is being substituted for the existing source of fly ash in an approved mix design, tests to determine the air content of the plastic concrete shall be performed at the Concrete Producer's facility and at the job site, in the presence of WVDOH personnel, on at least the first three batches of concrete produced with this different approved source of fly ash.

9.3 Two batches of concrete, produced with this mix containing either all cement or fly ash from a different approved source shall then be tested in the presence of WVDOH District Materials personnel. Both of these batches of concrete shall be tested in the

plastic state for air, consistency, and yield. Each batch shall have an air content, consistency, and yield equal to the specified value plus or minus the following tolerances: Air content, ± 1 percent; Consistency, ± 1 in. (± 25 mm) of slump; Yield, ± 2 percent.

9.3.1 Three 4 by 8 in. (100 by 200 mm) cylinders shall be made from each batch outlined in Section 9.3 and tested in compression at an age of 28 days. The values of the physical properties of this new mix design (with the fly ash replacement) shall be the average of the physical properties established in the two batches produced in Section 9.3. These values shall be listed in the column for the mix with the "Minimum Cement Factor" in Attachment 3.

The following properties of each batch of concrete produced in Section 9.3 shall be listed in Attachment 2: A-bar of total solids, consistency, air content, unit weight and & yield, water-cement ratio, and temperature. For those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1, the following properties of each batch of concrete produced in Section 9.3 shall be listed in Attachment 2 OAG: optimized aggregate gradation (OAG) worksheet, consistency, air content, unit weight & yield, water-cement ratio, and temperature.

9.4 The average compressive strength of the two batches produced in Section 9.3 must have an average compressive strength, which exceeds the "Design 28-Day Compressive Strength" required by the specifications.

9.5 The submittal for a mix design change from a mix containing fly ash to a mix using either only cement as the cementitious material or fly ash from a different approved source, as outlined in Section 9, shall include completed copies of Attachments 1, 3 and 6-ASR. It shall also include a completed copy of Attachment 2 for each of the batches produced in Section 9.3. Attachments 1 OAG, 2 OAG, and 3 OAG shall be used in lieu of Attachments 1, 2, and 3 respectively, for those mix designs which meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1. All pertinent information supporting these attachments and pertaining to the information in them shall be submitted also. This mix design change submittal shall be submitted to the District in the same manner as a normal mix design, and it shall then be forwarded to MCS&T Division for review and approval. A new lab number will be assigned to this mix design, and it shall, from that point forward be treated as a new mix design, using only cement as the cementitious material, or using fly ash from a different approved source along with the original source of cement as the cementitious materials.

10. ADDITION OF HYDRATION CONTROL STABILIZING ADMIXTURES TO EXISTING MIX DESIGNS

10.1 Approved Hydration Control Stabilizing Admixtures, as specified in Section 707.15, designed to stop the hydration of cement in a concrete mix, enabling an extension to the allowable discharge time from a truck mixer as outlined in Section 601.7 of the Specifications may be added to an existing approved concrete mix design in accordance

with the procedures outlined in this Section. This option is not permitted for SCC mix designs produced in accordance with Section 603.

10.2 Two separate batches of concrete shall be produced as outlined in Section 8.3. These concrete batches shall be tested as outlined in Sections 8.3 and 8.4.

10.2.1 Additional testing, as outlined in the second, third, and fourth paragraphs of Section 707.15.2.1, shall also be performed on one of the batches produced in Section 9.2 to verify that the allowable concrete discharge time may be extended.

10.3 If the requirements set forth in Section 8.6 are met, then the procedures set forth in Sections 8.8 and 8.9 shall be followed, and the existing mix shall be approved for use with the hydration control stabilizing admixture, and a new lab number will be assigned to this mix design.

10.4 No additional changes to the existing mix design are permitted at the time that these concrete batches are being produced for the acceptance of the addition of the hydration control stabilizing admixture to the existing mix design.

Michael Mance
Digitally signed by Michael Mance
Date: 2025.10.01 19:26:06 -04'00'

Michael A Mance, PE
Director
Materials Control, Soils & Testing Division

MM:Td
MP 711.03.23 Steward – Cement and Concrete Section
ATTACHMENTS

Source:		Facility:	
Source Code:		Facility Code:	
Class of Concrete:		Material Code:	
Design Laboratory:		Date:	

Cementitious Material Data			
Data	Cement	Supplementary Cementitious Material (SCM) 1	Supplementary Cementitious Material (SCM) 2
Name			
Type			
Material Code			
Source			
Source Code			
Facility			
Facility Code			
Specific Gravity			

Admixture Data				
Data	Air Entrainment	Additional Admixture 1	Additional Admixture 2	Additional Admixture 3
Name				
Type				
Material Code				
Source				
Source Code				
Facility				
Facility Code				

Aggregate Data		
Data	Coarse Aggregate	Fine Aggregate
Class/Size		
Type		
Material Code		
Source		
Source Code		
Facility		
Facility Code		
Specific Gravity		
A-Bar		
Absorption		
Fineness Modulus		
Unit Weight		

Source: _____
Facility: _____
Design Laboratory: _____
Class of Concrete: _____
Date: _____

Check The Appropriate Box For Designated Batch:	Minimum Cement Factor		Mininimum Cement Factor + 1 Bag		Minimum Cement Factor with Different w/c	Additional Batch
	Batch 1	Batch 2	Batch 1	Batch 2		

Material	Mass	Units	Volume		Units
Cement		lb (kg)			ft^3 (m^3)
SCM 1		lb (kg)			ft^3 (m^3)
SCM 2		lb (kg)			ft^3 (m^3)
Latex Admixture		lb (kg)	gal (L)		ft^3 (m^3)
Water		lb (kg)	gal (L)		ft^3 (m^3)
Air Content, by volume		%			ft^3 (m^3)
Coarse Aggregate		lb (kg)			ft^3 (m^3)
Fine Aggregate		lb (kg)			ft^3 (m^3)
Total		lb (kg)			ft^3 (m^3)
Air Entrain. Admixture		oz/Cwt (mL/100kg)			fl. oz. (mL)
Chemical Admixture 1		oz/Cwt (mL/100kg)			fl. oz. (mL)
Chemical Admixture 2		oz/Cwt (mL/100kg)			fl. oz. (mL)
Chemical Admixture 3		oz/Cwt (mL/100kg)			fl. oz. (mL)

Mixture Test Data							
$\bar{A}$ Total Solids	W/C Ratio	Cement Factor (ft^3)	Temperature	Consistency	Air Content	Unit Weight	Yield

Compressive Stength, psi (MPa)		
Specified Test Age:	Actual Test Age (hours)	4" x 8" (100 x 200 mm) Strengths
24 ± 2 Hours		
3 Days		
7 Days		
14 Days		
28 Days		
28 Days		
28 Days		
Avg. 28 Day Strength		#DIV/0!

SAM #

Surface Resistivity Test	
Sample	Result (kΩ-cm)
A	
B	
C	
Batch Average Result (kΩ-cm)	

SUMMARY

Source: _____
Facility: _____
Design Laboratory: _____
Class of Concrete: _____
Corresponding Design 28-day Compressive Strength from Table 601.3.1A (psi): _____
Corresponding Maximum Water Content from Table 601.3.1A: _____
Date: _____

	Minimum Cement Factor		Minimum Cement Factor + 1 Bag		Minimum Cement Factor with Different w/c	
Material	Mass	Units	Mass	Units	Mass	Units
Cement		lb (kg)		lb (kg)		lb (kg)
SCM 1		lb (kg)		lb (kg)		lb (kg)
SCM 2		lb (kg)		lb (kg)		lb (kg)
Water		lb (kg)		lb (kg)		lb (kg)
Coarse Aggregate		lb (kg)		lb (kg)		lb (kg)
Fine Aggregate		lb (kg)		lb (kg)		lb (kg)
Total		lb (kg)		lb (kg)		lb (kg)
Air Entrain. Admixture		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)
Chemical Admixture 1		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)
Chemical Admixture 2		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)
Chemical Admixture 3		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)
Total A-Bar Solids						
Water Cement Ratio						
Cement Factor		ft^3 (m^3)		ft^3 (m^3)		ft^3 (m^3)
Temperature		^OF (^OC)		^OF (^OC)		^OF (^OC)
Consistency		inches (mm)		inches (mm)		inches (mm)
Air Content		%		%		%
Unit Weight		lb/ft^3 (kg/m^3)		lb/ft^3 (kg/m^3)		lb/ft^3 (kg/m^3)
Yield		ft^3 (m^3)		ft^3 (m^3)		ft^3 (m^3)
Aggregate Correction Factor per AASHTO T 152		%		%		%

Compressive Strength, psi (Mpa)	Minimum Cement Factor Batch	Minimum Cement Factor + 1 Bag Batch	Minimum Cement Factor with Different w/c
1 Day			
3 Days			
7 Days			
14 Days			
28 Days			
28 Days			
28 Days			
Avg. 28 Day Strength	#DIV/0!	#DIV/0!	#DIV/0!
Plant Standard Deviation at time of Mix Design Approval (psi):			
Average SAM Number:		Average Resistivity (kΩ-cm):	

Fields will be Automatically Filled After Attachment 3 is Completed	28-day Compressive Strength (Known Y-Value)	Water/Cementitious Material Ratio (Known X-Value)
Average Strength of Two Batches at Target (Minimum) Cement Factor (from Field D49 in Attachment 3)	#DIV/0!	0
Average Strength of Two Batches at Target (Minimum) Cement Factor + 1 Bag (from Field H49 in Attachment 3)	#DIV/0!	0
Strength of Batch at Target (Minimum) Cement Factor but with Different w/c (from Field L49 in Attachment 3)	#DIV/0!	0
	Result of Best-Fit Line (Slope) #VALUE!	Result of Best-Fit Line (Y-Intercept) #VALUE!

Class of Concrete =	0
Maximum Water Content from Table 601.3.1A =	0
Target (Minimum) Cement Factor (lbs.) = (from Fields D19, D20, and D21 of Attachment 3)	0
Design Compressive Strength (psi) from Table 601.3.1A =	0
Plant Compressive Strength Standard Deviation (psi) =	0
Mix Design Approval Strength (psi) =	0
w/c that corresponds to the Mix Design Approval Strength =	#VALUE!
Maximum w/c Allowed in the Field =	**#VALUE!**
Total Maximum Pounds of Water Allowed in the Mix (Including Field Adjustments), at the Target (Minimum) Cement Factor) =	**#VALUE!**
Total Maximum Gallons of Water Allowed in the Mix (Including Field Adjustments), at the Target (Minimum) Cement Factor) =	**#VALUE!**

Fields will be Automatically Filled After Attachment 3 is Completed	28-day Compressive Strength (Known Y-Value)	Water/Cementitious Material Ratio (Known X-Value)
Average Strength of Two Batches at Target (Minimum) Cement Factor (from Field D49 in Attachment 3)	#DIV/0!	0
Average Strength of Two Batches at Target (Minimum) Cement Factor + 1 Bag (from Field H49 in Attachment 3)	#DIV/0!	0
	Result of Best-Fit Line (Slope) #VALUE!	Result of Best-Fit Line (Y-Intercept) #VALUE!

Class of Concrete =	0
Maximum Water Content from Table 601.3.1A =	0
Target (Minimum) Cement Factor (lbs.) = (from Fields D19, D20, and D21 of Attachment 3)	0
Design Compressive Strength (psi) from Table 601.3.1A =	0
Plant Compressive Strength Standard Deviation (psi) =	0
Mix Design Approval Strength (psi) =	0
w/c that corresponds to the Mix Design Approval Strength =	#VALUE!
Maximum w/c Allowed in the Field =	**#VALUE!**
Total Maximum Pounds of Water Allowed in the Mix (Including Field Adjustments), at the Target (Minimum) Cement Factor) =	**#VALUE!**
Total Maximum Gallons of Water Allowed in the Mix (Including Field Adjustments), at the Target (Minimum) Cement Factor) =	**#VALUE!**

Class of Concrete, Precast/Prestress Member	

Cementitious Material Data			
Data	Cement	Supplementary Cementitious Materials (SCM) 1	Supplementary Cementitious Materials (SCM) 2
Mass (lb/kg)			
Alklai Content (%)			
CaO (%)(Fly Ash Only)			

Aggregate Material Data		
Data	Reactivity	Most Reactivity
Coarse Aggregate		
Fine Aggregate		

1	Level of Prevention	If Level of Prevention is "V", stop here.

For Class H Concrete, Skip 2,3,4 and 5.

For Evaluation of the Effectiveness of SCM or/and Lithium Nitrate Admixture (ASTM C1567), skip 2,3,4, and 6. If concrete mix using a 100 percent lithium nitrate admixture dosage, skip 2,3,4,5, and 6.

2	Alkali Content of Concrete (Option 1)	0.00	lb/yd³ (kg/m³)
3	Replacement Level of SCM (Option 2)		%

4	For Prevention Level "Z" Only		
	Alkali Content of Concrete		%
	Replacement Level of SCM		%

5	Evaluation of the Effectiveness of SCM or/and Lithium Nitrate Admixture (ASTM C1567)		
	Data	Evaluation with Reactive Fine Aggregate	Evaluation with Reactive Coarse Aggregate
	Expansion results (%)		
	SCM (%)		
	Replacement of SCM in Mix Design (%)		
	Lithium Nitrate Admixture Dosage Rate (%)		

6	Option chosen from Specification Table 601.3.1C for Class H Concrete	

Source:		Facility:	
Source Code:		Facility Code:	
Class of Concrete:		Material Code:	
Design Laboratory:		Date:	

Cementitious Material Data			
Data	Cement	Supplementary Cementitious Material (SCM) 1	Supplementary Cementitious Material (SCM) 2
Name			
Type			
Material Code			
Source			
Source Code			
Facility			
Facility Code			
Specific Gravity			

Admixture Data				
Data	Air Entrainment	Additional Admixture 1	Additional Admixture 2	Additional Admixture 3
Name				
Type				
Material Code				
Source				
Source Code				
Facility				
Facility Code				

Aggregate Data		
Data	Coarse Aggregate	Fine Aggregate
Class/Size		
Type		
Material Code		
Source		
Source Code		
Facility		
Facility Code		
Specific Gravity		
Absorption		
Fineness Modulus		
Unit Weight		

Source:
Facility:
Design Laboratory:
Class of Concrete:
Date:

Check the Appropriate Box for the Designated Batch:	Batch 1	Batch 2	Additional Batch

Material	Mass	Units	Volume	Units
Cement		lb (kg)		ft^3 (m^3)
SCM 1		lb (kg)		ft^3 (m^3)
SCM 2		lb (kg)		ft^3 (m^3)
Water		lb (kg)	gal (L)	ft^3 (m^3)
Air Content, by volume		%		ft^3 (m^3)
Coarse Aggregate 1		lb (kg)		ft^3 (m^3)
Coarse Aggregate 2		lb (kg)		ft^3 (m^3)
Fine Aggregate		lb (kg)		ft^3 (m^3)
Total		lb (kg)		ft^3 (m^3)
Air Entrain. Admixture		oz/Cwt (mL/100kg)		fl. oz. (mL)
Chemical Admixture 1		oz/Cwt (mL/100kg)		fl. oz. (mL)
Chemical Admixture 2		oz/Cwt (mL/100kg)		fl. oz. (mL)
Chemical Admixture 3		oz/Cwt (mL/100kg)		fl. oz. (mL)

Mixture Test Data at T_0							
W/C Ratio	Cement Factor, ft^3 (m^3)	Concrete Temperature, °F (°C)	Slump Flow, in. (mm)	Air Content, %	Unit Weight, lb/ft^3 (kg/m^3)	Yield, ft^3 (m^3)	$T_{50,\ seconds}$
VSI	J-Ring, in. (mm)	Rpd. Asmnt. of Static Seg. Resist., in. (mm)	Segregation Resistance, %	Workable Period, minutes			

Compressive Strength Test, psi (Mpa)							
Test Age:	24 ± 2 hours	3 days	7 days	14 days	28 days	28 days	28 days
Actual Test Age (hours)							
Compressive Strength							
Average 28-day Compressive Strength:					#DIV/0!		

Modulus of Elasticity Test, psi (Mpa)						
Test Age:	3 days	7 days	14 days	28 days	28 days	28 days
Actual Test Age (hours)						
Modulus of Elasticity						
Average 28-day Modulus of Elasticity:				#DIV/0!		

Length Change (Shrinkage), % Length Change						
Test Age	Initial Reading	Reading at End of 28-day Curing Period	4 days after 28-day curing period	7 days after 28-day curing period	14 days after 28-day curing period	28 days after 28-day curing period
Specimen 1						
Specimen 2						
Specimen 3						
Average Length Change (Shrinkage) after 28-days of water curing and 28-days of Air Storage:						#DIV/0!

Surface Resistivity Results	
Sample	Results (kΩ-cm)
A	
B	
C	
Average Results (kΩ-cm)	

SAM#

Freeze-Thaw Resistance		
	# of Cycles Completed	Durability Factor
Specimen 1		
Specimen 2		
Specimen 3		
Average Durability Factor:		#DIV/0!

Creep Testing							
Age at Initial Loading (hours):		Comp. Str. Cylinder 1, psi (Mpa):		Comp. Str. Cylinder 2, psi (Mpa):		Initial Load, psi (Mpa):	
Initial Elastic Strain at Time of Initial Loading (Determined within 2 minutes after Initial Loading):							
	Loaded Cylinders - Total Strain	Control Cylinders - Drying Strain	Load Induced Strain	Load Induced Strain per Unit Stress	Creep Strain	Creep Strain per Unit Stress	Creep Coefficient
90 days After Initial Loading:							

SUMMARY

Source: _____

Facility: _____

Design Laboratory: _____

Class of Concrete: _____

Date: _____

	Mix Properties	
Material	Average Value from Two Trial Batches	Units
Cement		lb (kg)
SCM 1		lb (kg)
SCM 2		lb (kg)
Water	gal (L)	lb (kg)
Coarse Aggregate 1		lb (kg)
Coarse Aggregate 2		lb (kg)
Fine Aggregate		lb (kg)
Total Batch Weight		lb (kg)
Air Entrain. Admixture		oz/Cwt (mL/100kg)
Chemical Admixture 1		oz/Cwt (mL/100kg)
Chemical Admixture 2		oz/Cwt (mL/100kg)
Chemical Admixture 3		oz/Cwt (mL/100kg)
Water Cement Ratio		
Cement Factor		ft^3 (m^3)
Temperature		^OF (^OC)
Slump Flow		inches (mm)
Air Content		%
Unit Weight		lb/ft^3 (kg/m^3)
Yield		ft^3 (m^3)
T_{50}		seconds
VSI		
J-Ring		inches (mm)
Rapid Assessment of Static Segregation Resist.		inches (mm)
Segregation Resistance		%
Aggregate Correction Factor per AASHTO T 152		%

Compressive Strength, psi (Mpa)	Avg.Compressive Strength of both Trial Batches
24 ± 2 hours	
3 Days	
7 Days	
14 Days	
28 Days	
28 Days	
28 Days	
Avg. 28 Day Strength	#DIV/0!

Prestressing Strand Bond Strength Test (in accordance with MP 603.06.20) Check Applicable Box	
Pass:	
Fail:	

Average SAM Number	
Average Resistivity (kΩ-cm)	

Source:		Facility:	
Source Code:		Facility Code:	
Class of Concrete:		Material Code:	
Design Laboratory:		Date:	

Cementitious Material Data			
Data	Cement	Supplementary Cementitious Material (SCM) 1	Supplementary Cementitious Material (SCM) 2
Name			
Type			
Material Code			
Source			
Source Code			
Facility			
Facility Code			
Specific Gravity			

Admixture Data				
Data	Air Entrainment	Additional Admixture 1	Additional Admixture 2	Additional Admixture 3
Name				
Type				
Material Code				
Source				
Source Code				
Facility				
Facility Code				

Aggregate Data				
Data	Coarse Aggregate (I)	Coarse Aggregate (II)	Fine Aggregate (I)	Fine Aggregate (II)
Class/Size				
Type				
Material Code				
Source				
Source Code				
Facility				
Facility Code				
Absorption				
Fineness Modulus				
Unit Weight				

Source:
Facility:
Design Laboratory:
Class of Concrete:
Date:

Check The Appropriate Box For Designated Batch:	Minimum Cement Factor		Mininimum Cement Factor + 1 Bag		Minimum Cement Factor with Different w/c	Additional Batch
	Batch 1	Batch 2	Batch 1	Batch 2		

Material	Mass	Units	Volume		Units
Cement		lb (kg)			ft^3 (m^3)
SCM 1		lb (kg)			ft^3 (m^3)
SCM 2		lb (kg)			ft^3 (m^3)
Latex Admixture		lb (kg)	gal (L)		ft^3 (m^3)
Water		lb (kg)	gal (L)		ft^3 (m^3)
Air Content, by volume		%			ft^3 (m^3)
Coarse Aggregate (I)		lb (kg)			ft^3 (m^3)
Coarse Aggregate (II)		lb (kg)			ft^3 (m^3)
Fine Aggregate (I)		lb (kg)			ft^3 (m^3)
Fine Aggregate (II)		lb (kg)			ft^3 (m^3)
Total		lb (kg)			ft^3 (m^3)
Air Entrain. Admixture		oz/Cwt (mL/100kg)			fl. oz. (mL)
Chemical Admixture 1		oz/Cwt (mL/100kg)			fl. oz. (mL)
Chemical Admixture 2		oz/Cwt (mL/100kg)			fl. oz. (mL)
Chemical Admixture 3		oz/Cwt (mL/100kg)			fl. oz. (mL)

Mixture Test Data							
–	W/C Ratio	Cement Factor (ft^3)	Temperature	Consistency	Air Content	Unit Weight	Yield

Compressive Stength, psi (MPa)		
Specified Test Age:	Actual Test Age (hours)	4" x 8" (100 x 200 mm) Strengths
24 ± 2 Hours		
3 Days		
7 Days		
14 Days		
28 Days		
28 Days		
28 Days		
Avg. 28 Day Strength		#DIV/0!

SAM #

Surface Resistivity Test	
Sample	Results (kΩ-cm)
A	
B	
C	
Results (kΩ-cm)	

SUMMARY

Source: _____
Facility: _____
Design Laboratory: _____
Class of Concrete: _____
Corresponding Design 28-day Compressive Strength from Table 601.3.1A (psi): _____
Corresponding Maximum Water Content from Table 601.3.1A: _____
Date: _____

	Minimum Cement Factor		Minimum Cement Factor + 1 Bag		Minimum Cement Factor with Different w/c	
Material	Mass	Units	Mass	Units	Mass	Units
Cement		lb (kg)		lb (kg)		lb (kg)
SCM 1		lb (kg)		lb (kg)		lb (kg)
SCM 2		lb (kg)		lb (kg)		lb (kg)
Water		lb (kg)		lb (kg)		lb (kg)
Coarse Aggregate (I)		lb (kg)		lb (kg)		lb (kg)
Coarse Aggregate (II)		lb (kg)		lb (kg)		lb (kg)
Fine Aggregate (I)		lb (kg)		lb (kg)		lb (kg)
Fine Aggregate (II)		lb (kg)		lb (kg)		lb (kg)
Total		lb (kg)		lb (kg)		lb (kg)
Air Entrain. Admixture		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)
Chemical Admixture 1		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)
Chemical Admixture 2		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)
Chemical Admixture 3		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)		oz/Cwt (mL/100kg)
Water Cement Ratio						
Cement Factor		ft^3 (m^3)		ft^3 (m^3)		ft^3 (m^3)
Temperature		^OF (^OC)		^OF (^OC)		^OF (^OC)
Consistency		inches (mm)		inches (mm)		inches (mm)
Air Content		%		%		%
Unit Weight		lb/ft^3 (kg/m^3)		lb/ft^3 (kg/m^3)		lb/ft^3 (kg/m^3)
Yield		ft^3 (m^3)		ft^3 (m^3)		ft^3 (m^3)
Aggregate Correction Factor per AASHTO T 152		%		%		%

Compressive Strength, psi (Mpa)	Minimum Cement Factor Batch	Minimum Cement Factor + 1 Bag Batch	Minimum Cement Factor with Different w/c
1 Day			
3 Days			
7 Days			
14 Days			
28 Days			
28 Days			
28 Days			
Avg. 28 Day Strength	#DIV/0!	#DIV/0!	#DIV/0!

Plant Standard Deviation at time of Mix Design Approval (psi):			
Average SAM Number:		Average Resistivity (kΩ-cm):	

Cure Method:		Standard		Accelerated		Age (Days):

Class of Concrete, Precast/Prestress Member	

Cementitious Material Data			
Data	Cement	Supplementary Cementitious Materials (SCM) 1	Supplementary Cementitious Materials (SCM) 2
Mass (lb/kg)			
Alklai Content (%)			
CaO (%)(Fly Ash Only)			

Aggregate Material Data		
Data	Reactivity	Most Reactivity
Coarse Aggregate (I)		
Coarse Aggregate (II)		
Fine Aggregate (I)		
Fine Aggregate (II)		

1	Level of Prevention		If Level of Prevention is "V", stop here.

For Class H Concrete, Skip 2,3,4 and 5.

For Evaluation of the Effectiveness of SCM or/and Lithium Nitrate Admixture (ASTM C1567), skip 2,3,4, and 6. If concrete mix using a 100 percent lithium nitrate admixture dosage, skip 2,3,4,5, and 6.

2	Alkali Content of Concrete (Option 1)	0.00	lb/yd³ (kg/m³)
3	Replacement Level of SCM (Option 2)		%

4	For Prevention Level "Z" Only		
	Alkali Content of Concrete		%
	Replacement Level of SCM		%

5	Evaluation of the Effectiveness of SCM or/and Lithium Nitrate Admixture (ASTM C1567)				
	Data	Fine Aggregate (I)	Fine Aggregate (II)	Coarse Aggregate (I)	Coarse Aggregate (II)
	Expansion results (%)				
	SCM (%)				
	Replacement of SCM in Mix Design (%)				
	Lithium Nitrate Ad. Dosage Rate (%)				

6	Option chosen from Specification Table 601.3.1C for Class H Concrete

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION DIVISION
OF HIGHWAYS MATERIALS CONTROL, SOILS AND TESTING
DIVISION

MATERIALS PROCEDURE

MAINTAINING SPECIFIED LEVEL OF STRENGTH IN PORTLAND CEMENT CONCRETE

1. PURPOSE

1.1 The purpose of this procedure is to set forth a method of adjusting the cement content of portland cement concrete so that a reasonable conformance with the specified level of strength may be assured.

2. SCOPE

2.1 The procedure shall apply to all classes of concrete.

3. PROCEDURE

3.1 Initial Cement Requirement

3.1.1 "Initial Cement Requirement" is the cement requirement determined by the formal laboratory design method outlined in MP 711.03.23.

3.2 Reevaluating Cement Requirement

3.2.1 A concrete mix design referred to herein means a combination of particular source and type of materials and a cement factor which satisfies the requirement of the governing specification, said combination of materials and cement factor being formulated for the express purpose satisfying the requirement of a particular class of concrete specified for the work. The cement factor in a particular mix design may be changed without invalidating the design. If source or type of materials in a mix design are changed, then the mix design is considered changed, and two or more mix designs would result from such change(s).

Strength data which represents two cement factors in one mix design may be processed collectively in the derivation of statistical parameters, average and standard deviation, for example, if it is felt that such a treatment does not significantly affect the statistics.

3.2.2 For the various classes of concrete which are designed in conformance with MP 711.03.23, the first reevaluation of cement requirement shall be made after at least ten pieces of strength data are available to evaluate the adequacy of the mix design. Thereafter, a reevaluation of cement requirement shall be made at monthly intervals at which time, the evaluation shall be based on the strength data developed during the

preceding two months or on the last ten pieces of data developed, whichever is greater.

3.3 Method of Evaluating Cement Requirement

3.3.1 The cement requirement for all classes of concrete governed by this procedure shall be the quantity necessary to maintain the average strength of the concrete within the range of the Design Strength (f'_c) plus K_1 standard deviations and the Design Strength (f'_c) plus K_2 standard deviations $\{(f'_c + K_1\sigma) < \bar{X} < (f'_c + K_2\sigma)\}$.The average strength ($\bar{X}$) and the standard deviation (σ) shall be calculated using the strength data developed during the previous two months or the last ten pieces of strength data, whichever is greater.

3.3.2 If the average strength of concrete can be maintained at a level which is equal to or greater than the Design Strength plus K_2 standard deviations $\bar{X} > (f'_c + K_2\sigma)$, then the cement factor which causes this level of average strength to be developed may be reduced as indicated in Article 3.3.4.3 except that in no instance shall the cement factor be reduced below a level of the target specified cement factor minus 47 lbs. of cement per cubic yard.

3.3.3 If the average strength of the concrete is maintained below the level of the Design Strength plus K_1 standard deviations, $\bar{X} < (f'_c + K_1\sigma)$, then the cement factor which causes this level of average strength to be developed shall be increased as indicated in Article 3.3.4.2.

3.3.4 The relationship between the level of concrete strength (considered to be the average of all data developed during the preceding two months or the average of the last ten pieces of strength data, whichever is greater, and represented by $\bar{X}$), and the action which must be taken regarding the cement factor is as follows:

3.3.4.1 If the average strength is maintained at a level between the Design Strength plus K_1 standard deviations and the Design Strength plus K_2 standard deviations $\{(f'_c+K_1\sigma) < \bar{X} < (f'_c+K_2\sigma)\}$ the cement factor shall be maintained without change.

3.3.4.2 If the average strength falls below the Design Strength, plus K_1 standard deviations $\{\bar{X} < (f'_c+K_1\sigma)\}$ the cement factor shall be increased in accordance with the following formula:

$$Ci = \frac{(f'_c + K_1\sigma) - \bar{X}}{200}$$

Where C_i = Number of 23.5 lb. increments of cement increase per cubic yard, rounded up to a whole number.

f'_c = Design Strength K_1 = Factor from Table 1 σ = Standard Deviation

$\bar{X}$ = Average Strength

3.3.4.2.1 When the cement factor for a certain mix design, which contains a Supplementary Cementitious Material (SCM), is required to be increased, the Concrete Producer has two options to meet the cement factor increase requirement.

Option 1: Make the cement factor increase entirely with cement.

Option 2: Make the cement factor increase with the same cement/SCM ratio that is used in the subject mix design. For example, if 20% of the cementitious material in the subject mix design is fly ash and 80% of the cementitious material in the subject mix design is cement, and the cement factor was required to be increased by 23.5 pounds, the cement factor increase would consist of an additional 5 lbs. of fly ash and an additional 19 pounds of cement. Fractions of a pound that are 0.5 and above shall be rounded up, and fractions of a pound that are below 0.5 shall be rounded down.

3.3.4.3 If the average strength falls above the Design Strength plus K_2 standard deviations $\{\bar{X} > (f'_c+K_2\underline{\sigma})\}$ the cement factor may be decreased in accordance with the following formula:

$$Cd = \bar{X} - \frac{(f'_c + K_2\sigma)}{200}$$

Where C_d = Number of 23.5 lb. increments of cement to be decreased per cubic yard, rounded to the nearest whole number.

K_2 = Factor from Table 1

3.3.4.3.1 When the cement factor for a certain mix design, which contains a SCM, is permitted to be decreased, and if the Concrete Producer elects to decrease that cement factor, the cement factor shall be decreased with the same cement/SCM ratio that is used in the subject mix design. For example, if 20% of the cementitious material in the subject mix design is fly ash and 80% of the cementitious material in the subject mix design is cement, and the cement factor was permitted to be decreased by 23.5 pounds, the cement factor decrease would consist of a reduction of 5 lbs. of fly ash and a reduction of 19 pounds of cement. Fractions of a pound that are 0.5 and above shall be rounded up, and fractions of a pound that are below 0.5 shall be rounded down.

3.4 Reporting

Once each month, the Materials Control, Soils and Testing Division will publish a list of concrete producers (Commercial Suppliers and/or Contractors), with all concrete mix designs for each concrete producer, and their corresponding cement factor, determined in conformance with this MP.

3.5 Reevaluating Concrete Mix Design

A concrete mix design which is approved for a particular project will remain valid to the extent that it satisfies the requirement for that particular project for its duration.

A concrete mix design which is developed in accordance with MP 711.03.23 and maintained for a period of three years shall be re-approved in accordance with Section 6 of MP 711.03.23. It is the Contractor's responsibility to make adjustments to the design mix as necessary to maintain in the concrete proper placement properties, workability, finishability, yield, consistency, air content, and other requirements of the governing specification. The Contractor should be especially aware of this responsibility when the cement factor is changed in conformance with this procedure.

09/09/2020

Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

RLS:M
ATTACHMENT

TABLE 1 VALUES OF "K" FACTORS

NUMBER OF PIECES OF DATA	K1	K2
10	1.604	3.615
11	1.588	3.510
12	1.576	3.429
13	1.565	3.365
14	1.557	3.313
15	1.549	3.270
16	1.543	3.233
17	1.538	3.202
18	1.533	3.175
19	1.528	3.151
20	1.525	3.130
21	1.521	3.112
22	1.518	3.096
23	1.515	3.081
24	1.513	3.067
25	1.511	3.055
26	1.508	3.044
27	1.507	3.034
28	1.505	3.024
29	1.503	3.016
30	1.501	3.008
Above 30	1.500	3.000

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

STANDARD METHOD OF TEST FOR DETERMINING THE QUALITY OF WATER USED WITH HYDRAULIC CEMENT

1. PURPOSE

1.1 To establish a standard method of test and acceptance criteria to be used in determining the quality of water used with hydraulic cement.

2. PURPOSE

2.1 This procedure is applicable to untreated water sources used in combination with mixtures containing hydraulic cement. An untreated water source may be defined as a source other than a treated public water system.

2.2 Treated water systems may be used without testing.

3. APPLICABLE DOCUMENTS

3.1 ASTM C1602

3.2 AASHTO T 106

3.3 AASHTO T 162

3.4 ASTM C191

4. PROCEDURE

4.1 Untreated water shall be tested at the source for pH. When the pH of the water is between 4.5 and 8.5 no further testing is necessary.

4.2 If the pH is less than 4.5 or more than 8.5, all tests listed in this procedure will be conducted. A water source whose pH is determined to be within the limits defined in section 4.1 but appears to be contaminated with foreign material which could have an adverse effect on the Portland cement concrete shall have a sample forwarded to the Materials Division and all tests listed in this procedure will be conducted. The sample shall be accompanied with the required documentation indicating the sampler's reasons for requesting testing. These tests shall be conducted before first use and thereafter once every 6 months, or more often when there is reason to believe that a change has occurred in the characteristics of the water source.

5. TEST METHODS

5.1 Total Solids by Mass, Chloride as Cl^-, Sulfate as SO_4, and Alkalies as (Na2O + 0.658 K2O).

5.1.1.1 Tests shall be conducted in accordance with ASTM C1602.

5.2 Compressive Strength

5.2.1 The water under test shall be compared, in mortar, with distilled water. The proportions of dry materials in the mortar shall be 500 grams of Type III Cement, 1500 grams of graded

OTTAWA sand and the amount of water sufficient to produce a flow of 110+/-5 in 25 drops in accordance with AASHTO T 106 using the sample under test and compared to three specimens made using distilled water.

5.3 Time of Setting by Vicat Needle

5.3.1 Time of set will be prepared with the test sample and Type III Cement in accordance with ASTM C191. A control specimen will be made with distilled water for basis comparison.

6. ACCEPTANCE CRITERIA FOR UNTREATED WATER SOURCES

Performance Requirements for Untreated Water Source	Limit
Compressive Strength (Min% Control at 1 day)	90
Time of Set, (deviation from control)	-60 to +90 minutes

Chemical and Physical Limits for Untreated Water Source		
Maximum Concentration in Combined Mixing Water, ppm		Limit
A	Chloride as Cl^-, ppm	
	In prestressed concrete or bridge decks	500
	Other reinforced concrete in moist environments or containing aluminum embedments or dissimilar metals or with stay-in-place galvanized metal forms	1,000
B	Sulfate as SO_4, ppm	3,000
C	Alkalies as (Na_2O + 0.658 K_2O), ppm	600
D	Total solids by mass, ppm	50,000

05/31/2023
Ronald L. Stanevich, P.E.
Director
Materials Control, Soils and Testing Division

MP 715.07.20 Steward – Cement and Concrete Section
RLS:Tp

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