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 277, Standard Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
18. T309, Standard Method of Test for Temperature of Freshly Mixed Portland Cement Concrete

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 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 C 192) 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 T277 (ASTM C1202), AASHTO T309 (ASTM C1064), AASHTO T11 (ASTM C117), AASHTO T19 (ASTM C29), AASHTO T27 (ASTM C136), AASHTO T84 (ASTM C128), AASHTO T85 (ASTM C127), and AASHTO R76 (ASTM C702). A listing of these laboratories, that are approved to develop concrete mix designs for the Division, is available on the WVDOH, MCS&T Web

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

Page2. 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.

4.2.2 The aggregate correction factor, as defined in AASHTO T 152, shall be listed in Attachment 3. Attachment 3 OAG shall be used for those mix designs which meet the

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

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 the 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 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. Two rapid chloride permeability tests, in accordance with AASHTO T 277, 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. Two rapid chloride permeability tests specified in Section 679.2.2 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 rapid chloride permeability 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, 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 rapid chloride permeability 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 rapid chloride permeability 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 rapid chloride permeability 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 leu 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 leu 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 leu 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

rapid chloride permeability specimens (each to be tested at an age of 90 days or earlier 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 leu 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 average of the two rapid chloride permeability test results from the representative batch produced in Section 7.2.3 or 7.2.3.1 must be 1,000 coulombs or less 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 leu 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 leu 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 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 8.3. 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 leu 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 rapid chloride permeability test (Class H concrete and specialized concrete overlays as outlined in Section 679), a minimum of one permeability specimen shall be fabricated from each of the batches produced in Section 8.3. The average value of these permeability specimens shall be no more than ten percent greater than the mix design permeability 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 permeability specimens shall be less than or equal to the mix design permeability 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 leu 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 leu 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 leu 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: 2024.10.02 08:41:43 -04'00'

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

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

Producer/ Supplier:		Producer/Supplier Code:	
Location:			
Class of Concrete:		SM Material Code:	
		AWP Material Code:	
Design Laboratory:		Date:	

Cementitious Material Data			
Data	Cement	Supplementary Cementitious Material (SCM) 1	Supplementary Cementitious Material (SCM) 2
Name			
Type			
SM Material Code			
AWP Material Code			
Producer/Supplier			
Location			
Producer/Supplier Code:			
Specific Gravity			

Admixture Data				
Data	Air Entrainment	Additional Admixture 1	Additional Admixture 2	Additional Admixture 3
Name				
Type				
SM Material Code				
AWP Material Code				
Producer/Supplier				
Location				
Producer/Supplier Code:				

Aggregate Data		
Data	Coarse Aggregate	Fine Aggregate
Class/Size		
Type		
SM Material Code		
AWP Material Code		
Producer/Supplier		
Location		
Producer/Supplier Code:		
Specific Gravity		
A-Bar		
Absorption		
Fineness Modulus		
Unit Weight		

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ATTACHMENT 2

Producer/Supplier: _____

Location: _____

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							
$\overline{A}$ 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!	

Rapid Chloride Permeability Testing (When Applicable)		
Method of Curing (Check Applicable Box)	Standard	Accelerated
	Age at Time of Test (Days)	Total Adjusted Charge Passed (Coulombs)
Test 1		
Test 2		
Average		#DIV/0!

SUMMARY

Producer/Supplier: _____

Location: _____

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 Value of Rapid Chloride Permeability Test (Coulombs):			

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	

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OCTOBER 2, 2024
ATTACHMENT 1 S-P

Producer/ Supplier:		Producer/Supplier Code:	
Location:			
Class of Concrete:		SM Material Code:	
		AWP Material Code:	
Design Laboratory:		Date:	

Cementitious Material Data			
Data	Cement	Supplementary Cementitious Material (SCM) 1	Supplementary Cementitious Material (SCM) 2
Name			
Type			
SM Material Code			
AWP Material Code			
Producer/Supplier			
Location			
Producer/Supplier Code:			
Specific Gravity			

Admixture Data				
Data	Air Entrainment	Additional Admixture 1	Additional Admixture 2	Additional Admixture 3
Name				
Type				
SM Material Code				
AWP Material Code				
Producer/Supplier				
Location				
Producer/Supplier Code:				

Aggregate Data		
Data	Coarse Aggregate	Fine Aggregate
Class/Size		
Type		
SM Material Code		
AWP Material Code		
Producer/Supplier		
Location		
Producer/Supplier Code:		
Specific Gravity		
Absorption		
Fineness Modulus		
Unit Weight		

Producer/Supplier:
Location:
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!

Rapid Chloride Permeability Testing

	Age at Time of Test (days)	Total Adjusted Charge Passed (coulombs)
Specimen 1		
Specimen 2		
Specimen 3		
Average Total Charge Passed (coulombs):		#DIV/0!

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

Producer/Supplier: _____

Location: _____

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		^{O}F (^{O}C)
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:	

MP 711.03.23
OCTOBER 2, 2024
ATTACHMENT 1 OAG

Producer/ Supplier:		Producer/Supplier Code:	
Location:			
Class of Concrete:		SM Material Code:	
		AWP Material Code:	
Design Laboratory:		Date:	

Cementitious Material Data			
Data	Cement	Supplementary Cementitious Material (SCM) 1	Supplementary Cementitious Material (SCM) 2
Name			
Type			
SM Material Code			
AWP Material Code			
Producer/Supplier			
Location			
Producer/Supplier Code:			
Specific Gravity			

Admixture Data				
Data	Air Entrainment	Additional Admixture 1	Additional Admixture 2	Additional Admixture 3
Name				
Type				
SM Material Code				
AWP Material Code				
Producer/Supplier				
Location				
Producer/Supplier Code:				

Aggregate Data				
Data	Coarse Aggregate (I)	Coarse Aggregate (II)	Fine Aggregate (I)	Fine Aggregate (II)
Class/Size				
Type				
SM Material Code				
AWP Material Code				
Producer/Supplier				
Location				
Producer/Supplier Code:				
Specific Gravity				
Absorption				
Fineness Modulus				
Unit Weight				

MP 711.03.23
OCTOBER 2, 2024
ATTACHMENT 2 OAG

Producer/Supplier: _____
Location: _____
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" x 200 mm)	(100 Strengths
24 ± 2 Hours			
3 Days			
7 Days			
14 Days			
28 Days			
28 Days			
28 Days			
Avg. 28 Day Strength		#DIV/0!	

Rapid Chloride Permeability Testing (When Applicable)		
Method of Curing (Check Applicable Box)	Standard	Accelerated
	Age at Time of Test (Days)	Total Adjusted Charge Passed (Coulombs)
Test 1		
Test 2		
Average		#DIV/0!

SUMMARY

Producer/Supplier: _____

Location: _____

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 Value of Rapid Chloride Permeability Test (Coulombs): _____

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