Materials Procedures Committee Meeting

Meeting Date: 6/24/2020 - 9:00 AM

	MP Number	Champion	MP Title	Up for Vote?	Votes					
					MCST	CA	TED	OPP	EGR	p/f
1*	**106.03.50 - Attachment**	**Phil Brown**	WEST VIRGINIA TECHNICIAN INSPECTOR CERTIFICATION PROGRAM HANDBOOK	y						
2*	**711.03.23 - Attachment**	**Suman Thapa**	MIX DESIGN FOR PORTLAND CEMENT CONCRETE (ASR FORM).	y						
3*	**607.02.01**	**Jesse Sizemore**	ACCEPTANCE PROCEDURE FOR QUALIFIED PRODUCT LIST FOR ELECTRICAL AND TRAFFIC ITEMS FOR USE ON ROADWAYS AND BRIDGES	y						
4&	**631.02.00**	**Jesse Sizemore**	SUBMISSION OF BILL OF ELECTRICAL EQUIPMENT, SIGNAL EQUIPMENT, AND MATERIALS	n						
5&	**601.03.53**	**Mance/Thapa**	STANDARD METHOD FOR DETERMINATION OF OPTIMIZED AGGREGATE GRADATION IN PORTLAND CEMENT CONCRETE	n						
6&	**601.03.50**	**Mance/Thapa**	GUIDE FOR QUALITY CONTROL AND ACCEPTANCE REQUIREMENTS FOR PORTLAND CEMENT CONCRETE	n						
7&	**711.03.23**	**Mance/Thapa**	MIX DESIGN FOR PORTLAND CEMENT CONCRETE	n						
	*Up for Vote									
	**Editor Edit									
	&New									

WEST VIRGINIA TECHNICIAN INSPECTOR CERTIFICATION PROGRAM HANDBOOK

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1. INTRODUCTION

Welcome to the West Virginia Department of Transportation Inspector Training Certification Program (TICP). The purpose of the West Virginia Division of Highways (WVDOH) Technician and Inspector Certification Program is to improve the quality assurance of embankments, subgrades, base course, asphalt and Portland cement concrete by the certification of industry and Division of Highways personnel. This document is to establish guidelines for this purpose.

It is the Division's intent to conduct a cooperative program of training, study, and examination so that personnel of the producer, contractor, and the Division of Highways will be able to better assure, by their increased technical knowledge, the level of quality required by the governing specifications.

This document, along with MP 106.03.50, is applicable to all requirements, guidelines, and other support documents of the Division of Highways that reference conditions, methods, and levels of qualification specific to the Division of Highways training and certification program.

There are often changes and additions to the TICP, so please, thoroughly review this document as well as the Materials Division Website to find out about any changes that may pertain to you

2. CERTIFICATION BOARD

As per MP 106.03.50 the certification board members shall be as follows:

1. State Highway Engineer
2. Human Resources Director
3. Materials Control Soils & Testing Director
4. Quality Assurance Training Program Administrator
5. Applicable Materials Control Soils and Testing Group Supervisor's

3. APPLICATION AND CLASS SIGN-UP INSTRUCTIONS

For course registration, instructions, please visit the WVDOH MCST Webpage[1] for Instructions:

4. CERTIFICATIONS

The TICP offers certification classes in the following disciplines:

1. Aggregate Technician
2. Aggregate Sampling Inspector
3. Soils & Aggregate Compaction Technician
4. Portland Cement Concrete Technician

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

5. Portland Cement Concrete Inspector
6. Asphalt Plant Technician
7. Asphalt Field & Compaction Technician

EXCEPT AS NOTED HEREIN ALL CERTIFICATIONS ARE VALID FOR A THREE-YEAR PERIOD

5. CLASS SUPPLY LIST

We recommend that participants bring the following items with them to the certification classes:

1. Laptop Computer or Tablet (Mandatory)
2. Photo ID
3. Current WV specification book and the latest supplemental to the specification book. You will need this during the test. These are also available in printable PDF format on the WVDOH Webpage.[2]
4. Hand held calculator (No electronic devices other than a Hand held calculators are allowed to be used during testing.)
5. Hi-lighters
6. Sticky Notes
7. Ruler / Straight edge

6. SPECIAL NEEDS AND REQUESTS

Applicants with special needs should notify the Training Certification Program coordinator prior to the class to ensure that the training location is prepared to accommodate their needs.

7. RECIPROCAL CERTIFICATIONS

The West Virginia Division of Highways may recognize reciprocity certifications from other states. Please see MP 106.03.51 for detailed instructions.

American Concrete Institute (ACI) Field Testing Grade I certification will be accepted as a portion of the West Virginia PCC Inspector training. However, the applicant must pass the online West Virginia PCC. Inspector written certification test before a certification will be issued.

Acceptance of WVDOH Certifications by other state agencies is at the sole discretion of the other agency.

8. TRAINING

The Division of Highways, contractors, and producers may sponsor courses of

[2] https://transportation.wv.gov/highways/contractadmin/specifications/Pages/default.aspx

instruction consisting of schools and seminars to help prepare personnel for certification under one or more of these certification programs. To the extent possible, these courses of instruction will be joint efforts of the industry and WVDOH. Nothing in this document shall be interpreted to prohibit any party from conducting courses of instruction for their personnel to assist in preparation for these exams.

The purpose of the schools is to provide helpful information and instruction for persons preparing to take the technician/inspector examinations. These courses are designed to provide instruction for persons with a basic foundation in the subject matter.

9. CERTIFICATIONS

All certifications listed in the sections below require written examinations. Some of the listed certifications require a practical examination after successful completion of the written examination. It is the responsibility of the applicant to determine which certification is applicable to his/her assignment. The following is a description of the certifications listing relevant information about each:

10. AGGREGATE CERTIFICATIONS

10.1 Aggregate Technician

The written examination for an Aggregate Inspector consists of the following areas:

1. Specifications
2. Aggregate Specifications and Procedures
3. Aggregate Fundamentals
4. Sampling, Control, and Inspection of Aggregates
5. Aggregate Testing
6. Gradations
7. T11 Wash Test

After successful completion of the written examination, the applicant will be required to pass a practical examination consisting of his/her demonstration of testing common to normal aggregate quality requirements. Certification as an Aggregate Technician qualifies the employee, either Industry or Division, to perform sampling and/or testing of aggregates relevant to the quality control program or acceptance program respectively.

10.2 Aggregate Sampling Inspector

The written examination for an Aggregate Sampling Inspector consists of the following areas:

1. Specifications

2. Sampling Fundamentals
3. Sampling Methods and Equipment

There is no in-person class for the Aggregate Sampling Inspector Certification; the class is online-only and on-demand. The Aggregate Sampling Inspector Certification requires the successful completion of the examination. Certification as an Aggregate Sampling Inspector qualifies the employee, either Industry or Division, to perform sampling of aggregates relevant to the quality control program or acceptance program respectively.

The test will be available online throughout the year, but may only be attempted twice per year. A score of 70 is required for passing.

11. COMPACTION CERTIFICATIONS

11.1 Soils & Aggregate Compaction Technician (SACT) - The written examination for the Soils & Aggregate Compaction Technician consists of the following areas:

1. Specifications
2. Compaction Test Procedures
3. Radiation Safety and Nuclear Gauge
4. Test Procedure Problems

After successful completion of the written examination, the applicant will be required to pass a practical examination demonstrating his/her proficiency in using the testing equipment. Certification of the Compaction Technician qualifies the employee, either Industry or Division, to conduct tests on all soil construction materials that require compaction testing.

12. CONCRETE CERTIFICATIONS

12.1 Portland Cement Concrete Technician

The written examination for a Portland Cement Concrete Technician consists of the following areas:

1. Specifications
2. Fundamentals
3. Sampling and Testing
4. Control and Inspection
5. Mix Proportioning and Adjustment

The Portland Cement Concrete Technician certification requires only the successful completion of the written examination; no practical examination is required. Certification of the Portland Cement Concrete Technician qualifies the employee, either Industry or Division, to make plant and mix adjustments, proportioning, and other duties.

12.2 Portland Cement Concrete Inspector

The written examination for a Portland Cement Concrete Inspector consists of the following areas:

1. Specifications
2. Fundamentals
3. Sampling and Testing
4. Control and Inspection
5. Specifications

After successful completion of the written examination, the applicant will be required to pass a practical examination demonstrating his/her proficiency in conducting tests common to concrete quality control. Certification as a Portland Cement Concrete Inspector qualifies the employee, either Industry or Division, to perform sampling and/or testing of concrete relevant to the quality control program or acceptance program respectively.

13. ASPHALT CERTIFICATIONS

13.1 Asphalt Plant Technician

The written examination for the Asphalt Plant Technician consists of the following
areas:

1. Specifications
2. Fundamentals
3. Sampling and Testing
4. Control and Inspection
5. Mix Proportioning and Adjustment

After successful completion of the written examination, the applicant will be required to pass a practical examination demonstrating their proficiency in conducting tests common to Asphalt quality control. Certification of the Asphalt Technician qualifies the employee, either Industry or Division, to take asphalt mixture samples, perform quality control or quality assurance testing on plant produced asphalt mixture, make plant and mix adjustments, aggregate proportioning, and other duties.

13.2 Asphalt Field and Compaction Technician (AFCT) –

The written examination for the Asphalt Field and Compaction Technician consists of the following areas:

1. Specifications
2. Compaction Test Procedures
3. Radiation Safety and Nuclear Gauge
4. Test Procedure Problems

5. Testing Forms

After successful completion of the written examination, the applicant will be required to pass a practical examination demonstrating his/her proficiency in using the testing equipment. Certification of the Asphalt Field & Compaction Technician qualifies the employee, either Industry or Division, to conduct tests on all asphalt materials that require compaction testing.

14. EXAMINATIONS

All participants shall be required to furnish their own laptop or tablet to take the final course exams. Examinations, both written and practical, will be coordinated by the Materials Control, Soils & Testing Division of the Division of Highways. The locations and dates of the examinations will be announced at least two weeks prior to being given. The examinations may be held on a regional basis when feasible. All written examinations will be a one-part, 'open-book' type, with a time limit.

If an applicant fails to receive a minimum score of 70% on the first exam, they will be given another attempt to score a 70%. This second attempt shall be a subsequent, scheduled make-up exam. Failure to attend any examination counts as a failed exam.

If the re-test examination is not passed, the applicant may not take another test in the 12-month period without first attending the certification school. Practical examinations require performance of the tests required by the specifications for the material type involved.

After the applicant passes the written examination, they will be granted two attempts within a 12-month period to pass the practical exam. All practical examinations are pass / fail. If an applicant fails the practical twice, the applicant may not take another practical test in the same 12-month period without first attending the certification school. The scheduling of the practical examination and re-examination is to be established by the section running the certification class.

If a technician who possesses an active certification fails an exam or practical for re-certification during their active period, this does not revoke or void their current certification.

15. CERTIFICATION AND RE-CERTIFICATION

15.1 Certification

An individual must pass the examination in each level for which they are requesting certification. Unless otherwise noted, to pass the written examinations, the applicant must obtain minimum score of 70 percent.

If an applicant fails to receive a minimum score of 70% on the first exam, they will be given another attempt at a later date to score a 70%. This second attempt shall be a subsequent, scheduled make-up exam. Failure to attend any examination counts as a failed exam.

Upon successfully completing the requirements for certification, the applicant may print their certification card from the divisions web-site.
http://dotftp.wv.gov/materialsdir/

This certification is not transferable. A certification shall be valid for Three years and expire December 31, of the 3rd year of certification.

15.2 Re-Certification

The renewal of all certifications shall require a written exam and a hands-on practical exam, where applicable.

Applicants will be given two scheduled attempts to pass the recertification exam and one attempt to pass the practical exam (each, respectively). Any applicant that fails to acquire a minimum score of 70% on a recertification exam or who fails the subsequent practical exam will not have their certification renewed. The applicant may not take additional recertification or practical exams for the failed certification(s) again less than 12-months after the first failed exam without first taking the respective certification class.

Virtual practicals are permissible and preferable, but not required. If a virtual practical is chosen by the applicant, setup including equipment, material and location of virtual practicals is the responsibility of the applicant. Audio, video and other tech support issues are also the responsibility of the applicant.

Any failed recertification examination taken prior to the expiration date of the current certification, either practical or written will not result in termination of any current certification prior to the expiration date of that certification.

The certification holder shall be responsible updating their personal information on the online learning website.
http://www.onlinelearning.wv.gov/student/home.html

Certification holders shall be responsible to ensure that their certifications stay current. The West Virginia Division of Highways will no longer mail reminder letters to certification holders.

If an applicant seeking recertification disagrees with a recertification decision, they may file a written appeal with the board. (See Appealing a Decision).

16. TESTING PROTOCOL

The TICP has a testing protocol that must be followed. The protocol includes testing environment, time limits, proctoring exams, etc. The entire protocol will be covered with attendees prior to testing.

17. REVOCATION OF CERTIFICATION

WVDOT TICP grants certification upon satisfactory completion and maintenance of certain conditions and may be revoked upon any breach of these conditions.

Generally, certifications may be revoked if in the opinion of the certifying authority, an individual has knowingly committed acts detrimental to the integrity of the Certification Program or transportation industry. Examples of situations that warrant revocation are, but not limited to:

- Deliberate falsification of field or quality control test results or records.
- Deliberate falsification of calculations, test results or materials
- Cheating on certification/re-certification exams.
- Submittal of false information on certification applications.
- Submitting trial mix mixture and/or calculations completed by someone other than the signatory, or knowingly supplying trial mix mixture and/or calculations for another individual's certification.

The Program Administrator will take the lead in gathering facts and investigating any allegations which may require revocation of a certification. The review board will notify the individual in writing of intent to revoke certification(s).

18. APPEALING A DECISION

Any individual who disagrees with a decision by the board has 10 business days from the date of receipt of the notification to respond in writing to the board and present documentation to support their continued certification and/or request an opportunity for a meeting to present their case.

If the individual fails to respond within 10 days of receipt of the original notification of revocation letter, the revocation becomes final.

Not later than 20 business days after receiving a request for a meeting from the individual, the board will schedule a meeting in which the individual can present their case. If the board was not persuaded by the documentation

provided by the individual and the board continues to believe that revocation of the certification is warranted, the individual may file a written appeal to the State Highway Engineer for review. All information including any letter(s) of explanation from the individual will accompany the documents submitted to the State Highway Engineer. The board will mail the decision of the State Highway Engineer for or against revocation of certification to the individual concerned. The decision by the state highway engineer is final.

19. THE LENGTH OF REVOCATION SHALL BE AS FOLLOWS:

19.1 First Offense

This may include revocation of all certifications for up to one year. After the revocation period the individual may obtain recertification by passing respective certification exam and a practical (if applicable.) If either exam is failed, the individual will be required to take the certification class before being permitted to test again. The individual will be required to retake and pass the written exam regardless of whether it was previously passed.

19.2 Second Offense

This may include revocation of all certifications for up to for five years. There is also the possibility of demotion and reduced pay for WVDOH employees. After the revocation period the individual may obtain recertification by passing respective certification exam and a practical (if applicable) at the discretion of the board. If either exam is failed, the individual will be required to take the certification class before being permitted to test again. The individual will be required to retake and pass the written exam regardless of whether it was previously passed.

19.3 Third Offense

This may include revocation of all certifications for life. There is also the possibility of termination, demotion and reduced pay for WVDOH employees.

20. CONTACT INFORMATION

If you have any questions about our program or need more information. Please contact: Qaschoolscoordinator@wv.gov

MP 711.03.23
SUPERSEDES: SEPTEMBER 2018
REVISED: MAY 2020
ATTACHMENT 1

Source:		Source Code:	
Source Location:		Producer/Supplier Code:	
Class of Concrete:		Materials Code:	
		SiteManager Mat. Code:	
Design Laboratory:		Date:	

Cementitious Material Data			
Data	Cement	Supplementary Cementitious Material (SCM) 1	Supplementary Cementitious Material (SCM) 2
Name			
Type			
Materials Code			
SiteManager Mat. Code			
Source			
Source Location			
Source Code			
Producer/Supplier Code:			
Specific Gravity			

Admixture Data				
Data	Air Entrainment	Additional Admixture 1	Additional Admixture 2	Additional Admixture 3
Name				
Type				
Materials Code				
SiteManager Mat. Code				
Source				
Source Location				
Source Code				
Producer/Supplier Code:				

Aggregate Data		
Data	Coarse Aggregate	Fine Aggregate
Class/Size		
Type		
Materials Code		
SiteManager Mat. Code		
Source		
Source Location		
Source Code		
Producer/Supplier Code:		
Specific Gravity		
A-Bar		
Absorption		
Fineness Modulus		
Unit Weight		

MP 711.03.23
SUPERSEDES: SEPTEMBER 2018
REVISED: MAY 2020
ATTACHMENT 2

Source: _____
Source 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							
$\bar{A}$ 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)	6" x 12" (150 x 300 mm) Strengths	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!	#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!

MP 711.03.23
SUPERSEDES: SEPTEMBER 2018
REVISED: MAY 2020
ATTACHMENT 3

SUMMARY

Source: _____

Source 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
	6" x 12" Cyl. (150x300 mm)	4" x 8" Cyl. (100x200 mm)		
1 Day				
3 Days				
7 Days				
14 Days				
28 Days				
28 Days				
28 Days				
Avg. 28 Day Strength	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
If applicable, are 4" x 8" (100 x 200 mm) cylinders permitted in the field:				#DIV/0!
Plant Standard Deviation at time of Mix Design Approval (psi):				

Average Value of Rapid Chloride Permeability Test (Coulombs):	

MP 711.03.23
SUPERSEDES: SEPTEMBER 2018
REVISED: MAY 2020
ATTACHMENT 4

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!**

MP 711.03.23
SUPERSEDES: SEPTEMBER 2018
REVISED: MAY 2020
ATTACHMENT 5

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!**

MP 711.03.23
MARCH, 2021
ATTACHMENT 6-ASR

Class of Concrete, Precast/Prestress Member	

Cementitious Material Data		
Data	Cement	Supplementary Cementitious Materials (SCM) 1
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 Admix	
	Data	Evaluation with Reactive Fine 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

Supplementary Cementitious Materials (SCM) 2

ture (ASTM C1567)

Evaluation with Reactive Coarse Aggregate

MP 711.03.23
SUPERSEDES: SEPTEMBER 2018
REVISED: MAY 2020
ATTACHMENT 1 S-P

Source:		Source Code:	
Source Location:		Producer/Supplier Code:	
Class of Concrete:		Materials Code:	
		SiteManager Mat. Code:	
Design Laboratory:		Date:	

Cementitious Material Data			
Data	Cement	Supplementary Cementitious Material (SCM) 1	Supplementary Cementitious Material (SCM) 2
Name			
Type			
Materials Code			
SiteManager Mat. Code			
Source			
Source Location			
Source Code			
Producer/Supplier Code:			
Specific Gravity			

Admixture Data				
Data	Air Entrainment	Additional Admixture 1	Additional Admixture 2	Additional Admixture 3
Name				
Type				
Materials Code				
SiteManager Mat. Code				
Source				
Source Location				
Source Code				
Producer/Supplier Code:				

Aggregate Data		
Data	Coarse Aggregate	Fine Aggregate
Class/Size		
Type		
Materials Code		
SiteManager Mat. Code		
Source		
Source Location		
Source Code		
Producer/Supplier Code:		
Specific Gravity		
Absorption		
Fineness Modulus		
Unit Weight		

MP 711.03.23
SUPERSEDES: SEPTEMBER 2018
REVISED: MAY 2020
ATTACHMENT 2 S-P

Source:
Source 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:							

MP 711.03.23
SUPERSEDES: SEPTEMBER 2018
REVISED: MAY 2020
ATTACHMENT 3 S-P

SUMMARY

Source: _____

Source 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:	

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

MATERIALS PROCEDURE
ACCEPTANCE PROCEDURE FOR HIGH TENSION CABLE BARRIER SYSTEM FOR USE ON ROADWAYS

1 PURPOSE

1.1 To establish procedures for qualifying High-Tension Cable Barrier (HTCB) items acceptable for use on West Virginia Division of Highways (WVDOH) projects.

1.2 To establish a procedure for maintaining a record of above items.

1.3 To establish a procedure for transmitting approval of such items to the Districts and to Contractors of WVDOH projects.

2 SCOPE

2.1 This procedure shall apply to only HTCB associated items, "miscellaneous" associated hardware, and any other items included on the approved product list for 607.002.001 – MASH - High Tension Cable Barrier Systems maintained by the Materials Control, Soils, and Testing Division (MCST) of the WVDOH covered by Section 607 SPECIAL PROVISION FOR HIGH TENSION CABLE BARRIER SYSTEM of the West Virginia Division of Highways Special Provisions for the project.

3 APPLICABLE DOCUMENTS

3.1 West Virginia Department of Transportation, Division of Highways, Standard Specifications, Roads and Bridges and Section 607 SPECIAL PROVISION FOR HIGH TENSION CABLE BARRIER SYSTEM. of the West Virginia Department of Transportation, Division of Highways, Standard Specifications, Roads and Bridges, for the project.

4 ACCEPTANCE PROCEDURE

4.1 Accepting the HTCB material package shall require the following:

4.1.1 Determine the date of letting of the contract to determine the edition and supplements of the West Virginia Department of Transportation, Division of Highways, Standard Specifications, Roads and Bridges applicable to the project.

Deleted: High Tension
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4.1.2 Review Section 607 SPECIAL PROVISION FOR HIGH TENSION CABLE BARRIER SYSTEM of the West Virginia Department of Transportation, Division of Highways, Standard Specifications, Roads and Bridges, for the project, in order to understand the special provision for the project. Document the FHWA Eligibility Letter for ~~National Cooperative Highway Research Program (NCHRP) 350 or~~ Manual for Assessing Safety Hardware (MASH) FHWA Eligibility Letter for a tested 4 cable system meeting MASH Test Level (TL3) ~~tested on a slope of 6:1 or steeper~~. And on the Division's Approved Product List.

4.1.3 Document the HTCB system is on the approved product list for Section 607 SPECIAL PROVISION FOR HIGH TENSION CABLE BARRIER SYSTEM, for the project.

4.1.4 Document the vendor has provided all training and supervision in compliance provided all training and supervision in compliance with Section 607.4.4 - —Cable System Installation and Certification of the Special Provision for the project.

4.1.5 Document the contractor has provided all submittals and documentation required in Section 607.2.3 - Submittals, including manuals.

4.1.6 Document the contractor has supplied the materials specified in Section 607.2.1.1 - Repair Materials of the Special provisions of the project and the contract documents.

4.1.7 Document all other requirements of the specifications and contract documents.

5 APPROVAL CRITERIA

5.1 Approval shall be granted to a High Tension Cable Barrier System (HTCB) upon documentation the material represented meets the requirements of the applicable West Virginia Department of Transportation, Division of Highways, Standard Specifications, Roads and Bridges and Section 607 SPECIAL PROVISION FOR HIGH TENSION CABLE BARRIER SYSTEM of the West Virginia Department of Transportation, Division of Highways, Standard Specifications, Roads and Bridges, for the project, as outlined in Section 4 of this materials procedure.

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

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West Virginia Division of Highways
ACCEPTANCE FOR HIGH TENSION CABLE BARRIER (HTCB)

Sample Number _____

Project Number _____

Contract ID _____

District _____

Name of Form Completer _____ Date _____

Date of Letting _____

I am interested in volunteering for the following types of activities:

- ☐ Name of HTCB Manufacturer.
- ☐ Have you reviewed Sect 607—Special Provisions for this project
- ☐ Is the FHWA Eligibility Letter for National Cooperative Highway Research Program (NCHRP) 350 or Manual for Assessing Safety Hardware (MASH) FHWA Eligibility Letter for a tested 4 cable system meeting Test Level (TL3) tested on a slope of 6:1 or steeper present?
- ☐ Is the HTCB system on the approved product list for Section 607 SPECIAL PROVISION FOR HIGH TENSION CABLE BARRIER SYSTEM.
- ☐ Has the vendor provided all training and supervision in compliance with Section 607.4.4—Cable System Installation and Certification of the Special Provision for the project?
- ☐ Has the contractor provided all the submittals and documentation required in Section 607.3 of Have you reviewed Sect 607—Special Provisions for this project?
- ☐ Has the contractor provided all the submittals and documentation required in Section 607.3 of Have you reviewed Sect 607—Special Provisions for this project?

☐ ACCEPTED _____

If all items listed above are true; mark accepted, print your name, date, and sign. _____

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

SUBMISSION AND PROCESSING OF BILLS OF ELECTRICAL EQUIPMENT, SIGNAL EQUIPMENT, AND ELECTRICAL MATERIALS

1. PURPOSE

1.1 To provide a standardized method for identifying for evaluation and documenting proposed and installed location, quantity, description, make, type, grade, capacity, and manufacturer's catalog number of all electrical equipment, signal equipment, and materials installed on West Virginia Division of Highways projects in order to comply with subsection 631.2 of the West Virginia Department of Transportation, Division of Highways, Standard Specifications for Roads and Bridges and Supplementals (Standard Specifications) and/or Materials Control, Soils and Testing Division (MCS&T) Materials Procedures.

2. SCOPE

2.1 This procedure applies to all electrical equipment, signal equipment, and materials.

2.2 This procedure applies to all documents listing electrical, signal equipment, and materials on submittals, shop drawings, bills of electrical and signal equipment and material including materials previously approved on submittals, shipping documents, and on records of completion plans in order to create an as built record of materials.

3. DEFINITIONS

3.1 **Electrical, Signal Equipment, and Materials Bill of Materials (ESBOM):** Shall be submitted in a spreadsheet format as directed in this Materials Procedure and made part of the Electrical Submittal.

3.2 **Electrical Submittal (ES)-** The Electrical Submittal (ES) form shall be in a text searchable Portable Document Format prepared as directed in this Materials Procedure and submitted to the project and made a part of the Electrical Submittal Bill of Materials.

3.3 **Bill of materials item number-** Bill of materials item numbers shall be sequential and unique to one and only one individually described item within a project. Duplicated items from the same vendor shall have the same bill of materials item number; however, duplicated items from different vendors may have different bill of materials item numbers. Bill of materials line and bill of materials item numbers number shall be sequential and shall not be duplicated in the same project; therefore, the contractor should assign blocks of bill of materials line and bill of materials item numbers to each vendor. Bill of materials item numbers for each item shall be

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permanent on all documents from the same vendor (ESBOM, ES, shipping documents) throughout the project and shall not be changed.

3.4 **Itemized Bill of Electrical Equipment and Materials-** Itemized Bills of Electrical Equipment and Materials shall include an Electrical Equipment, Signal Equipment, and Materials Bill of Materials (ESBOM), and an Electrical Submittal (ES) submitted simultaneously as attachments to one email to the project.

3.5 **File Names-** ESBOM and ES form files shall be named as such: ContractReference#ESBOM##R##.pdf and ContractReference#ES##R##Item##D##.pdf. The initial ESBOM ContractReference#ES1R0.xlxs and the initial ES shall be named ContractReference#ES1R0Item1D1.pdf for the first electrical submittal, first item, and first document, the ES number, Revision Number, and Document Numbers shall increase sequentially for each Electrical Submittal and revision; document numbers shall increase incrementally for each document submission for each item, such that there will be a new text searchable PDF file for each document submitted for each item included in the ESBOM. These form files shall be submitted electronically to the construction engineer's designee and material shall not be accepted on the project without a valid approval number on the shipping documents.

3.6 **PDF file-** A PDF file is a type of file that contains a bitmapped image of a document to appear as the original document permitting the document to be archived digitally.

3.7 **Shipping Documents-** Shipping documents are documents accompanying a shipment of material to document the contents of the shipment and shall accompany each delivery of material and equipment and shall be the abbreviated ESBOM with the items shipped listed sequentially by bill of materials item number including only bill of materials item number, quantity, description, manufacturer, manufacturer's catalog number, and the approval number for each item.

3.8 **Substitutions-** Should substitution of items on the Electrical Submittal (ESBOM) form be made, the contractor shall strike through those items substituted and initiate a new ES and ESBOM with new bill of materials item numbers for the substituted items. A note shall be made in the comments column on the ESBOM indicating the bill of materials item number the substitutions are made for.

3.9 **Text searchable PDF file-** A text searchable PDF file is a PDF file that includes a bitmapped image of a document to appear as the original document with textual content stored as hidden text. The hidden text allows other programs to search the file and is useful for archiving content critical documents.

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4. ELECTRICAL BILL OF MATERIALS COMPLETION

4.1 All material used on the project shall have a complete ESBOM prior to installation on the project. Material shall be listed on a separate ESBOM for each pay item number.

4.2 The ESBOM shall be submitted by completing the spreadsheet titled Example Electrical ESBOM## ##.xlsx. on the WVDOH MCS&T Website and naming the spreadsheet in this format: Contract Reference#ESBOM## ##. xlsx.

4.3 The manufacturer's documentation for all items on the Electrical Bill of Materials of the electrical submittal (ES) shall be submitted in a text searchable portable document format ES with the file name in the following format: Contract ID#ES#Item#page# "example:202100195#ES#item#0001p001.pdf.

4.4 Shop drawings, circuit diagrams, and photograph images may be submitted as an image type PDF file.

5. ELECTRICAL SUBMITTAL COMPLETION

5.1 The Electrical Submittal (ES) shall include documentation and/or data sheets defining and certifying the manufacturing standards of the electrical equipment, signal equipment, and materials described and listed in the Electrical, Signal Equipment, and Materials Bill of Materials (ESBOM).

5.2 The Electrical Submittal (ES) shall be in a text searchable Portable Document Format as directed in this Materials Procedure.

5.3 The ESBOM shall be completed as directed in this Materials Procedure.

5.4 All material delivered to the project shall be listed on a completed and approved ES prior to delivery to the project and listed on shipping documents as directed in this Materials Procedure.

6. ST-1 DOCUMENTATION AND SUBMISSION TO MCS&T

7. PROCEDURE

7.1 The contractor shall submit an ESBOM and ES in the correct electronic format to the District Construction Engineer's designee for all materials before electrical equipment, signal equipment, or materials are purchased or installed in order to comply with Section 631 of the West Virginia Department of Transportation,

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Division of Highways, Standard Specifications for Roads and Bridges and Supplementals (Standard Specifications).

7.2 The Construction Engineer's designee shall complete an ST-1 as a text searchable PDF and attach the ES to and make it a part of the ST-1 as a text searchable document.

7.3 The ST-1 and the ESBOM shall be transmitted to the Materials Control, Soils, and Testing Division's ST-1 email address DOT.St1dmir@wv.gov as a file folder named the ST-1 "ST-1 number#".

7.4 The Traffic Materials Engineer shall evaluate or forward the ES and ESBOM to the Traffic Division for evaluation as needed. Should the Traffic Division evaluate any portion of an ES and ESBOM the evaluated ES and ESBOM shall be returned to the Traffic Materials Engineer with comments. The Materials Traffic Engineer shall transmit the approved ES and ESBOM to the District Construction Engineer's designee after affixing an approval number or the non-concurred ES with comments.

7.5 No materials may be accepted at the project without completed shipping documents.

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7.6 No materials shall be accepted at the project without shipping documents with approval numbers.

7.7 Any deviation from this procedure shall initiate a District Materials Inspection Report.

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

SAMPLE ID# _____
DATE _____
CONTRACT ID _____
LINE NUMBER(S) _____
LAB NUMBER _____
AUTHORIZATION # _____
STATE PROJ # _____
FED. PROJ. # _____

LINE NUMBER	STRUCTURE DESCRIPTION	PAY ITEM	MATERIAL CODE	FEATURE CODE (SECT 639)	ITEM NUMBER	SUBSECTION	QUANTITY	DESCRIPTION	GRADE	MAKE	STYLE	TYPE	MANUFACTURER'S CATALOG NUMBER	APPROVAL NUMBER
1	SIGNAL CONTI	660001-001		DOH_CNST.	1	715.42.8.9	1	CIRCUIT BREAKER		SQUARE D			QO230	
2	SIGNAL CONTI	660001-001		DOH_CNST.	2	715.42.8.9	1	CIRCUIT BREAKER		SQUARE D			QO120	

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

MATERIALS PROCEDURE

STANDARD METHOD FOR DETERMINATION OF OPTIMIZED AGGREGATE GRADATION IN PORTLAND CEMENT CONCRETE

1. PURPOSE

1.1 To establish a procedure for determination of optimized aggregate gradation in portland cement concrete.

1.2 To establish a uniform definition of optimized aggregate gradation.

2. SCOPE

2.1 This procedure shall apply in all cases where the specification allows the combined aggregate gradation test in portland cement concrete.

2.2 The combined aggregate gradation test is used to determine if the optimized aggregate gradation has been achieved.

3. DEFINATIONS

Optimized aggregate gradation characterizes the proportions of different sizes of aggregates in concrete mix designs. Optimized aggregate gradation helps to improve aggregate packing which involves minimizing the paste content while still producing a workable mixture.

4. PROCEDURE

4.1 Since the aggregates in a portland cement concrete mix consist of coarse and fine aggregates, this procedure will address the determination of optimized aggregate gradation through the combined aggregate gradation test.

4.1.1 The mass of each aggregate used in the concrete mix shall be used to determine the percent of each constituent aggregate in the optimized aggregate gradation.

4.1.1.1 Determine the total mass of aggregate:

$M_{ca(I)} + M_{ca(II)} + M_{fa(I)} + M_{fa(II)} = M_t$

Where:

$M_{ca(I)}$ = mass of coarse aggregate (I) (SSD) used in one cubic yard of concrete.

$M_{ca(II)}$ = mass of coarse aggregate (II) (SSD) used in one cubic yard of concrete.

$M_{fa(I)}$ = mass of fine aggregate (I) (SSD) used in one cubic yard of concrete.

$M_{fa(II)}$ = mass of fine aggregate (II) (SSD) used in one cubic yard of concrete

M_t = mass of total aggregate used in one cubic yard of concrete.

4.1.1.2 Determine the relative percent (R_A) of each type of aggregate.

Coarse aggregate (I) percent = $\frac{Mca(I)}{Mt} * 100$

Coarse aggregate (II) percent = $\frac{Mca(II)}{Mt} * 100$

Fine aggregate (I) percent = $\frac{Mfa(I)}{Mt} * 100$

Fine aggregate (II) percent = $\frac{Mfa(II)}{Mt} * 100$

4.1.2 Determine the gradation of each type of aggregate using AASHTO T 27 and T 11. Submit gradation reports showing the combined percent passing and the combined percent retained as shown in the attached example. Include in the report, each individual aggregate gradation starting the largest appropriate sieve for that material and including all the consecutive smaller sizes through the No. 200 sieve. The passing percent of each type of aggregate shall be reported to nearest hundredth percent.

5. CALCULATIONS

5.1 Calculate the combined % passing on each sieve using the following equation:

$C_P = \sum[\{(P_A)(R_A)\}/100]$

where:

C_P = Combined % Passing
P_A = % Passing of each type of Aggregate
R_A = Relative % of each type of Aggregate (See Section 4.1.1.2)

5.2 Calculate the combined % retained on each sieve using the following equation:

$$C_R = C_{RX} - C_P$$

Where:

C_R = Combined % Retained
C_{RX} = Combined % Passing of next larger sieve size
C_P = Combined % Passing

5.3 The attached spreadsheet shall be used to calculate the values of the mass of total aggregate (M_t), relative percent (R_A) of each type of aggregate, combined percent passing (C_P), and combined percent retained (C_R). Once the percent passing of each type of aggregate is entered into the attached spreadsheet, the spreadsheet will automatically perform all the required calculation for optimized aggregate gradation. The spreadsheet will also plot the tarantula chart for optimized aggregate gradation.

6 EVALUATION

6.1 If the combined aggregate gradation meets the requirements of Section 601.3.2.4.1, the combined aggregate gradation shall be considered as Optimized Aggregate Gradation.

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

RLS:Mtd

EXAMPLE OF DETERMINATION OF OPTIMIZED AGGREGATE GRADATION IN PORTLAND CEMENT CONCRETE

1. Total mass of aggregates in one cubic yard of concrete:

   $M_{ca(I)}$ = Mass of SSD Coarse Aggregate (I) = 1511 lb.

   $M_{ca(II)}$ = Mass of SSD Coarse Aggregate (II) = 265 lb.

   $M_{fa(I)}$ = Mass of SSD Fine Aggregate (I) = 1260 lb

   $M_{fa(II)}$ = Mass of SSD Coarse Aggregate = 0

   M_t = Total mass of aggregates

1.1 Enter the mass of each type of aggregate in the attached spreadsheet. The spreadsheet will calculate the relative percent (R_A) of each type of aggregate.

2. Percent Passing of each type of aggregate from individual gradation.

Sieve Size	Coarse Aggregate (I)	Coarse Aggregate (II)	Fine Aggregate (I)
2 in	100.00	100.00	100.00
1½ in	100.00	100.00	100.00
1 in	98.00	100.00	100.00
¾ in	70.31	100.00	100.00
½ in	45.21	100.00	100.00
⅜ in	21.93	96.31	100.00
No. 4	4.93	19.18	99.12
No. 8	1.00	3.12	85.63
No. 16	1.00	1.00	65.32
No. 30	1.00	0.00	31.02
No. 50	1.00	0.00	12.21
No. 100	1.00	0.00	1.62
No. 200	0.80	0.90	0.60

2.1 Enter the percent passing of each type of aggregate in the attached spreadsheet. The spreadsheet will calculate the combined % passing (C_P) on each sieve, the combined % retained (C_R) on each sieve, Coarse Sand % Retained (#8 - # 30 Sieve), and Fine Sand % Retained (#30 - #200 Sieve). The spreadsheet will also plot the tarantula chart.

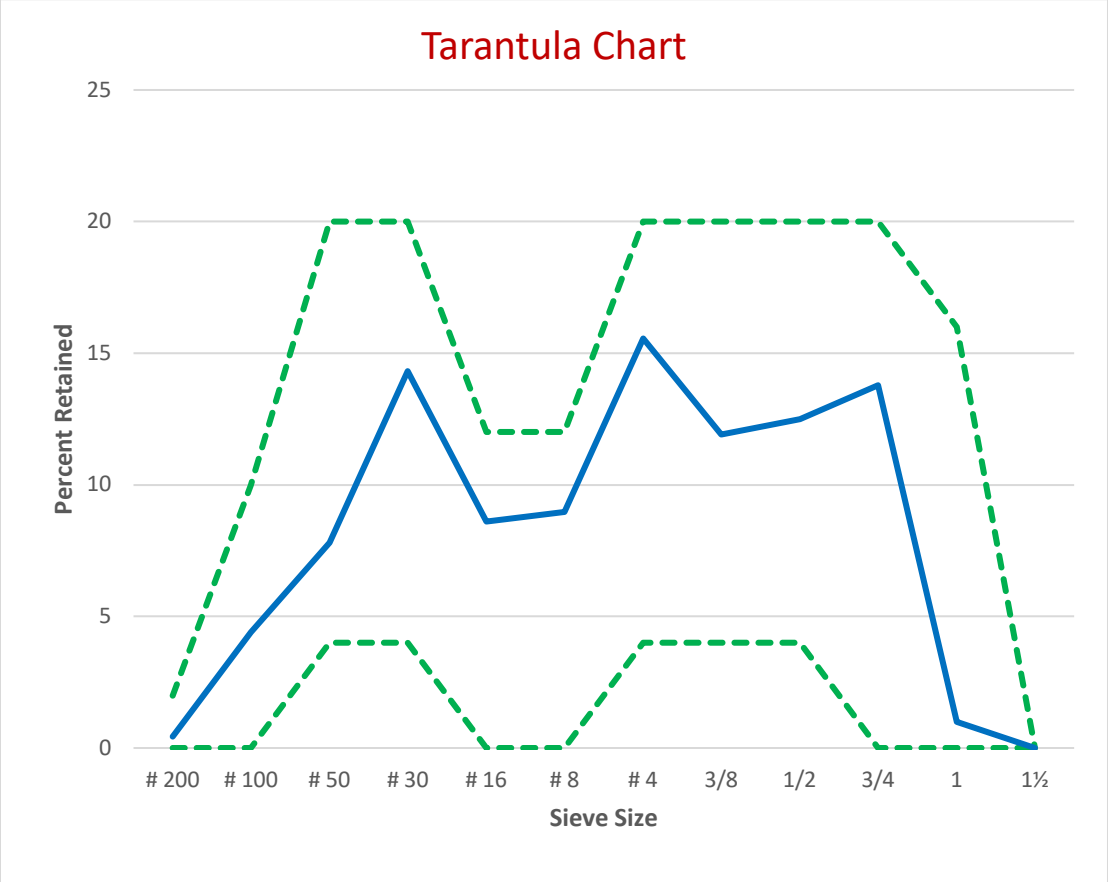
Table 1A

Aggregate Classification				
	Coarse Aggregate (I)	**Coarse Aggregate (II)**	**Fine Aggregate (I)**	**Fine Aggregate (II)**
Mass (lb)	1511	265	1260	0
Total Mass (M_t) (lb)	3036			
Relative (R_A) (%)	49.77	8.73	41.50	0.0

Table 1B:Sieve Analysis Example

Sieve Size	**Coarse Aggregate (I)**	**Coarse Aggregate (II)**	**Fine Aggregate (I)**	**Fine Aggregate (II)**	**Combined % Passing (C_P)**	**Combined % Retained (C_R)**	**Meet Spec**
Relative (R_A) %	49.77	8.73	41.50	0.00			
	% Passing (P_A)						
2 in	100.00	100.00	100.00	0.00	100.00	0.00	Yes
1½ in	100.00	100.00	100.00	0.00	100.00	0.00	Yes
1 in	98.00	100.00	100.00	0.00	99.00	1.00	Yes
¾ in	70.31	100.00	100.00	0.00	85.22	13.78	Yes
½ in	45.21	100.00	100.00	0.00	72.73	12.49	Yes
⅜ in	21.93	96.31	100.00	0.00	60.82	11.91	Yes
No. 4	4.93	19.18	99.12	0.00	45.26	15.56	Yes
No. 8	1.00	3.12	85.63	0.00	36.31	8.96	Yes
No. 16	1.00	1.00	65.32	0.00	27.69	8.61	Yes
No. 30	1.00	0.00	31.02	0.00	13.37	14.32	Yes
No. 50	1.00	0.00	12.21	0.00	5.57	7.81	Yes
No. 100	1.00	0.00	1.62	0.00	1.17	4.40	Yes
No. 200	0.80	0.90	0.60	0.00	0.73	0.44	Yes

Coarse Sand % Retained (#8 - # 30 Sieve) This range amount is a minimum of 15%	**31.89**	Yes
Fine Sand % Retained (#30 - #200 Sieve) This allowable range amount is between 24 - 34%	**27.0**	Yes



May 14, 2021

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION

FOR

SECTION 601
STRUCTURAL CONCRETE

601.3-PROPORTIONING:

601.3.1-Mix Design Requirements:

ADD THE FOLLOWING AT THE END OF SUBSECTION

The contractor may develop mix designs with a reduced target cement factor as indicated in Table 601.3.1D in lieu of Table 601.3.1A, provided the aggregates used in those mix designs meet the requirements for optimized aggregate gradation in Section 601.3.2.4.1. The Ā requirements will not apply for mix designs that use optimized aggregate gradation.

TABLE 601.3.1D

Class of concrete	**Design 28 Day Compressive Strength**	**Target Cement Factor**	**Maximum Water Content**	**Nominal Maximum Aggregate Size**	**Entrained Air**
	Pounds per Square inch	lbs./c.y. Note 1	lb. of water/lb. of cement Note 2	Inches	Percent
A	3500	642	0.51	1/2	7.5
K	4000	618	0.44	1	7.0
B	3000	524	0.49	1	7.0
C	2500	454	0.58	1	6.0
D	2000	360	0.62	1	5.5
H	See Table 601.3.1E	618	0.40	1	6.5
DC Note 3	4500	665	0.44	1/2	6.0

Note 1 An equal mass of a SCM may be substituted for Portland cement up to the maximum amount in Table 601.3.1B. Only one SCM is permitted in a mix design, except for Class H concrete. The target cement factor of Class H concrete shall consist of Option 1 or Option 2 from Table 601.3.1E. The Contractor may choose either option.

TABLE 601.3.1D

Note [2] When using a SCM, masses of these materials shall be considered as cement for purposes of establishing maximum water content.

Note [3] Nominal maximum aggregate size of 3/4 inches may be used in Class DC concrete, provided the Engineer approves the use of that size aggregate for the specific project on which it is to be used. That approval will depend on the minimum spacing of the reinforcing steel in the drilled caisson.

TABLE 601.3.1E

Option	Cement	Fly Ash	Slag Cement	Silica Fume
1	440 lbs.	127 lbs.		25 lbs.
2	397 lbs.		186 lbs.	25 lbs.

601.3.2-Field Tolerances and Adjustment:

601.3.2.4-Total Solids Ā:

ADD THE FOLLOWING AT THE END OF FIRST PARAGRAPH

This sub-section will not apply for mix designs with optimized aggregate gradation. Sub-section 601.3.2.4.1 shall be used in lieu of sub-section 601.3.2.4.

601.3.2.4-Total Solids Ā:

ADD THE FOLLOWING SUBSECTION

601.3.2.4.1-Optimized Aggregate Gradation: The optimized aggregate gradation is performed by mechanical analysis on all of the coarse and fine aggregates used in any mix design. The cumulative combined percent retained from all aggregate gradation shall conform Table 601.3.2.4.1A. The cumulative combined percent retained from all aggregate gradations in Table 601.3.2.4.1A is based on the Tarantula Curve for optimized aggregate gradation. The contractor shall determine optimized aggregate gradation in accordance with MP 601.03.53.

Table 601.3.2.4.1A

Sieve Size	Combined % Retained
1½ in	0%
1 in	≤ 16%
¾ in	≤ 20%
½ in	4 - 20%
⅜ in	4 - 20%
No. 4	4 - 20%
No. 8	≤ 12%
No. 16	≤ 12%
No. 30	4 - 20%
No. 50	4 - 20%
No. 100	≤ 10%
No. 200	≤ 2%

Table 601.3.2.4.1A

Sieve Size	Combined % Retained
Coarse Sand % Retained (No.8 to No. 30 Sieve)	> 15%
Fine Sand % Retained (No. 30 (to No. 200 Sieve)	24% - 34%

The combined aggregate gradation test shall be performed by the contractor (in accordance with MP 601.03.53) at least once for every 50 cubic yards of concrete that are produced from the same mix design. 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. However, not more than one combined aggregate gradation test (for each mix design) shall be required per calendar day as long as not more than 400 cubic yards of concrete are produced in a single day from the same mix design. In situations when more than 400 cubic yards of concrete are produced in a single day from the same mix design, two combined aggregate gradation tests shall be required (one in the AM and one in the PM) for that mix design.

Table 601.3.2.4.1B

Sieve Size	Allowable variation from Combined % Retained in Design Mix [Note 1]
1½ in	± 5% of the % retained on this sieve in the Design Mix
1 in	± 5% of the % retained on this sieve in the Design Mix
¾ in	± 5% of the % retained on this sieve in the Design Mix
1/2 in	± 5% of the % retained on this sieve in the Design Mix
⅜ in	± 5% of the % retained on this sieve in the Design Mix
No. 4	± 5% of the % retained on this sieve in the Design Mix
No. 8	± 4% of the % retained on this sieve in the Design Mix
No. 16	± 4% of the % retained on this sieve in the Design Mix
No. 30	± 4% of the % retained on this sieve in the Design Mix
No. 50	± 3% of the % retained on this sieve in the Design Mix
No. 100	± 2% of the % retained on this sieve in the Design Mix
No. 200	± 2% of the % retained on this sieve in the Design Mix

Note [1] The maximum allowable % retained on each sieve size noted in Table 601.3.2.4.1A shall not be exceeded during production.

During any calendar week (Sunday through Saturday) in which concrete is being produced, a minimum of one combined aggregate gradation test shall be required (for each mix design from which concrete is being produced). This combined aggregate gradation test shall be conducted on the first day of production of that calendar week.

Should the moving average of any five consecutive combined aggregate gradation tests have a working range outside of the limits sets forth on Table 601.3.2.4.1B, for any of the sieve sizes listed, production shall be discontinued until appropriate corrections are made. Corrections shall be made either in the aggregate proportions in the concrete mix (the mix

design), the gradation of the aggregates, or the storage and loading of the aggregate, as the Contractor may elect.

When the small quantity work condition applies, the combined aggregate gradation test required after 50 cubic yards of concrete production shall be performed on the day that the 50 cubic yard quantity is achieved. All concrete produced on that day (the day that the 50 cubic yard quantity is achieved) shall be represented by the previous combined aggregate aggradation test. The combined aggregate gradation test conducted on the day that the 50 cubic yard quantity is achieved shall represent the next 50 cubic yards of concrete produced, beginning with the concrete produced on the next day of production.

When, in a concrete mix, gradations tests show that the percentage of material which passes the No. 200 (75 μm) sieve, exceeds the amount permitted in Sections 702.1.2 and 703.4, and provided the Engineer permits the material to remain in place and the Contractor elects to leave the material in place, then a penalty shall be applied in the manner outlined in the following paragraph.

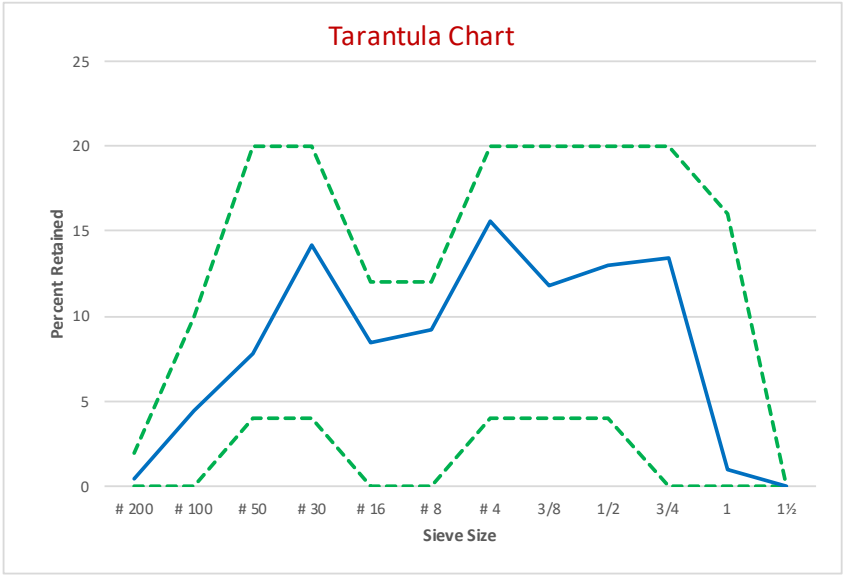
It shall be determined which material (coarse aggregate, fine aggregate, or both) caused the total material finer than the No. 200 (75 μm) sieve to exceed the specification limits as determined in Sections 702.1.2 and 703.4. The mass of the material(s) in the concrete mix (Mca, Mfa, or both, as defined in MP 601.03.53), which caused the total material finer than the No. 200 (75 μm) sieve to exceed the specification limits shall be divided by Mt (as defined in MP 601.03.53). The resulting number shall be multiplied by the unit price of the concrete, as billed by the Concrete Supplier and by the quantity of non-specification concrete placed. That value shall be the penalty applied for the use of the material which did not meet the specification requirements.

Aggregate Classification				
	Coarse Aggregate (I)	Coarse Aggregate (II)	Fine Aggregate (I)	Fine Aggregate (I)
Weight (lb)	1511	265	1260	0
Total Mass (lb)	3036			
Relative (Ra) (%)	49.8	8.7	41.5	0.0

Table 1:Sieve Analysis Example

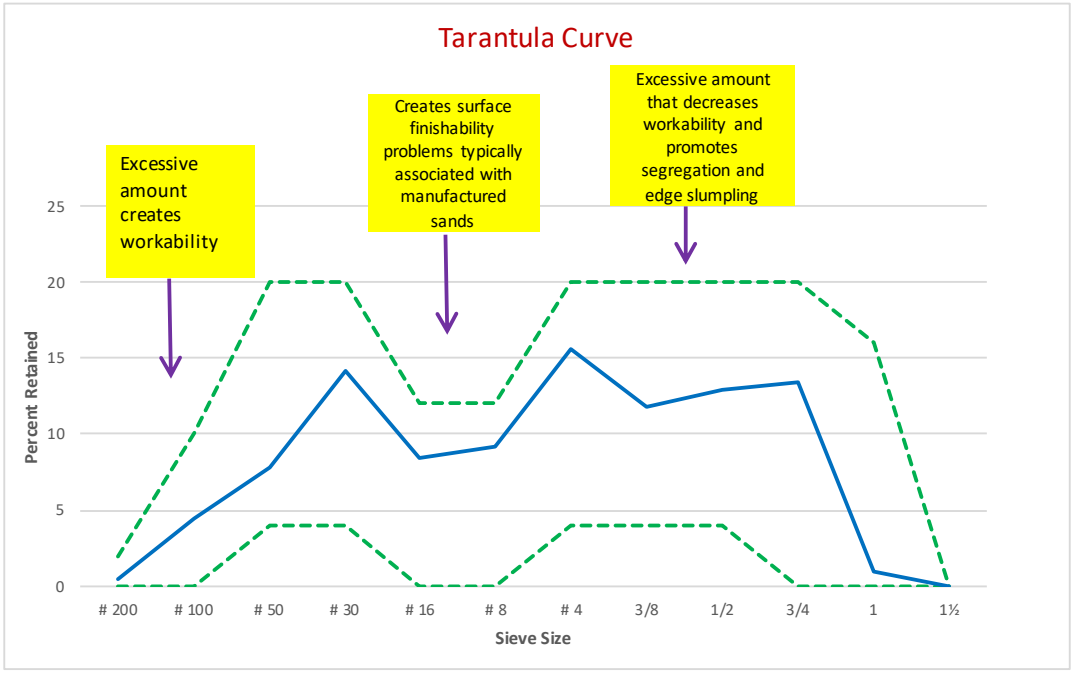
Sieve Size	Coarse Aggregate (I)	Coarse Aggregate (II)	Fine Aggregate (I)	Fine Aggregate (II)	Combined % Passing (C_P)	Combined % Retained (C_R)	Meet Spec
Relative (R_A) %	49.8	8.7	41.5	0.0			
	% Passing (P_A)						
2 in	100.00	100.00	100.00	0.00	100.00	0.00	Yes
1½ in	100.00	100.00	100.00	0.00	100.00	0.00	Yes
1 in	98.00	100.00	100.00	0.00	99.00	1.00	Yes
¾ in	71.03	100.00	100.00	0.00	85.58	13.42	Yes
½ in	45.00	100.00	100.00	0.00	72.63	12.95	Yes
⅜ in	22.00	96.31	100.00	0.00	60.86	11.77	Yes
No. 4	4.93	19.18	99.12	0.00	45.26	15.59	Yes
No. 8	1.00	3.12	85.00	0.00	36.05	9.22	Yes
No. 16	1.00	1.00	65.00	0.00	27.56	8.49	Yes
No. 30	1.00	0.00	31.02	0.00	13.37	14.19	Yes
No. 50	1.00	0.00	12.21	0.00	5.57	7.81	Yes
No. 100	1.00	0.00	1.62	0.00	1.17	4.40	Yes
No. 200	0.80	0.90	0.60	0.00	0.73	0.44	Yes

Coarse Sand % Retained (#8 - #30 Sieve)	**31.89**	Yes
This range amount is a minimum of 15%		
Fine Sand % Retained (#30 - #200 Sieve)	**26.8**	Yes
This allowable range amount is between 24 - 34%		



THIS PAGE IS JUST FOR INFORMATION. COMBINED % RETAINED AND TARANTULA CURVE AUTOMITICALLY FILLED AFTER SPREADSHEET IS COMPLETED.

Sieve Size (in)	Combined % Retained	Maximum % Boundary	Minimum % Boundary
# 200	0.4	2	0
# 100	4.4	10	0
# 50	7.8	20	4
# 30	14.2	20	4
# 16	8.5	12	0
# 8	9.2	12	0
# 4	15.6	20	4
3/8	11.8	20	4
1/2	13.0	20	4
3/4	13.4	20	0
1	1.0	16	0
1½	0.0	0	0
2	0.0	0	0



THIS PAGE IS USED FOR COMBINED AGGREGATE GRADATION TEST (TABLE 601.3.2.4.1B)

Sieve Size	Combined % Retained in Mix Design	Combined % Retained in Gradation Test	Variation (%)	Allowable Variation
1½ in	1.00	0.98	2	± 5%
1 in	1.02	1.01	1	± 5%
¾ in	13.94	13.20	5	± 5%
½ in	12.44	12.03	3	± 5%
⅜ in	11.77	11.15	5	± 5%
No. 4	15.59	15.93	-2	± 5%
No. 8	9.22	8.90	3	± 4%
No. 16	8.49	8.26	3	± 4%
No. 30	14.19	14.75	-4	± 4%
No. 50	7.81	8.02	-3	± 3%
No. 100	4.40	4.48	-2	± 2%
No. 200	0.44	0.43	2	± 2%

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. GENERAL REQUIREMENTS

3.1 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.

4. QUALITY CONTROL PLAN

4.1 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.

4.1.1 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.

4.1.2 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.

4.2 Quality Control Plan Guidelines

4.2.1 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.

4.2.2 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.

4.2.3 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.

4.2.4 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.

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

4.2.4.2 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 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 Cement and Concrete Reference Laboratory (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.

4.2.4.3 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. A listing of these laboratories is available on the WVDOT internet site at the following link: https://transportation.wv.gov/highways/mcst/Pages/APL_By_Number.aspx. 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.

4.2.5 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 AASTO 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.

4.2.6 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 4.2.6.1), 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 4.2.6.2 are met for each project on which the reduced testing of miscellaneous concrete is applied.

4.2.6.1 Miscellaneous concrete shall be defined as relatively small quantities, not exceeding 25 yd^3 (19 m^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

4.2.6.2 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.

4.2.6.3 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.

4.2.7 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.

4.2.8 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 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. 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

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

4.2.9 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-printed on the ticket. In the case of Portland Cement Concrete 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-printed 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-printed on the ticket.

4.2.9.1 All batch tickets for Structural Concrete and Portland Cement Concrete Pavement Concrete transported by truck mixers shall have all of the following items pre- printed on the ticket: Producer/Supplier Code, Producer/Supplier Name, Producer/Supplier Location, Mix Design Laboratory Reference Number, Date, Sequence Number, Volume (yd^3/m^3), Time Batched, Time Unloaded, Contract Identification Number (CID #), Federal and/or State Project Number, Material Code, Material Name, Water Allowed (Gallon/Liter), Water at Plant (gallon/liter), Weight of Ice at Plant (lb/kg), Water at Job (Gallon/Liter), Weight of Cement (lb/kg), Weight(s) of Pozzolan(s) (lb/kg), Weight of Fine Aggregate (lb/kg), Weight of Coarse Aggregate (lb/kg), Admixture Name(s) and Dose (ounces/mL), Temperature ($^oF/^oC$), Cylinder I.D., Initial Counter, Final Counter, Target Consistency (in/mm), Actual Consistency (in/mm), Target Air (%), Actual Air (%), Truck Number.

4.2.9.2 All batch tickets for concrete delivered by means of non-agitator trucks or truck agitators shall have all of the following items pre-printed on the ticket: Producer/Supplier Name, Mix Design Laboratory Reference Number, Date, Sequence Number, Volume (yd^3/m^3), Time Batched, Time Unloaded, CID#, Federal and/or State Project Number, Material Code, Material Name, Water Allowed (Gallon/Liter), Water at Plant (Gallon/Liter), Weight of Ice at Plant (lb/kg), Weight of Cement (lb/kg), Weight of SCM (lb/kg), Weight of Fine Aggregate (lb/kg), Weight of Coarse Aggregate (lb/kg), Admixture Name(s) and Weight(s) (ounces/grams), Temperature ($^oF/^oC$), Target Consistency (in/mm), Actual Consistency (in/mm), Target Air (%), Actual Air (%), Truck Number.

4.2.9.3 The batch ticket in the case of either type of concrete shall be a pre-printed batch ticket prepared by the plant. This ticket may be either computer generated or a standard

pre-printed form with blank spaces 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 space on the batch ticket for completion. Volume is to be reported to the nearest 0.01 yd^3 (0.01 m^3). Consistencies are to be reported to the nearest 0.25 inch (5 mm). Target and Actual Air are to be reported to the nearest 0.1% (to the nearest 0.25% if the volumetric method is used).

4.2.10 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.

4.2.11 Non-Conforming Materials:

4.2.11.1 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.

4.2.12 Types of QC Plans:

4.2.12.1 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.

4.2.12.2 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.

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

4.2.12.4 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.

4.3 Master QC Plan

4.3.1 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.

4.3.2 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.

4.3.3 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).

4.3.4 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.

4.3.5 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.

4.3.5.1 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.

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

4.3.5.3 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).

4.3.6 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.

5. ACCEPTANCE SAMPLING AND TESTING

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

5.2 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.

5.3 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.

5.4 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.

6. ABSENT TESTING OF MATERIAL

6.1 If the Contractor fails to perform testing of the material in accordance with the Contractor's Division Approved Quality Control Plan, payment for the entire item shall be withheld, pending the Engineer's decision whether or not to allow the material to remain in place.

6.1.1 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.

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

RLS:Fm

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

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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 (75 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 T 23 and MP 601.04.20. They shall be tested in accordance with AASHTO T 22 and the applicable section of the Standard 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 4.2.5 of MP 601.03.50.

8. Testing of Miscellaneous Concrete will be as specified in Section 4.2.6 and Sub-Sections 4.2.6.1 thru 4.2.6.3 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 WVDOH 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 project.

7. *State that batch tickets will conform to requirements of MP601.03.50 Section 4.3.9 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. He/She 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. He/She 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:

WVDOT 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

MP 711.03.23
SUPERSEDES: JULY 2020
REVISED JUNE 2021

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. TEST PROCEDURE

3.1 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 Page1. 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.

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

3.2 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. Attachments 1 S-P and 6-ASR shall be used for SCC produced in accordance with Section 603.

3.2.1 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, Alklai 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 S-P shall be used for SCC produced in accordance with Section 603.

3.2.2 The aggregate correction factor, as defined in AASHTO T 152, shall be listed in Attachment 3. Attachment 3 S-P shall be used for SCC produced in accordance with Section 603.

3.2.3 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 WVDOH form XXX, Optimized Aggregate Gradation worksheet, shall be included in the mix design submittal package.

3.2.4 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,

Commented [TS1]: I think we should create another form similar to T301E. We Would need to know Minus No.200 from the gradation. What do you think?
Do you have editable form T301E?

Commented [MMA2R1]: I agree that we should create another form similar to T301E. I don't have an editable copy of that form. Please check with Kelly Chapman and Dave Matics about that.

maximum load applied to the cylinder, type of fracture, and compressive strength of the cylinder.

3.3 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 w/c than the previous four batches. The slump tolerance in Section 3.4 shall not apply to this fifth batch.

3.3.1 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 of 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 of 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.

3.4 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.

3.4.1 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.

3.5 When the properties of a concrete batch have been established within acceptable limits, seven 6 by 12 in. (150 by 300 mm) cylinders shall be made from each batch produced in Section 3.3 (or 3.3.1) 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 3.3 (or 3.3.1) 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 w/c. 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.

3.5.1 For any class of concrete other than SCC produced in accordance with Section 603, if it is desired to use 4 by 8 in. (100 by 200 mm) cylinders as the basis for acceptance or early strength determination in the field, in accordance with Section 601.4.4, then seven 4 by 8 in. (100 by 200 mm) cylinders shall be fabricated and tested as outlined in Section 3.5 for the first two trial batches at the minimum cement factor in addition to the seven 6 by 12 in. (150 by 300 mm) cylinders.

3.5.1.1 If the average compressive strength of the six 28-day 4 by 8 in. (100 by 200 mm) cylinders for the batches at the minimum cement factor is not more than 10.0 percent greater than the average compressive strength of the six 28-day 6 by 12 in. (150 by 300 mm) cylinders for the batches at the minimum cement factor, then 4 by 8 in. (100 by 200 mm) cylinders will be permitted to be used in the field. Otherwise, any cylinders fabricated in the field for acceptance or early strength determination must be 6 by 12 in. (150 by 300 mm) cylinders.

3.5.1.2 The following formula shall be used during the mix design approval process to determine if the average compressive strength of the three 28-day 4 by 8 in. (100 by 200 mm) cylinders is greater than 110.0 percent of the average compressive strength of the three 28-day 6 by 12 in. (150 by 300 mm) cylinders:

If $\bar{X}_{4x8} > \bar{X}_{6x12} \times 1.10$, then 4 by 8 in. (100 by 200 mm) cylinders are not permitted to be used in the field.

Where:

$\bar{X}_{6\times12}$ = Average 28-day compressive strength of 6 by 12 in. (150 by 300 mm) cylinders.

$\bar{X}_{4\times8}$ = Average 28-day compressive strength of 4 by 8 in. (100 by 200 mm) cylinders.

3.5.2 The following properties of each batch of concrete produced in Sections 3.3 (or 3.3.1) shall be listed in Attachment 2: A-bar of total solids, consistency, air content, unit weight and yield, water-cement ratio, and temperature.

3.5.3 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.

3.6 Mix design submittal packages including Attachments 1, 2, 3 and 6-ASR, A-bar worksheet(s) or 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.

3.6.1 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 of 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. 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.

4. ACCEPTANCE CRITERIA

4.1 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 6 by 12 in. (150 by 300 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.

4.2 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.

4.2.1 Note that the "Design 28-Day Compressive Strength" required by the Specifications is the minimum field strength sought in 6 by 12 in. (150 by 300 mm) or 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 4.1 or 4.2 for mix design approval, shall be noted as the “Mix Design Approval Strength”.

4.3 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, with the exception of 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.

5. PROPORTIONING DESIGN MIX

5.1 If the average of the batches produced in Section 3.3 (or 3.3.1), with the specified minimum cement factor, satisfies the acceptance criteria of Section 4, then it will be considered acceptable as the mix design for the class of concrete being designed.

5.2 If the average of the batches produced in Section 3.3 with the specified minimum cement factor does not satisfy the acceptance criteria of Section 4, then a linear compressive strength-cement factor relationship will be established using the average

28-day compressive strength, based on the 6 by 12 in. (150 by 300 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. (2.2 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.

5.2.1 If neither of the averages of the batches produced in Section 3.3 satisfies the acceptance criteria of Section 4, then that proposed mix design cannot be considered as acceptable, and a new mix design will be required.

5.2.2 Section 5.2 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 3.3.1 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.

5.3 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 w/c (i.e. fifth batch), when applicable. 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 of the 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 3.4.1, shall be submitted also.

5.4 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.

5.4.1 Using the three different water-cement ratios from the batches produced in Section 3.3 and the corresponding 28-day compressive strengths from Section 3.5, the Excel file in Attachment 4 of this MP shall be used to create a best-fit line through these three points.

5.4.2 The water-cement ratio (w/c) that corresponds to the Mix Design Approval Strength, as outlined in Section 4.1 or 4.2, 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 w/c (i.e. the w/c 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 w/c in Table 601.3.1A be exceeded).

5.4.3 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.

5.4.4 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.

6. MIX DESIGN RE-APPROVAL

6.1 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 6.2 and conducted at the Concrete Producer or a Division Approved Laboratory, meeting the requirements of Section 3.1. 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.

6.1.1 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 number. The WVDOH District

Materials personnel shall verify whether or not there are a minimum of fifteen air content, slump, and compressive strength tests for that mix design in the previous three-year period.

6.1.2 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 6.1. MCS&T Division shall then update the approval date of the subject mix design.

6.1.3 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 6.2.

6.2 The following procedures shall be used to re-approve concrete mix designs that do not meet the criteria in Section 6.1.

6.2.1 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.

6.2.2 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.

6.2.3 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 6 by 12 in. (150 by 300 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.

6.2.3.1 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

Commented [TS3]: What is the purpose of unit weight?

Commented [MMA4R3]: It's used, along with the fineness modulus, in developing mix designs.

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Commented [MMA5]: Don't we still need to conduct fineness modulus testing even if we're doing optimized gradations? Isn't it still used to develop mix designs?

Deleted: and fineness modulus (fine aggregate)

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 6.2.2.

6.2.4 If a Concrete Producer desires to have the option of using 4 by 8 in. (100 by 200 mm) cylinders in the field for a mix design which has already been approved, then at the time of mix design re-approval, or at any time prior to that time three additional 6 by 12 in. (150 by 300 mm) 28-day compressive strength specimens and six 4 by 8 in. (100 by 200 mm) 28-day compressive strength specimens shall be fabricated and tested from the batch produced in Section 6.2.3 or 6.2.3.1. The six 6 by 12 in. (150 by 300 mm) cylinders shall then be compared to the six 4 by 8 in. (100 by 200 mm) cylinders as outlined in Section 3.5.1.1 in order to determine if 4 by 8 in. (100 by 200 mm) cylinders will be permitted in the field for the subject mix design.

6.3 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 6.2 in the applicable sections of Attachments 1, 2, and 3. The Concrete Producer or Division Approved Laboratory Personnel shall then submit those attachments, along with the test data required in Section 6.2.2 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.

6.3.1 For mix design re-approval purposes, the compressive strength of the representative batch produced at the Producer, as outlined in Section 6.2.3, 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 4.

6.3.1.1 If a laboratory batch is produced in lieu of a batch at the Producer, as outlined in Section 6.2.3.1, 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 4.1.

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

Where:
f'_{cr} = Required compressive strength of the batch produced in Section 6.2.3.1 (expressed in psi)
f'_c = Design 28-Day Compressive Strength (expressed in psi)
σ = Concrete Plant Standard Deviation (outlined in Section 4.1)

6.3.2 For mix design re-approval purposes, the average of the two rapid chloride permeability test results from the representative batch produced in Section 6.2.3 or 6.2.3.1 must be 1,000 coulombs or less in order for the mix design to be re-approved.

6.3.3 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.

7. CHANGING A COMPONENT MATERIAL USED IN A MIX DESIGN

7.1 Whenever more than one component material in an approved mix design is changed simultaneously, a new laboratory mix design, in accordance with Section 3 shall be required. This option is not permitted for SCC mix designs produced in accordance with Section 603.

7.1.1 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 in order for that component material change to be approved, are outlined in the following sections.

7.2 The changes, outlined below, to any of the following component materials are permitted provided the requirements in Section 7.3 are met. Only one component material may be changed at a time, otherwise a new laboratory mix design in accordance with Section 3 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, in order 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.

7.2.1 Cement: The source of cement may be changed provided the requirements of Section 7.3 are met.

7.2.2 Supplementary Cementitious Material (SCM): The source and/or type of SCM may be changed provided the requirements of Section 7.3 are met.

7.2.3 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 7.3 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.)

7.2.4 Latex Admixture: The source of latex admixture may be changed provided the requirements of Section 7.3 are met.

7.2.5 Fine Aggregate: The source of fine aggregate may be changed provided the requirements of Section 7.3 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.

7.2.6 Coarse Aggregate: The source of coarse aggregate may be changed provided the requirements of Section 7.3 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 3 shall be required.

7.3 When a change to any individual component material in an approved mix design, as outlined in Sections 7.1.1 and 7.2, 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.

7.3.1 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, A-bar of total solids, and fineness modulus (fine aggregate) 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 for the mix, if necessary, to adjust any batch volumes.

Commented [MMA6]: Can we discontinue fineness modulus testing when using optimized gradation?

7.3.2 In lieu of the two batches produced at the Producer's facility, as outlined in Section 7.3, two batches may be produced at a Division Approved Laboratory, meeting the requirements of Section 3.1. 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 7.3.1.

7.3.3 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 3.2.

7.3.4 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.

7.3.4.1 If laboratory batches are produced in lieu of batches at the Producer, as outlined in Section 7.3.2, then the batch tolerances specified in Section 3.4 shall apply.

7.3.5 When the properties of a concrete batch have been established within acceptable limits, 3 - 6 in by 12 in. (150 by 300 mm) cylinders shall be made from each batch produced in Section 7.3 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 7.3. 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 7.3 shall be listed in Attachment 2: A-bar of total solids, consistency, air content, unit weight and yield, water-cement ratio, and temperature.

7.4 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 7.3. The average value of these permeability specimens shall be no more than 10 percent greater than the mix design permeability value, required in the applicable specification, when tested at the time frame specified in the applicable specification.

7.4.1 If laboratory batches are produced in lieu of batches at the Producer, as outlined in Section 7.3.2, 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.

7.5 If 4 by 8 in. (100 by 200 mm) cylinders were approved for use with the mix design which was approved prior to the component material change, then 4 by 8 in. (100 by 200 mm) cylinders shall also be approved for use with the new mix (with the component material change) with no further testing required.

7.5.1 Otherwise, if it is desired to use 4 by 8 in. (100 by 200 mm) cylinders as the basis for acceptance or early strength determination in the field with the new mix (with the component material change) then three 4 by 8 in. (100 by 200 mm) 28-day compressive strength specimens shall be fabricated and tested from each of the batches produced in Section 7.3. The six 6 by 12 in. (150 by 300 mm) cylinders from these batches shall then be compared to the six 4 by 8 in. (100 by 200 mm) cylinders from these batches as outlined in Sections 3.5.1.1 and 3.5.1.2 in order to determine if 4 by 8 in. (100 by 200 mm) cylinders will be permitted in the field for the subject mix design.

7.6 The average compressive strength of the two batches produced at the Producer in Section 7.3 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 4.1.

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

Where:
f'_{cr} = Required average compressive strength of the batches produced in Section 7.3 (expressed in psi)
f'_c = Design 28-Day Compressive Strength (expressed in psi)
σ = Concrete Plant Standard Deviation (outlined in Section 4.1)

7.6.1 If laboratory batches are produced in lieu of batches at the Producer, as outlined in Section 7.3.2, 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 4.1.

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

7.6.2 If the average compressive strength of the two batches produced in Section 7.3 (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 7.7 are met.

7.7 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 7.3 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.

7.7.1 In lieu of the two batches produced at the Producer's facility, as outlined in Section 7.7, 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 3.1. 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.

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

7.7.3 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.

7.7.3.1 If laboratory batches are produced in lieu of batches at the Producer, as outlined in Section 7.7.1, then the batch tolerances specified in Section 3.4 shall apply.

7.7.4 When the properties of a concrete batch have been established within acceptable limits, three 6 by 12 in. (150 by 300 mm) cylinders shall be made from each batch produced in Section 7.7 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 7.7. These values shall be listed in the column for the mix with the "Minimum Cement Factor + 1 Bag" in Attachment 3.

The following properties of each batch of concrete produced in Section 7.7 shall be listed in Attachment 2: A-bar of total solids, consistency, air content, unit weight and yield, water-cement ratio, and temperature.

7.7.5 If the average of the batches produced in Section 7.3, with the specified target cement factor, does not satisfy the acceptance criteria set forth in Section 7.6, then a linear compressive strength-cement factor relationship will be established using the average 28-day compressive strength [based on the 6 by 12 in. (150 by 300 mm) cylinder results] of the batches with the target cement factor (Section 7.3) and the average 28-day compressive strength of the batches with the target cement factor plus one bag of cement (Section 7.7). This relationship will be interpolated to determine a cement factor [to the nearest 1 lb. (2.2 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.

7.7.6 If neither of the averages of the batches produced in Sections 7.3 or 7.7 satisfy the acceptance criteria in Section 7.6, then that proposed component material change cannot be considered as acceptable, and a new laboratory mix design will be required in order to make a change in component materials.

7.8 The submittal for a proposed mix design change, as outlined in Section 7, 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 7. All pertinent information supporting these attachments and pertaining to the information in them shall be submitted also. 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.

7.9 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 7.

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

8.1 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.

8.1.1 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.

8.2 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.

8.2.1 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.

8.3 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.

8.3.1 Three 6 by 12 in. (150 by 300 mm) cylinders shall be made from each batch outlined 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 fly ash replacement) 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.

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.

8.4 The average compressive strength of the two batches produced in Section 8.3 must have an average compressive strength, which exceeds the "Design 28-Day Compressive Strength" required by the specifications.

8.5 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 8, 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 8.3. 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.

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

9.1 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.

9.2 Two separate batches of concrete shall be produced as outlined in Section 7.3. These concrete batches shall be tested as outlined in Sections 7.3 and 7.4.

9.2.1 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 in order to verify that the allowable concrete discharge time may be extended.

9.3 If the requirements set forth in Section 7.6 are met, then the procedures set forth in Sections 7.8 and 7.9 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.

9.4 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.

Ronald L. Stanevich, P.E.
Director
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Attachments