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QUALITY CONTROL FOR CONCRETE PAVING WITH PERFORMANCE-ENGINEERED MIXTURES (PEM)

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Summary and Disclaimers

The purpose of this tech brief is to describe quality control (QC) for concrete paving projects using performance-engineered mixtures (PEM). The document is intended for highway agency and contractor engineers.

Introduction

Quality control (QC) by contractors, concrete suppliers, and materials suppliers is an integral component of a transportation agency's quality assurance (QA) program and supports the construction of long-lasting concrete infrastructure. Recently, the Federal Highway Administration (FHWA) supported the development and publication of *Quality Control for Concrete Paving: A Tool for Agency and Industry* (Cavalline et al. 2021), which provides an overview of QA and QC for concrete paving and aims to help both contractors and agencies improve or enhance their existing QC programs. Based upon material presented in that document, this tech brief provides an overview of quality control activities for concrete paving projects using performance-engineered concrete mixtures (PEMs).

The Need for Performance-Engineered Mixtures

Many agency specifications for concrete pavements and constituent materials have changed very little over the past few decades. Specifications have historically been prescriptive, including requirements for means, methods, and materials. Prescriptive requirements for concrete mixture proportioning, such as minimum cementitious materials contents and maximum water-to-cementitious materials (w/cm) ratios, are also commonly specified. Although prescriptive provisions are the most used specification approach, FHWA and many state agencies recognize that these requirements stifle innovation and place most of the risk on the agency. In some cases, premature distress and failure have occurred in concrete pavements that were nevertheless designed and constructed using prescriptive specifications.

While specification approaches have remained largely unchanged for quite some time, many aspects of the concrete industry have evolved substantially. For example, constituent materials such as portland cement and fly ash have changed. Supplementary cementitious materials (SCMs) and admixtures are now commonly used, and new materials and construction technologies are emerging. The environment in which many concrete pavements must serve has also become more severe. The effects of climate change have caused pavements to be increasingly exposed to harsh weather, adverse events, and other stressors. In wet freeze-thaw environments, deicers are being used with greater frequency.

Testing technologies have also advanced. New test methods to evaluate concrete performance have been developed, and others showing promise are emerging. Many of these tests provide a better understanding than what was previously attainable of the potential durability performance of concrete and support improved economics and sustainability (Sutter and Hooton 2023). Despite these advancements, tests developed in the early twentieth century such as slump, strength, and air content are still the primary tests used today to support QC, process control, and acceptance. However, these tests are only weakly linked to long-term pavement performance.

Advantages of Performance-Engineered Mixtures

Decades of research have led to an improved understanding of approaches that support the specification, design, and construction of concrete that meets specific performance requirements. In recent years, some agencies have begun moving toward performance specifications and PEMs as part of FHWA's PEM initiative (Ahlstrom 2016, Taylor 2017). In contrast to mixtures based on prescriptive specifications, PEMs allow contractors and suppliers to use their knowledge to produce better quality concrete (Cackler et al. 2017a). AASHTO R 101, Standard Practice for Developing Performance Engineered Concrete Pavement Mixtures, provides guidance on specifying and developing PEMs.

PEMs provide a number of advantages to both agencies and industry. Historically, concrete strength has been a property of primary interest during mixture design, approval, and construction, despite the fact that strength does not correlate well with long-term performance. The PEM approach, in contrast, allows designers to optimize specific concrete properties with respect to the environment, function, and design life of a structure. PEM technologies and approaches also allow designers, contractors, and suppliers to capitalize on their expertise and experience, fostering innovation and supporting the development of mixtures that provide both economic and performance benefits. This, in turn, reduces agency risk.

New PEM testing technologies allow agencies to better predict the durability of a concrete mixture without relying on strength as a surrogate measure. As such, the life-cycle cost of pavements designed using the PEM approach can be considerably reduced. Paired with a robust QC program, the PEM approach works to reduce material and construction variability, extending pavement service life (Cackler et al. 2017b).

As agencies implement performance-type specification provisions, contractor QC programs and plans will become an increasingly important component of project QA. During the transition to performance specifications, many of the prescriptive contractual requirements and responsibilities related to quality will be transferred to the contractor, along with some of the performance risks.

Summary of Performance-Engineered Mixture Requirements

Six concrete properties are used to characterize PEMs. These properties and the current test methods for each are summarized in Table 1. It should be noted that the PEM approach is scalable and customizable, allowing the engineer to pick and choose which concrete properties and test methods are appropriate for the project scope, size, and environment.

Table 1. PEM properties and test methods

Concrete Property	Test Methods
Concrete strength	• AASHTO T 97, Standard Method of Test for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading) • AASHTO T 22, Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens
Susceptibility to warping and cracking due to shrinkage	• AASHTO T 160, Standard Method of Test for Length Change of Hardened Hydraulic Cement Mortar and Concrete • AASHTO T 334, Standard Method of Test for Estimating the Cracking Tendency of Concrete (Figure 1)
Freeze-thaw durability	• AASHTO T 152, Standard Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method • AASHTO T 196M/T 196, Standard Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method • AASHTO TP 118, Standard Method of Test for Characterization of the Air-Void System of Freshly Mixed Concrete by the Sequential Pressure Method (Figure 2) • AASHTO M 224, Standard Specification for Use of Protective Sealers for Portland Cement Concrete • AASHTO T 365, Standard Method of Test for Quantifying Calcium Oxychloride Formation Potential of Cementitious Pastes Exposed to Deicing Salts • ASTM C1585, Standard Test Method for Rate of Absorption of Water by Hydraulic-Cement Concretes
Transport properties	• AASHTO TP 119, Standard Method of Test for Electrical Resistivity of a Concrete Cylinder Tested in a Uniaxial Resistance Test (Figure 3) • AASHTO T 358, Standard Method of Test for Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration (Figure 4)
Aggregate stability	• ASTM C1646, Standard Practice for Making and Curing Test Specimens for Evaluating Resistance of Coarse Aggregate to Freezing and Thawing in Air-Entrained Concrete • AASHTO T 161, Standard Method of Test for Resistance of Concrete to Rapid Freezing and Thawing • AASHTO R 80, Standard Practice for Determining the Reactivity of Concrete Aggregates and Selecting Appropriate Measures for Preventing Deleterious Expansion in New Concrete Construction
Workability	• AASHTO TP 129, Standard Method of Test for Vibrating Kelly Ball (VKelly) Penetration in Fresh Portland Cement Concrete (Figure 5) • AASHTO TP 137, Standard Method of Test for Box Test in Slip Form Paving of Fresh Portland Cement Concrete (Figure 6)

University of North Carolina at Charlotte, used with permission

Figure 1. AASHTO T 334 cracking tendency test

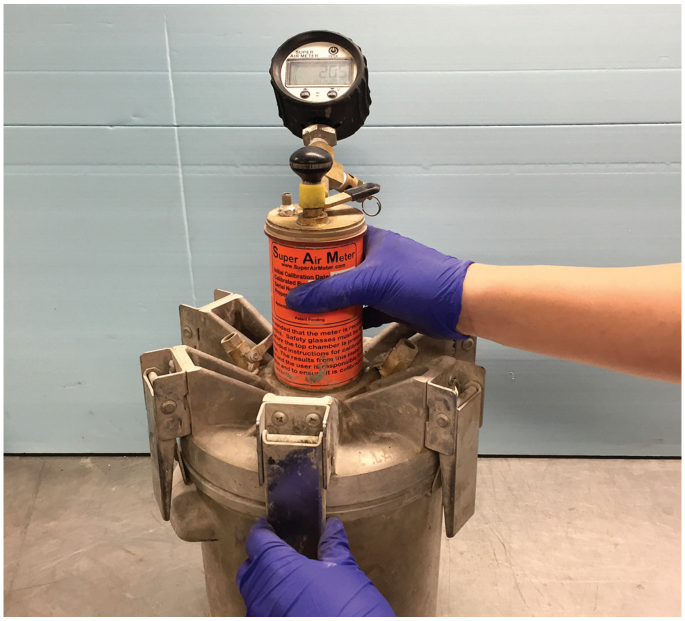

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Figure 2. AASHTO TP 118 super air meter (SAM)

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Figure 3. AASHTO TP 119 bulk resistivity test

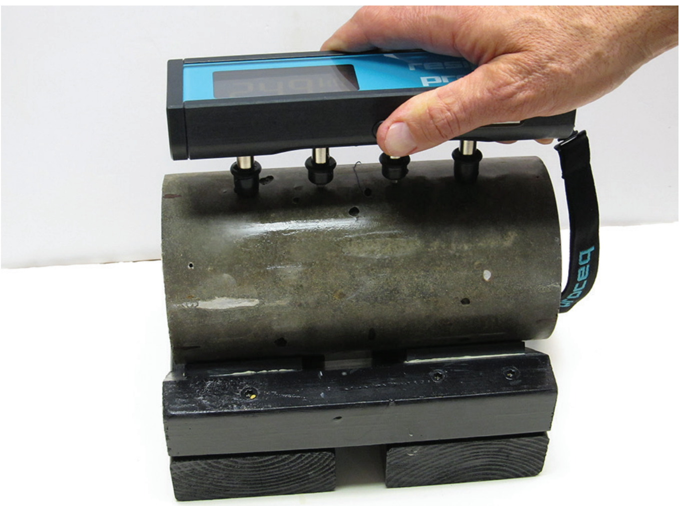

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Figure 4. AASHTO T 358 surface resistivity test

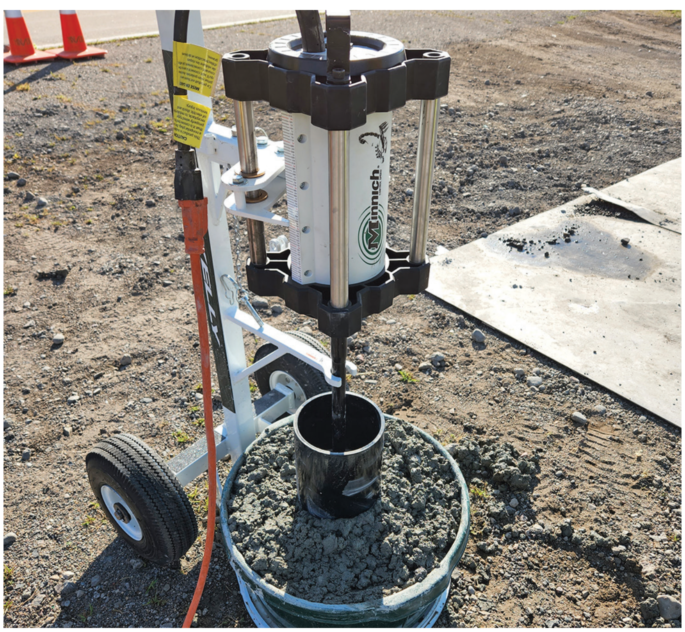

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Figure 5. AASHTO TP 129 VKelly test

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Figure 6. Box Test

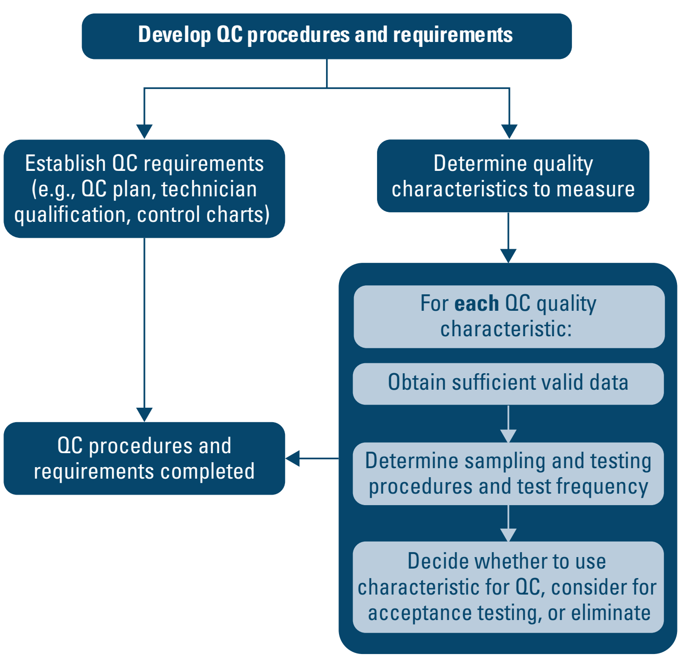
Selecting Quality Characteristics

For both PEMs and conventional concrete mixtures, selecting the appropriate quality characteristics to measure and control is critical to the success of a QC effort. To contextualize the selection of quality characteristics, Figure 7 presents a flowchart from FHWA (2003) illustrating the QC process.

Many quality characteristics used for acceptance cannot readily be measured while work is ongoing but can only be measured days or weeks after a particular segment of pavement is constructed. In such cases, quality is monitored using characteristics of the materials and the construction process that can be measured prior to or during construction (often as part of process control). Collectively, measurement, monitoring, and control of the appropriate characteristics helps ensure that the constructed work will meet the agency's acceptance criteria after the pavement is in place.

Once selected, the appropriate quality characteristics should be measured accurately. Measurements should also be made at intervals that allow the contractor to remain confidently aware of the status of the process in question and to be alerted to trends indicating that the process should be adjusted so that it remains in control. If sampling intervals are too long, the contractor will be unable to adjust the process in time to prevent out-of-specification work.

The simple act of paying attention to one aspect of the work often drives improvement in a wide range of other areas. In other words, monitoring and controlling one quality measure can help to identify other areas of potential improvement that, in turn, have corresponding measures that could be monitored and managed. As an added benefit, actions to improve the performance of one measure often translate into improvements in other measures.



Recreated from FHWA 2003

Figure 7. Quality control flowchart

Quality Control Plans

The first step towards implementing QC for any concrete paving project, regardless of whether PEMs and PEM testing technologies are used, is to develop a QC plan. A project-specific QC plan should be developed that clearly defines all QC responsibilities and activities and that documents all items that are to be measured and/or monitored. Clear action limits should be provided in the QC plan because they are necessary to ensure that proper process, mixture, and equipment adjustments can be made. For both PEMs and conventional mixtures, accurate and reliable data are critical for making appropriate process adjustments and, more broadly, are a valuable tool for decision-making.

Important elements of a QC plan include the following:

- Organization of the QC process (including personnel and operational units such as laboratories and crews) and personnel qualifications
- The elements of the company's QC program that support the QC plan, such as personnel training, qualification, and certification; laboratory certification; and equipment calibration and/or maintenance
- A listing of and full references to all applicable specifications and standards
- A listing of all materials required
- A description of mixture production, including stockpiling, aggregate testing, fresh concrete testing, hardened concrete testing, etc.
- A concrete paving plan, including prepaving activities, paving activities, joint sawing, joint sealing, etc.
- Adjustments to be made for various weather conditions and appropriate actions to take in response to changes in weather
- The individual ultimately responsible for quality for each activity, process, or test
- Corrective actions, including provisions to prevent and mitigate issues and to identify and address issues in a timely manner as they occur

All items should be described in sufficient detail to guide the work.

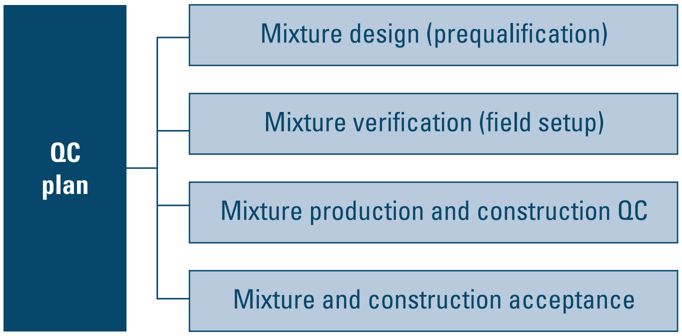


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Figure 8. Four stages of QC for portland cement concrete paving that should be included in a QC plan

The QC plan for portland cement concrete pavement construction should address four stages, as shown in Figure 8: mixture design (prequalification), mixture verification (field setup), mixture and construction QC, and mixture and construction acceptance.

QC for Concrete Pavement Projects

QC for concrete pavement projects differs based on agency requirements, the characteristics of a given project, and the contractor's resources, methods, preferences, and risk tolerance. The information presented below is therefore not intended to be all-inclusive. Rather, this information should serve as a starting point for contractors to develop QC programs and plans that meet their operational and project-based needs.

For a comprehensive description of current best practices for concrete pavement QC, as well as a QC plan outline and a model QC plan, readers are referred to *Quality Control for Concrete Paving: A Tool for Agency and Industry* (Cavalline et al. 2021). That publication presents actions, checklists, measurements, and inspection items for a wide range of QC items and summarizes this information in a series of tables. An example of a table for aggregate stockpile QC is provided in Table 2. Similar tables for QC items that should be monitored during the paving process are presented in *Quality Control for Concrete Paving: A Tool for Agency and Industry* (Cavalline et al. 2021), along with a QC plan outline and a model QC plan.

Development of a QC plan and construction processes should also rely heavily on the guidance provided in *Integrated Materials and Construction Practices for Concrete Pavements: A State-of-the Practice Manual* (Taylor et al. 2019) and *Field Reference Manual for Quality Concrete Pavements* (Fick et al. 2012).

QC During Mixture Design and Prequalification

Because the quality of concrete is heavily influenced by the quality and consistency of the component materials, QC for concrete mixture design and prequalification begins with material source selection and the QC efforts of material suppliers. To produce a concrete pavement that meets specifications and provides the desired performance, the contractor should be confident in the characteristics of the materials bought and used for the project and how the materials will perform. A comprehensive QC plan requires that, for all materials supplied to the project, the quality and production personnel should know and understand the following:

- The specifications for all products being supplied
- How to measure the required uniformity of the products being supplied
- Adjustments to make to the process if the uniformity changes

The contractor should ensure that potential material sources are prequalified and that any required testing for an approved source is completed prior to mixture design. Understanding source material properties and how to accommodate variability in these properties is also crucial. For example, aggregate uniformity and the susceptibility of aggregates to materials-related distress mechanisms such as alkali-silica reactivity (ASR) and D-cracking should be understood before proceeding with mixture design. The potential for a source material to change during the project should also be considered.

Table 2. Example summary table for aggregate stockpile QC

Key inspection items—Aggregate stockpiles	QC measurements—Aggregate stockpiles
• Visually inspect the stockpile for segregation. • Watch for rutting and pumping at the edges of the stockpile, which suggests that mud balls may be a concern.	• Sieve analysis—Performed during stockpiling; out-of-tolerance aggregates should be rejected • Aggregate moisture content
Checklist—Aggregate stockpiles	
✓ Verify that stockpile foundations have been stabilized. ✓ Verify that aggregate sources match the approved mixture design. ✓ Verify that aggregate gradation is within action limits.	

Source: Fick et al. 2012, Cavalline et al. 2021

ASTM and AASHTO standards state the requirements for each product used on a project, and agency specifications often include additional provisions to support the use of quality materials. Materials suppliers are also responsible for using their own QC programs to ensure that the material sold for use on a project complies with the appropriate standards, and information regarding each product should be accurately conveyed to the user.

QC activities during the mixture design and prequalification stage of a project should include all required actions to develop and evaluate concrete mixtures for conformance with the acceptance criteria specified for that project. The materials that will supply the project should be used when batching and testing trial mixtures during the design process and when preparing mixtures for prequalification testing. Although the specific requirements for QC testing during the mixture design and prequalification stage will vary based on agency specifications and project requirements, a summary of recommended laboratory tests for use during prequalification of a mixture is presented in Table 3 (Taylor et al. 2019).

Additional guidance on QC during mixture design and prequalification is provided in Chapter 3 of *Quality Control for Concrete Paving: A Tool for Agency and Industry* (Cavalline et al. 2021).

Table 3. Recommended laboratory tests during prequalification of a mixture, field setup/verification, and production QC

Concrete property	Test description	Test method	Prequalification	Field setup / verification	Production QC	Comments*
Workability	Aggregate gradation	ASTM C136 / AASHTO T 27, ASTM C566 / AASHTO T 255	✓	✓	✓	• Use individual gradations and proportions to calculate combined gradation.
	Combined gradation	Tarantula curve (Ley 2020)	✓	✓	✓	• Adjust combined gradation to achieve optimum workability (prequalification and field setup/verification). • Monitor uniformity (production QC).
	Aggregate moisture content	ASTM C29			✓	• Affects w/cm ratio and workability
	Paste content	Batch sheet	✓			• Adjust paste content to find minimum paste needed while still workable. • Confirm that total is below maximum permitted for shrinkage.
	VKelly or Box Test	AASHTO TP 129 / AASHTO PP 84	✓			• Confirm that the mixture responds well to vibration. • Adjust aggregate gradation and water content to achieve desired performance.
	Slump	ASTM C143 / AASHTO T 119M/T 119	✓	✓		• Test at 0, 5, 10, 15, 20, 25, and 30 minutes (prequalification). • Look for excessive slump loss due to incompatibilities, which is more likely at elevated temperatures (prequalification). • Determine approximate water-reducing admixture (WRA) dosage (field setup/ verification). • Indicates uniformity batch to batch (production QC).
	Segregation	—	✓	✓		• Look for signs of segregation in the slump samples.
	Water content	AASHTO T 318			✓	• Water content should be used as a QC real time test to inform permeability.

** Each comment applies to all stages with indicated with a checkmark (✓) unless specific stage(s) are denoted in parenthesis after the comment.*

Table 3 continued on following page

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Concrete property	Test description	Test method	Prequalification	Field setup / verification	Production QC	Comments*
Air void system	Foam drainage	—	✓			• Assess stability of the air void system for the proposed combination of cementitious materials and admixtures. • Select alternative admixture combinations if instability is observed.
	Air content	ASTM C231 / AASHTO T 152, T 196M/T 196	✓	✓	✓	• Determine approximate air-entraining admixture (AEA) dosage.
	SAM	AASHTO TP 118	✓	✓		• Target value established by the agency and/or QC plan (prequalification). • Determine AEA dosage range (field setup/ verification). • SAM can also be used to indicate uniformity batch to batch (production QC).
	Clustering	Retemper a sample and use optical microscopy to assess clustering	✓			• This can affect strength. • Air content can also jump with retempering.
	Hardened air	ASTM C457	✓			• Assess compliance with specification.
Unit weight	Unit weight	ASTM C138 / AASHTO T 121M/T 121	✓	✓	✓	• Indicates yield of the mixture and provides a rough estimate of air content (prequalification). • Establish a basis for QC monitoring (prequalification). • Confirm basis for QC monitoring (field setup/ verification). • Indicates uniformity batch to batch (production QC).
Strength development	Compressive or flexural strength	ASTM C39 / AASHTO T 22 and/or ASTM C78 / AASHTO T 97	✓	✓		• Test at 1, 2, 7, 28, and 56 days (prequalification). • Calibrate strength gain for early-age QC (prequalification). • Calibrate flexural with compressive strengths (prequalification). • Adjust w/cm ratio to ensure sufficient strength (prequalification). • Confirm strength development (field setup/ verification). • Indicates uniformity batch to batch (production QC).
	Maturity	ASTM C1074	✓		✓	• Calibrate the mixture so maturity can be used in the field to determine opening times (prequalification). • Opening times (production QC).

** Each comment applies to all stages with indicated with a checkmark (✓) unless specific stage(s) are denoted in parenthesis after the comment.*

Table 3 continued on following page

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Concrete property	Test description	Test method	Prequalification	Field setup / verification	Production QC	Comments*
Permeability	Combined gradation	Tarantula curve (Ley 2020)	✓	✓	✓	• Adjust combined gradation to achieve optimum workability (prequalification and field setup/verification). • Monitor uniformity (production QC).
	Resistivity / F-factor	AASHTO TP 119 and AASHTO T 358	✓	✓		• Sample conditioning per AASHTO TP 119 (Option A) is preferred. • Determine development of F-factor over time. • Adjust w/cm ratio to achieve required performance (prequalification).
	Sorption	ASTM C1585	✓			• Determine time to critical saturation.
	w/cm ratio	Microwave	✓			• Calibrate microwave test with batch data.
	Rapid chloride penetrability	ASTM C1202 / AASHTO T 277	✓	✓		• Evaluate chloride ion penetrability using the table provided in ASTM C1202 / AASHTO T 277. • Adjust w/cm ratio to achieve required performance. • Indicates uniformity (production QC).
Other	Hydration	Semi-adiabatic calorimetry	✓	✓	✓	• Determine hydration rates of mixture (prequalification). • Set a baseline for QC (prequalification). • Assess risk of incompatibilities if SCMs/ admixtures/temperatures change (prequalification). • Adjust SCM source, WRA type, or operating temperature if incompatibility is observed (prequalification). • Confirm baseline for QC (field setup/ verification). • Indicates uniformity batch to batch (production QC).
	Oxychloride risk	LT-DSC on paste	✓			• Assess risk of joint deterioration if salts are used. • Increase SCM dose if risk is excessive.
	Coefficient of thermal expansion	AASHTO T 336	✓			• Confirm that assumptions used in structural design are appropriate.
	Mortar content	Vibrate a container (air pot) for 5 minutes and measure depth of mortar at the top surface	✓			• This provides information on the coarse aggregate content; maximum is ~¼ in.

** Each comment applies to all stages with indicated with a checkmark (✓) unless specific stage(s) are denoted in parenthesis after the comment.*

QC During Field Setup

A list of recommended field setup tests is provided in Table 3. Each mixture submitted for use on a project should be tested at the plant where it will be produced. During these trials, a mixture can be optimized for performance in hot and cold weather, and all ingredients can be confirmed to be compatible in terms of workability, air content, and set time.

QC During Mixture Production

Tests recommended for QC during mixture production are listed in Table 3. In addition to using any of these tests in their project-level QC plans, contractors can use the PEM-related tests and approaches listed in this table, along with the tests and approaches described in AASHTO R 101, to improve their QC programs and achieve the benefits associated with more reliable production of quality concrete, even if PEM practices are not specified by the agency. From the agency's perspective, the PEM guidance provided in AASHTO R 101 allows flexibility in the use of alternative performance measures. As agencies move towards PEM specifications, contractors will increasingly need to adapt their QC measurements during mixture production to include performance-related tests.

Information on the items to be tested, the tests to be performed, the sampling protocol, testing frequencies, and replicates for testing during mixture production should be provided in the contractor's QC plan. The QC plan should also include a random sampling plan, a description of sample identification and storage systems, and a QC sampling and testing table. If presented in table format, the information on sampling and testing is easily referenced within the plan.

An example of a QC sampling and testing table that includes PEM tests is presented in Table 4. **Note that the information presented in Table 4 is shown as an example only. The table should not be used for any other purpose than to develop a project-specific schedule of testing to be incorporated into a QC plan.** Appropriate details for specific items such as lot sizes, numbers of sublots, and sampling and testing frequencies will vary based on agency requirements and project characteristics such as size, duration, staging, the type of work being performed, and other factors. In developing a QC plan for a given project, contractors should consider these factors and adjust the QC plan accordingly. American Concrete Pavement Association (ACPA) publication EB238P, *Concrete Pavement Field Reference: Paving*, provides a table of QC tests, procedures, and testing frequencies that can be used for roadways of different types (ACPA 2010).

Once an approved QC plan is in place for a project, daily construction activities should be monitored and adjusted accordingly. Monitoring and adjustment should be performed on the items required to control each construction activity or process outlined in the QC plan. These items include but are not limited to checklists, materials testing, measurements, and process adjustments. In addition to these items, elements of the contractor's QC program, such as personnel training and certification and equipment calibration and maintenance, should be monitored to ensure compliance with the plan.

Acceptance

Tests for mixture acceptance should be performed as specified by the agency. These tests may be performed by the agency or the agency's representative. The agency may also choose to use data from QC tests performed by the contractor in the acceptance process. The latter case further emphasizes the need for the contractor to ensure that appropriate QC provisions are in place to support the acceptance decision.

Closing

A well-developed and implemented QC plan can assure an agency that a concrete paving project will meet specifications and provide a quality investment. From the contractor's standpoint, the implementation of a comprehensive QC program and the use of QC plans can improve profitability, lower risk, and ultimately support business growth. As agencies move towards performance specifications, contractor QC programs and plans will need to adapt to meet these new requirements and capitalize on the opportunities offered by PEMs.

For both PEMs and conventional mixtures, accurate and reliable data are critical for making appropriate process adjustments and, more broadly, are a valuable tool for decision-making. A contractor QC plan should provide accurate and reliable data to support decision-making at each phase of a project and to enable process control during construction.

Agencies have various requirements for contractor QC, but these requirements are only the minimum provisions that should be considered. Additional QC activities are almost always required to ensure that risk is mitigated and a quality pavement is constructed.

A comprehensive description of current best practices, supporting checklists and tools, and a QC plan framework and model QC plan are presented in *Quality Control for Concrete Paving: A Tool for Agency and Industry* (Cavalline et al. 2021). Additional guidance on QC best practices is provided in other supporting publications, including *Integrated Materials and Construction Practices for Concrete Pavements: A State-of-the Practice Manual* (Taylor et al. 2019) and *Field Reference Manual for Quality Concrete Pavements* (Fick et al. 2012).

Table 4. Example QC sampling and testing table

Material	Test/Test method	Lot size	No. of sublots	Testing frequency	Sampling location	Sampling method	Report type
Coarse, intermediate, and fine aggregates	• Gradation: ASTM C136	5,000 yd²	5	1 per sublot and/or minimum 1 per day	Stockpile	Random, per agency specification	Tabular and graphical: percent retained, Tarantula curve
Fresh concrete	• Air content: ASTM C231	5,000 yd²	5	First 3 loads per day and for 3 loads whenever admixture dosages are adjusted	Plant, grade, and behind paver	Biased, start of day	Tabular and control chart
	• SAM: AASHTO T 152 • VKelly: AASHTO TP 129 or Box Test (Cook et al. 2014)	N/A	5	First 3 loads per day and for 3 loads whenever admixture dosages are adjusted	Plant	Biased, start of day	Tabular and control chart
Fresh concrete at grade	• Temperature: ASTM C1064 • Air content: ASTM C231 • Air void system: AASHTO T 152 • Unit weight: ASTM C138 • Water content: AASHTO T 318	5,000 yd²	5	1 per sublot	Grade	Random, per agency specification	Tabular and control chart
Hardened concrete	• Compressive strength: ASTM C39 • Resistivity: AASHTO T 358	5,000 yd²	5	1 set of 3 replicates per lot and/or minimum set of 3 replicates per day	Plant	Random, per agency specification	Tabular and control chart
Concrete pavement	• Thickness probe: per agency specification	5,000 yd²	5	1 per sublot	Grade	Random	Tabular and control chart
	• Maturity: ASTM C1074	5,000 yd²	5	1 per sublot	Grade	Random	Tabular and control chart
	• Thickness: ASTM C174 • Thickness: MIT SCAN-T3	5,000 yd²	5	1 per sublot	Pavement cores	Random	Tabular and control chart
	• Dowels: MIT-DOWEL-SCAN	N/A	N/A	All dowelled joints	All dowelled joints	N/A	N/A

Source: Fick et al. 2012

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About the National Concrete Pavement Technology Center

The mission of the National Concrete Pavement Technology Center (CP Tech Center) at Iowa State University is to unite key transportation stakeholders around the central goal of developing and implementing innovative technology and best practices for sustainable concrete pavement construction and maintenance.