NTPEP Committee Work Plan for

Evaluation of Concrete Coatings and Sealers

NTPEP Designation: CCS-18-01

NTPEP

AASHTO THE VOICE OF TRANSPORTATION | NATIONAL TRANSPORTATION PRODUCT EVALUATION PROGRAM

National Transportation Product Evaluation Program
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INTRODUCTION

The National Transportation Product Evaluation Program (NTPEP) was established to minimize the amount of duplicative testing of transportation materials performed by AASHTO member states by providing a process where manufacturer/suppliers submit their product(s) to NTPEP for laboratory and/or field testing. The results of the testing are then shared with member Departments for their use in product quality verification.

This work plan describes the NTPEP evaluation of concrete coatings and sealers (CCS). Test results from this program are provided to NTPEP member departments. In keeping with the NTPEP philosophy of purely testing materials, no conclusions are provided with the test results. The evaluation of the test results is left up to each member department.

The National Transportation Product Evaluation Program (NTPEP) serves the member departments of the American Association of State Highway and Transportation Officials (AASHTO).

1. SCOPE

1.1.1 This work plan describes the requirements and testing criteria for the National Transportation Product Evaluation Program (NTPEP) evaluation of concrete coatings and sealers (CCS). The National Transportation Product Evaluation Program (NTPEP) serves the member departments of the American Association of State Highway and Transportation Officials (AASHTO).

1.1.2 Results from this testing will be available through NTPEP DataMine at http://data.ntpep.org/ .

1.1.3 This work plan is furnished for the benefit of manufacturers/suppliers interested in participating in the program by submitting their product(s). The testing format has been established to provide the end user with test results which can be used to assess the performance of concrete coatings and sealers for long environmental exposures. Concrete coatings and sealers are not required to meet any specific compositional requirements for submission and testing in this program. Manufacturers are encouraged to submit product(s) that they believe will perform well and meet the demands of the transportation industry. Concrete coatings and sealers are intended for use on bridges, walls, barriers, similar structural concrete, and other masonry surfaces, both new and existing, prepared by abrasive blast cleaning or high-pressure water cleaning. Tested concrete coatings and sealers are intended to enhance durability, and/or aesthetics of concrete structures which are subject to degrading atmospheric exposure, such as marine, industrial, deicing chemicals, and high humidity. Concrete coatings and sealers consist of surface applied coatings, sealants, or stains.

1.1.4 This work plan defines the evaluation procedures for coatings and sealants for concrete which will serve as the standard testing protocol for AASHTO's National Transportation Product Evaluation Program for these product(s).

1.1.5 The testing facility may be either a state highway laboratory, university laboratory or a private independent laboratory appropriately equipped and capable of performing the required evaluations. All laboratories performing these evaluations shall be contracted through AASHTO/NTPEP. AASHTO/NTPEP testing programs do not provide pass/fail acceptance criteria. Evaluation reports will provide performance data. The accepting agency will make the determination regarding specification compliance for the product(s) selected. Details on the testing facility are found in Appendix A.

1.1.6 This work plan may involve hazardous materials, operations, and equipment. It does not purport to address all safety problems associated with its use. It is the responsibility of the user of this standard practice to establish the appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENTS

2.1 AASHTO Standards:

- M 6 – Standard Specification for Fine Aggregate for Hydraulic Cement Concrete
- M 80 – Standard Specification for Coarse Aggregate for Hydraulic Cement Concrete
- T 22 – Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens
- T 260 – Standard Method of Test for Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials
- TP 96 – Standard Method of Test for Protective Sealers for Portland Cement Concrete

2.2 ASTM Standards:

- C138, Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
- C143, Standard Test Method for Slump of Hydraulic-Cement Concrete
- C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
- C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
- C267, Standard Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes
- C307, Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts and Monolithic Surfacings
- C494, Standard Specification for Chemical Admixtures for Concrete
- C496, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
- C511, Standard Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
- C666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
- C672, Standard Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals
- C1064, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
- D522, Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
- D562, Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer
- D891-09, Standard Test Method for Specific Gravity, Apparent, of Liquid Industrial Chemicals
- D1475, Standard Test Method for Density of Liquid Coatings, Inks, and Related Products
- D1640, Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings
- D2369, Standard Test Method for Volatile Content of Coatings
- D2370, Standard Test Method for Tensile Properties of Organic Coatings
- D2371, Standard Test Method for Pigment Content of Solvent-Reducible Paints
- D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
- D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- D4587, Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
- D4940, Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blast Cleaning Abrasives.
- D5095, Standard Test Method for Determination of the Nonvolatile Content in Silanes, Siloxanes and Silane-Siloxane Blends Used in Masonry Water Repellent Treatments
- D6132, Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Coating Thickness Gage
- D6943, Standard Practice for Immersion Testing of Industrial Protective Coatings and Linings
- D7127, Standard Test Method for Measurement of Surface Roughness of Abrasive Blast Cleaned Metal Surfaces Using a Portable Stylus Instrument

- D7234, Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
- D7393, Standard Practice for Indicating Oil in Abrasives
- E96, Standard Test Methods for Water Vapor Transmission of Materials

3. Terminology

Concrete Coating – *Is the covering, typically liquid or semi-liquid, that is applied to cured concrete for aesthetic reasons as well as to make the structure or surface last longer and to reduce maintenance or repair costs.*

Sealer – *Sealers are divided into two basic types: coatings, which remain on the surface; and penetrants, which penetrate the concrete to some measurable depth and do not substantially change the appearance of the concrete. All sealers, by definition, are intended to reduce water penetration into concrete and to extend the service life of the concrete. Most sealers for highway structures are used to reduce the ingress of chlorides from deicers or seawater to protect the embedded reinforcing steel from corrosion. Therefore, improving the resistances, in concrete, to both water and chloride penetration is a basic property of all sealers.*

Primer – *Primers act as the initial barrier over the prepared concrete substrate. Single coat systems shall consist only of the primer.*

Intermediate Coat – *The intermediate coat for a three-coat system serves as a tie coat between primer and finish coat as well as a protective barrier for the concrete. The manufacturers for each (three-coat) coating system submitted for evaluation shall recommend the appropriate intermediate coat.*

Finish Coat – *The finish coat for each system evaluated serves as the final barrier coating and provides the desired aesthetic finish for the surface of the structure. The manufacturers for each coating system submitted for evaluation shall recommend the appropriate finish coat.*

4. PROGRAM OVERVIEW

4.1 Overview of the Program

4.1.1 The NTPEP test facilities evaluate manufacturer's product(s) according to the applicable testing standards that are listed in this document. The test facilities performing the evaluations are contracted to AASHTO.

4.1.2 The NTPEP Lead State will coordinate testing of accepted submittals with the testing facility and the manufacturer and designate the coating systems to be used as system monitors for testing.

4.1.3 Test fees that are paid by the manufacturer for evaluation of their product(s) will be paid to AASHTO. Testing fees are assessed to cover all costs associated with laboratory testing, field evaluation, administrative costs incurred by the NTPEP lead state, (electronic) report generation and distribution by AASHTO, document preparation and distribution to AASHTO member departments. Specific pricing for

submission of product(s) may be found at www.NTPEP.org. Laboratories will be reimbursed for testing performed if a system is withdrawn after testing has begun. If the manufacturer elects to withdraw initial samples after testing begins and resubmit product(s), the manufacturer will be charged additionally for all costs incurred by the laboratory during the initial testing. For information regarding costs, and their associated due dates, please refer to the Terms and Conditions located under DataMine's (http://data.ntpep.org) Legal Information section.

4.1.4 The Concrete Coating and Sealer Manufacturer may have a representative of the company present during the application process. AASHTO/NTPEP may also elect to have a representative present during the application process as part of the Quality Assurance function.

4.1.5 The Test Facility will notify the Concrete Coating and Sealer Manufacturer and the Lead State, at least fifteen working days prior to the coating or sealer application date. The Test Facility will provide completed concrete coating and sealer identification test results to the Lead State and the Concrete Coating and Sealer Manufacturer for review prior to the application date. If the materials received by the facility do not produce compositional results as reported in the preliminary information submitted by the company, the Manufacturer's representative will be expected to decide whether the system testing should proceed.

4.1.6 When present for the concrete coating and sealer application, the Manufacturer's representative is required to sign a statement attesting to the appropriate application of the concrete coatings and sealers by the Test Facility. The Manufacturer's representative will be expected to make decisions regarding any changes in the application process. If the Concrete Coating and Sealer Manufacturer elects not to have a representative present during the application process, they shall provide an affidavit confirming notification of the application dates and agreement not to contest the validity of the application or compositional testing process.

4.1.7 When the application process is complete, the Manufacturer is bound by the Non-Interference Policy as detailed in the General Terms and Conditions Section of submittal documents. All written or verbal correspondence between the Manufacturer and the Testing Laboratory, after the application of the concrete coatings and sealers, must be done through the Lead State. Any implication of interference from the Manufacturer during the testing and evaluation process will be cause for the evaluation to cease. Any written or verbal communication between the manufacturer and the Testing Facility that is not shared with the NTPEP Coordinator or the Lead State will be considered a violation of the Non-Interference Policy.

4.1.8 All information generated through this testing program is considered property of AASHTO.

4.2 Participation and Administration of the Program

4.2.1 Manufacturer participation and AASHTO administration of the program will be governed by the NTPEP Information and Operations Guide. This Guide provides the general requirements for submittal of product(s) and review of data that is generated through testing prior to posting for review by Member Departments. A copy of the Guide is available online at www.NTPEP.org.

4.2.2 Specifying agency representatives, authorized through AASHTO/NTPEP, will be permitted (at any time) access to inspect testing procedures being performed and/or review test records of any concrete coating or sealer being evaluated under this specification.

4.2.3 Preparation of test reports shall consist of uploading required data, images and certificate of testing to the NTPEP Data Mine program. The lead testing facility is responsible for compiling and entering the required information for each concrete coating or sealer in accordance with the approved process timeline.

4.2.4 The Concrete Coating and Sealer manufacturer will be responsible for reviewing the submittal timelines as posted online at www.NTPEP.org. All testing will be performed by contracted laboratories as described in this work plan.

4.2.5 This testing program will accept submissions four times annually, limited to the first 5 submissions each cycle. Manufacturers may submit samples during open submission cycles through the online submission process.

4.2.6 Concrete coating and sealer manufacturers participating in the AASHTO/NTPEP program must submit a completed NTPEP Product Evaluation Form (ePEF) to the attention of the AASHTO/NTPEP coordinator. This process is completed electronically through the NTPEP Data Mine program. It is required that Quality Control analysis data for submitted lots of coatings be supplied. Baseline compositional references will be established through these laboratory evaluations. Specifiers will utilize these values for compositional verification of field samples. All applicable compositional data contained in this work plan should be supplied for each component of each product in the coating system. The Concrete Coating and Sealer Manufacturer shall identify the coating or sealer type as well as if individual coatings within a system shall be tested separately.

4.2.7 Samples must be submitted to the designated testing facility in sufficient quantity to conduct all testing, as instructed by the NTPEP representative along with:

4.2.8 Information showing the manufacturer's name and description of product.

4.2.9 Manufacturer test results as outlined in Section 5 of the work plan.

4.2.10 The Concrete Coating and Sealer Manufacturer shall supply sufficient quantities of each concrete coating and sealer product to perform the required testing. The testing facility determines sufficient quantities for testing, application, and compositional analysis. The Concrete Coating and Sealer Manufacturer may supply single component product(s) or multi-component product(s) in pre-packaged kits. The Concrete Coating and Sealer Manufacturer shall provide the mixing ratio (by mass) of multi- component systems for the testing laboratory to mix the test material in quantities sufficient for testing. In addition, the Concrete Coating and Sealer Manufacturer shall indicate the minimum quantity of product to be mixed to assure proper reaction of the components. The test concrete coatings and sealers shall be supplied from manufactured stock with traceable batch numbers. The test concrete coating and sealer shall not be specifically manufactured for this test program.

4.2.11 Pigment—The leachable, heavy-metal compounds shall not exceed the regulatory limits of 40 CFR, 261.24, Table 1. Total levels of lead, cadmium, and chromium shall not exceed the specified limits for these elements.

4.2.12 The manufacturer shall supply certified Product Data Sheets, Safety Data Sheets, and chemical test results that will define the character and nature of the concrete coatings and sealers being submitted. Actual results shall be verified by the select laboratory, and shall be part of the select laboratory's report. This information will be kept in confidence by NTPEP unless directed otherwise by the manufacturer.

4.2.13 The Concrete Coating and Sealer Manufacturer shall supply all necessary data to apply the concrete coating and sealer, including but not limited to pot life, recoat windows and DFT range.

4.3 Policies for withdrawing materials from NTPEP evaluation programs

4.3.1 A written request to withdraw the Product Evaluation Form must be received by the NTPEP Coordinator at least five business days before the application of the material to the test panels is to begin. For information regarding costs, and their associated due dates, please refer to the Terms and Conditions located under DataMine's (http://data.ntpep.org) Legal Information section.

4.4 Policy for review of NTPEP reports

4.4.1 The Concrete Coating and Sealer Manufacturer will be given access to the AASHTO/NTPEP Data Mine and asked to review the data from their product(s) for release. Upon receipt of results to be reviewed, the Concrete Coating and Sealer Manufacturer will have thirty (30) days to complete their review. Any protest of the data from the Concrete Coating and Sealer Manufacturer must be submitted in writing to the NTPEP Coordinator. Failure of the manufacturer to complete data review or protest data within the thirty-day review period will result in automated release of data.

4.4.2 The NTPEP Coordinator, panel chairman and the testing facility generating the data in question, (Review Committee) will review data being protested to determine if an error was made. Typographical errors that are found will be corrected. Questions raised about the testing data, other than typographical errors, will be reported unless the investigation by the Review Committee verifies conclusively that the question(s) raised is legitimate.

4.4.3 A written notification will be sent by the NTPEP Coordinator to the Concrete Coating and Sealer Manufacturer indicating the decision within five (5) working days after the decision has been made. The decision of the Review Committee will be considered final. The appeals procedure outlined here supersedes the NTPEP Operating Policy and Procedures on this topic and is project panel specific in nature.

4.5 Policy on manufacturer publication of NTPEP test data

4.5.1 Manufacturers may publish NTPEP data after formal release through the reporting process under the following conditions:

4.5.2 Only test data for the manufacturer's own product(s) may be reproduced.

4.5.3 Manufacturers may utilize the test data on their own product(s) as a source of independent test data. However, the data may not be used for comparative marketing purposes with those ofother manufacturers.

4.5.4 Whenever NTPEP test data are used or presented, the following statement must be used: "The preceding test data excerpts were reproduced with the permission of AASHTO, however, this does not constitute endorsement or approval of the product, material, or device".

4.5.5 Some areas where a manufacturer may use NTPEP data are as follows:

4.5.6 To indicate that the product was tested by NTPEP in their product bulletins and brochures.

4.5.7 Use as references on Product Evaluation Forms required by many government agencies.

5. COATING IDENTIFICATION TESTING

5.1.1 The Concrete Coating and Sealer Manufacturer and the Test Facility shall perform the following referenced tests, as applicable, to define the character and nature of each coating product, and when indicated, each liquid component of a coating product. Perform each test in duplicate or the number of replicates as stated in the appropriate test method, whichever yields the greatest number of replicate tests. Reportable data shall comply with stated precision and bias statements. The Test Facility shall complete all coating identification testing of the concrete coating and sealer prior to application to test specimens. The facility shall have twenty (20) working days from the date samples are received, to complete all coating identification testing.

5.1.2 The Concrete Coating and Sealer Manufacturer and the Test Facility shall perform the following referenced tests, as applicable, to define the character and nature of each coating product, and when indicated, each liquid component of a coating product. Perform each test in duplicate or the number of replicates as stated in the appropriate test method, whichever yields the greatest number of replicate tests. Reportable data shall comply with stated precision and bias statements. The Test Facility shall complete all coating identification testing of the concrete coating and sealer prior to application to test specimens. The facility shall have twenty (20) working days from the date samples are received, to complete all coating identification testing.

5.1.3 The following tables indicate the various test methods that must be followed for Concrete Coatings and Sealers.

Concrete Sealers (Each Liquid Component and Mixed Material)

Test	Test Method
ATR-FTIR	CCS Workplan Section 5.3
Total Solids	ASTM D2369 or ASTM D5095
Specific Gravity	ASTM D891-09
VOC Content	EPA 450/3-84-019

Concrete Coatings (Each Coating and Individual Component(s) of a System)

Test	Test Method
Consistency KU	ASTM D562
Density	ASTM D1475
Drying/Curing	ASTM 1640
Volatile Content	ASTM D2369
Flexibility	ASTM D522
ATR-FTIR	CCS Workplan Section 5.3
Abrasion Resistance	ASTM D4060, CS-17 Wheels, 1000 Cycles, 1000 Gram Load
Pull Off Adhesion	ASTM D7234
Water Vapor Permeance	ASTM E96, Water Method
Pigment Content	ASTM D2371
VOC Content	EPA 450/3-84-019
Tensile Strength	ASTM D2370/ASTM C307

5.1.4 The infrared spectrum will be determined for concrete coatings and sealers using Attenuated Total Reflectance-Fourier Transform Infrared Spectroscopy (ATR-FTIR). The following parameters shall be used to collect the spectrum.

- A single bounce ATR with a diamond crystal accessory.
- The spectrum should contain the Infrared (IR) region of 600-4000 cm-1.
- A minimum of 16 scans per sample should be run.
- For liquid samples, place enough sample to completely cover the diamond crystal on the mounted block.
- For paste samples, use a spatula to cover the diamond crystal with enough sample to cover the crystal. Tap lightly to ensure complete contact between the sample and the crystal.
- For powder samples, finely grind the powder using a mortar and pestle or grinder. Use a spatula to put a small mound of the powder on top of the diamond crystal. Use a concave pressure tip to ensure complete contact between the powder and the crystal.
- For films, place enough film to cover the diamond crystal. Use a flat pressure tip to complete the contact between the film and the crystal.
- Spectrum should have % transmittance between 5-25% or absorbance units between 0.5-1.0 on the major peaks.
- The method of obtaining the spectrum shall be noted on the uploaded spectrum, including the sample preparation techniques and instrumentation details.
- The uploaded spectrum shall also include the 1) Manufacturer Name, 2) Product Name, 3) NTPEP Number, 4) Lot Number, 5) Lab ID, 6) Date Analyzed and 7) Peak Wavenumbers. Laboratory project identification may also be included, but is not required.
- To maintain confidentiality of proprietary information, IR Scans will not be publicly available. These will be password protected and available to NTPEP member states through DataMine.

6. PERFORMANCE TESTS TO BE PERFORMED BY TESTING FACILITY

6.1 Concrete Sealers for Portland Cement Concrete in accordance with AASHTO TP-96

Physical Tests for Concrete Sealers

Test	Reported Value
Moisture Vapor Transmission	Drying Rate Coefficient (DRC)
Waterproofing Performance	Moisture Content of Cubes, 7-Day Weight Gain, Saltwater Absorption Rate (SAR)
Chloride Penetration	Report the Relative Chloride Ratio (RCR) and Total Chloride
Depth of Penetration	Record Min., Max. and Ave. Depth of Penetration to Nearest 1 mm (0.04 in.)
Coating Thickness	Record Min., Max. and Ave. Thickness to Nearest 0.025 mm (0.001in.)
Coating Bond Strength	Record a minimum of 3 tests in MPa (psi)
Skid Resistance	Report British Pendulum Number (BPN) on Non-Weathered Samples
Time to Cure (Coating)	Gel Time, Tack-Free Time, and Final Set Time at Application Temperatures
Drying Time (Penetrating)	Initial Drying Time and Final Drying Time at Application Temperatures
Freeze Thaw Resistance	Record Concrete Deterioration Rating Scale and Freeze-Thaw Weight Loss Ratio (FTR)

6.2 Concrete Coatings for Portland Cement Concrete

Physical Tests for Concrete Coatings

Test	Reported Value	Test Procedure
Moisture Vapor Transmission/Permeance	Water Vapor Transmission	AASHTO TP96
Waterproofing Performance	Moisture Content of Cubes, 7-Day Weight Gain, Saltwater Absorption Rate (SAR)	AASHTO TP96
Chloride Penetration	Report the Relative Chloride Ratio (RCR) and Total Chloride	AASHTO TP96
Coating Thickness	Record Min., Max. and Ave. Thickness to Nearest 0.025 mm (0.001in.)	ASTM D6132
Drying Time and Time to Cure (Coating)	Gel Time, Tack-Free Time, and Final Set Time at Application Temperatures	TP96
Adhesion Testing	Coating bond strength, MPa (psi)	ASTM D7234
Immersion Testing	Photographs, Blisters, Color and Gloss Before and After	ASTM D6943, Method A, in 3% Sodium Chloride Solution
Freeze Thaw Testing	Record Concrete Deterioration Rating Scale and Freeze-Thaw Weight Loss Ratio (FTR)	TP96/ASTM C666
Adhesion Post Immersion Testing	MPa (psi)	ASTM D7234

Adhesion Post Freeze Thaw	MPa (psi)	ASTM D7234
UV Resistance	Photographs, Blisters, Color and Gloss Before and After	ASTM D4587

7. TEST SPECIMEN REQUIREMENTS

7.1 Test Specimen Size

Specimen Sizes

Specimen Type	Dimensions
Cubes	100 +/- 1.5mm (4 +/- 0.06 in.)
Concrete Slabs	150 x 100 x 50 mm (6 x 4 x 2 in.)
Freeze Thaw Prisms*	400 x 75 x 100 mm (16 x 3 x 4 in.)

*Do not immerse Freeze Thaw Prisms in Saltwater prior to testing in accordance with ASTM C666.

7.2 Recommended Concrete Mix Design:

7.2.1 The test facility is required to report the description of the final mix design used for making all specimens. Report the concrete raw material sources including aggregate source and gradation, cement source and mill certificate, all admixture sources and chemical compositions. Report the casting date of the specimens.

7.2.2 The test facility shall test and report the concrete plastic properties including slump, air content, temperature, and unit weight.

7.2.3 Select a representative and standard source of cement and aggregates. Use well-graded, normal density aggregates meeting the requirements of AASHTO M6 and AASHTO M80 and having a maximum nominal aggregate size of 13mm to 19mm (1/2 to ¾ inches). Use rigid molds to produce test panels and cubes. Do not use form oils or release agents that could contaminate the concrete surfaces. The concrete mixture should meet the requirements in the guidelines in the following table. Keep water/cement ratio, maximum aggregate size, and air content requirements fixed. Use a moderate cement content, and do not use fly ash or other supplementary materials. Use a chloride-free, lignosulfonate water-reducing admixture to obtain the correct slump, if needed. Other ASTM C494 Type A water-reducing admixtures may be used if they do not contain chloride or other material that may affect the pore structure. Do not use superplasticizer (high-range water-reducing admixture).

Guidelines of Recommended Mix Design

Constituent Properties	Guideline
Water to Cement Ratio (w/c)	0.50
Nominal Maximum Aggregate Size	13-19mm (1/2-3/4 in.)
28-day Compressive Strength (design)	27MPa min. (4000 psi min)
Entrained Air Content	5.0-7.0 %

Slump	75-125mm (3-5 in.)
Cement Content	300 kg/m3 (505 lb/yd3)
Sand Content, % Total Aggregate	40-42
Fineness Modulus of Sand	2.4-2.9
Air-Entraining Agent	Neutralized Vinsol Resin or Equivalent
Water-Reducing Agent	Lignosulfonates

7.2.4 Fabricate the test specimens in accordance with ASTM C192. Measure and account for aggregate moisture contents to ensure that the exact water to cement ratio (w/c) is used. Measure the concrete plastic properties, including slump (ASTM C143), air content (ASTM C231), temperature (ASTM C1064), and unit weight (ASTM C138). Consolidate test specimens in accordance with ASTM C192 and try to minimize the amount of surface voids in the specimens and strike off flush with a wood or magnesium float. Do not use a steel trowel or an aluminum float. Cover with moist burlap and plastic, such that the surfaces of the specimens are not marred or damaged but kept moist. For each batch produced, cast a minimum of three 4 x 8 in. cylinders for compressive strength testing in accordance with AASHTO T22.

7.2.5 Identify the finished surface with a small felt-pen mark. Maintain this face in an upward facing orientation throughout the course of the testing unless otherwise noted. Re-mark the surface whenever it is removed by sandblasting or other procedures.

7.2.6 Demold the specimens at the age of 24 +/- 2 hours and store samples in moist curing room in accordance with ASTM C511. The specimens may be kept in storage for a maximum of 182 days before starting testing. Do not coat any samples until after a minimum of 28 days of moist curing, unless evaluating the effect of the concrete coating or sealer on new concrete.

7.2.7 Identify each test specimen with its batch. Prior to use, weigh, number, and label each test specimen for future identification. Label in a manner that does not affect the water absorption or the accuracy of the weighing.

7.2.8 Fabricated test specimens shall be from a single batch of concrete for each unique concrete coating and sealer tested.

7.3 Total moisture content and baseline chloride content:

7.3.1 After 28 days of wet cure and prior to use of test specimens for testing; select 3 cubes from the curing chamber for determination of the total moisture content and baseline chloride content of each unique batch of concrete. Determine the saturated surface-dry weight (Wssd) by drying the surfaces with a towel and weighing to the nearest 0.1 g. Oven dry the test specimens at 110ºC ± 3ºC until they reach constant weight (Wod), defined as the weight achieved with less than 0.5% change in 24 hours. Calculate the total moisture capacity (Mssd) in percent by weight as follows:

7.3.1.1 *Mssd = ((Wssd - Wod)/Wod) x 100% by weight*

7.3.2 Split the oven-dried cubes in half in accordance with ASTM C496. Take one half of the split cube and pulverize by crushing and grinding to a powder. All crushing shall be done dry (i.e., without water). All material shall pass a 0.300-mm (No. 50) sieve. All pulverizing tools and sieves shall be washed with alcohol or distilled water and shall be dry before use with each sample. Test this half of the split cube for acid-soluble chloride content in accordance with AASHTO T260; this is the baseline chloride content for the concrete.

7.3.3 Chloride testing can be performed later in conjunction with chloride penetration testing on treated cubes. The oven-dried cubes should be stored in sealed plastic bags if testing is to be delayed.

7.3.4 Report the mean total moisture content and baseline chloride content for each test specimen batch.

7.4 Test panel preparation:

7.4.1 A minimum of three replicate test specimens shall be prepared to be coated for each coating or sealer system for each test. Three replicate test specimens shall be prepared and tested uncoated with each submitted coating or sealer system for Chloride Ion Penetration and Moisture Vapor Transmission testing.

7.4.2 After conditioning and immediately prior to coating, prepare the test specimens using a mineral or slag abrasive qualified to SSPC-AB1. The abrasive shall not contain detected oil when tested in accordance with ASTM D7393. The abrasive shall have a maximum conductivity of 150 µS/cm when determined in accordance with ASTM D4940. The abrasive shall have a maximum chloride content of 15 ppm when determined using an ion-specific electrode, using the extraction procedure specified in ASTM D4940. Lightly blast the specimens on all surfaces to remove all loose and friable material. The surface shall be clean, sharp, and free of embedded friable material, with adequate roughness to facilitate effective adhesion of the applied primer. Blow-off the samples with clean, dry air to remove residual abrasive media and dust prior to weighing. Morphology of the prepared surfaces shall be measured in accordance with ASTM D7127.

7.4.3 Adjust the moisture content of the test specimens immediately prior to coating and sealer application to achieve a moisture condition representing 50 ± 2% of the respective mean total moisture content for larger test specimens and 70 ± 2% for cubes. The method used to provide appropriately conditioned specimens must be documented by the test facility and provided to the Technical Committee Chairman for approval as a Standard Operating Procedure prior to the testing of systems.

7.4.4 Remove the required number of test specimens from the curing chamber, towel dry, and determine the saturated surface-dry weight (Wssd1) of each. Dry test panels and cubes in a conditioning chamber at 50 ± 5% Relative Humidity and 25 ± 3ºC until the estimated oven- dry weight (Wod1) is achieved for each test specimen and cube. Calculate the estimated oven- dry weight using the following formula:

7.4.4.1 *Wod1 = Wssd1/(1+(Mssd-m / 100), where Mssd-m = the mean of the total moisture content for each sample type as determined in Total Moisture Content.*

8. TESTING PROTOCOL

8.1 Concrete coating and sealer application procedure:

8.1.1 Each concrete coating and sealer shall be applied in accordance with the manufacturer's application instructions to all sides of the selected test specimens, unless otherwise specified. Concrete sealers shall be applied in accordance with AASHTO TP96. All concrete coatings shall be applied using proper airless equipment except when this method is specifically not allowed by the manufacturer. All coatings shall be applied to test specimens mounted vertically at a distance described in the manufacturer's recommendations (typically 18-21 inches) from the tip of the spray gun. The equipment shall be able to develop sufficient pressure to properly atomize the coating. The orifice size, application pressure, pump type and ratio, hose size and length, and any atypical application requirements shall be recorded. If the pressure used varies by more than 10 percent from the suggested pressure listed in the manufacturer's recommendations, the actual pressure used and a statement explaining the deviation shall be provided. Each coating shall be applied within the dry film thickness (DFT) range recommended by the manufacturer. Coatings must be applied to the specimens at the minimum (laboratory) recoat window. DFT shall be taken in accordance with ASTM D6132. Curing of the coated complete systems specimens shall be a minimum of 30 days and no more than 45 days at 25 +/- 2ºC and 50 +/- 5 percent relative humidity. Coated and sealed cubes shall be cured 24 +/- 2 hours at 25 +/- 2ºC and 50 +/- 5 percent relative humidity. Edges of test specimens shall be stripe coated by either roller, brush or spray to ensure proper build on test specimen edges.

8.1.2 Each sample shall be marked and identified by a NTPEP-assigned code number. The identification code number shall be placed on the back of each specimen with a permanent mark that will not adversely affect the specimen or testing to be performed. It will also be typed and placed in front of the corresponding specimen when photographs are taken. The code number will have a minimum height of 10 mm and will also identify the following information: test performed, specimen number, date of application to the specimen, date of test evaluation performed.

8.1.3 Color digital photographs shall be taken of each specimen with the NTPEP-assigned code number for each coating and sealer applied and tested. All photographs shall have a resolution of 6 megapixels or better. Photographs shall be taken with the appropriate illumination and focus to clearly show the critical performance features on each specimen.

8.2 Concrete coatings and sealers physical testing protocol:

Concrete Sealers

Test	Specimen	Number of Tests	Duration
Moisture Vapor Transmission (MVT)	Cubes	3 Treated/3 Untreated	0, 7 and 14 Days
Waterproofing Performance	Cubes	Same 6 cubes as MVT	7 Days
Chloride Penetration	Cubes	Same 6 cubes as MVT	14 and 21 Days
Depth of Penetration	Cubes	Same 6 cubes as MVT	Post Cube Split
Coating Thickness	Cubes	Same 6 cubes as MVT	Post Cube Split
Coating Bond Strength	Concrete Slab	1Treated Slab tested 3 times	After Final Cure
Skid Resistance	Concrete Slab	1 Treated, 1 Untreated	After Final Cure

Time to Cure (Coating)	Cubes	4 – 2 at Each Temperature	Initial Cure, Final Cure Time
Drying Time (Penetrating)	Cubes	4 – 2 at Each Temperature	Initial Dry, Final Dry Time
Freeze Thaw Resistance	Freeze Thaw Prism	3 Treated/3 Untreated	100, 200, 300 Cycles

Concrete Coatings

Test	**Specimen**	**Number of Tests**	**Duration**
Moisture Vapor Transmission (MVT)/Permeance	Cubes	3 per Coating* 3 per Complete System 3 Uncoated Control	0, 7 and 14 Days
Waterproofing Performance	Cubes	Same 9 Cubes as MVT	7 Days
Chloride Penetration	Cubes	Same 9 Cubes as MVT	14 and 21 Days
Coating Thickness	Cubes	Same 9 Cubes as MVT	Post cure/dry time
Drying Time and Time to Cure (Coating)	Cubes	4 – 2 at Each Temperature	Until Complete
Adhesion Testing	Concrete Slab	3 per Coating* 3 per Complete System	14 days after application
Immersion Testing	Concrete Slab	3 per Coating* 3 per Complete System 1 Uncoated Control	Immerse 14 Days After Application, Check at 7, 14, 21 and 28 days
Freeze Thaw Testing Adhesion Post F/T	Freeze Thaw Prism	3 per Coating* 3 per Complete System 3 Uncoated Control	Procedure A for 300 cycles/Adhesion testing at 50, 150 and 300 cycles
UV Resistance	Concrete Slab Cut to ¾ inch thick	3 per Coating* 3 per Complete System	Cycle 2 for 2500 Hours, Check at 500 Hour Intervals.

* The testing of the individual coatings of a system should only be tested if they are intended for use independent of the complete system.