Project Work Plan for

NTPEP Laboratory Evaluation of Detectable Warning Systems

NTPEP Designation: DWS-17-01

American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001
NTPEP Committee Work Plan for

**Evaluation of Laboratory Evaluation of Detectable Warning Systems**

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**SUMMARY**

The American Association of State Highway and Transportation Officials (AASHTO) hosts a nationally recognized testing program called National Transportation Product Evaluation Program (NTPEP). NTPEP is a voluntary program whereby manufacturers may submit their products for a coordinated group evaluation. Individual manufacturers/suppliers are assessed a testing fee that covers costs for actual laboratory testing and/or field evaluation by either state highway agencies or approved testing labs. The Detectable Warning Systems (DWS) program operates with capabilities of AASHTO member departments. A portion of the testing fee is used for publishing and distributing NTPEP Reports to AASHTO member departments. NTPEP Reports are available to the general public through the AASHTO Bookstore. These DWS test reports will be made available in electronic format.

This document is furnished for the benefit of manufacturers/suppliers wishing to submit their products, which are classified as Detectable Warning Systems (DWS). The testing format has been established to provide the end user with test results which can be used to make performance judgements on DWS for long environmental exposures. The testing format for this standard has been developed around concrete panels, polymer panels, composite panels and metal panels, however DWS are not required to meet any specific compositional requirements for submission and testing in this program. Manufacturers’ are encouraged to submit products that they believe will perform well and meet the demands of the DWS industry.

This work plan defines the evaluation procedures for DWS which will serve as the standard testing protocol for AASHTO’s National Transportation Product Evaluation Program.

Private testing laboratories approved by AASHTO/NTPEP shall perform the laboratory testing and field evaluations. The laboratory may be a state highway or an independent laboratory.

AASHTO/NTPEP testing programs do not provide pass/fail acceptance criteria. AASHTO/NTPEP testing evaluation reports will not indicate pass/fail.
1. **SCOPE**

1.1 This standard practice covers the requirements and testing criteria for the National Transportation Product Evaluation Program (NTPEP) evaluation of detectable warning systems. The National Transportation Product Evaluation Program (NTPEP) serves the member departments of the American Association of State Highway and Transportation Officials (AASHTO).

1.2 The results of this program may be used for product quality verification by individual member Departments. If used for quality verification, a letter of certification from the detectable warning systems (DWSs) manufacturer indicating testing was conducted by NTPEP that supports published values may be required by member Departments.

2. **REFERENCED DOCUMENTS**

2.1 AASHTO M 333 - Standard Specifications for Detectable Warning Surfaces
2.2 AASHTO TP 103-13 - Standard Method of Test for Detectable Warning Systems
2.3 Florida Department of Transportation Specifications: Section 527- Detectable Warnings on Walking Surfaces, pp. 598-600.
2.5 2010 ADA Standards for Accessible Design. “Section 705 Detectable Warnings,” Department of Justice, September 2010.
2.6 ADA Accessibility Guidelines – Appendix A4.29.2 “Detectable Warnings on Walking Surfaces”.
2.7 Nevada Department of Transportation Specifications Division - Standards and Manuals Section- “Detectable Warnings”. Sept. 2006.
2.8 TRB’s National Cooperative Highway Research Program (NCHRP) Report 670: Recommended Procedures for Testing and Evaluating Detectable Warning Systems
2.10 ACI 503 R, “Use of Epoxy Compounds with Concrete”
2.14 ASTM C 125, “Standard Terminology Relating to Concrete and Concrete Aggregates”
2.15 ASTM C 293/C 293M, “Standard Test Method for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading)”
2.18 ASTM C 496/C 496M, “Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens”
2.24 ASTM C 936/C 936M, “Standard Specification for Solid Concrete Interlocking Paving Units”
2.25 ASTM C 947, “Standard Test Method for Flexural Properties of Thin-Section Glass-Fiber-Reinforced Concrete (Using Simple Beam With Third-Point Loading)”
2.29 ASTM C 1583/C 1583M, “Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)”
3. SIGNIFICANCE AND USE

3.1 This standard practice utilizes laboratory testing to determine properties and evaluate the performance of detectable warning systems. This practice is intended to only determine the properties of detectable warning systems. Acceptability of each material based upon the data generated as a result of the testing and evaluation in this practice is the responsibility of the user.

4. FORM SUBMITTAL, SCHEDULING OF TESTING AND SAMPLING

4.1 Submittal of Product Evaluation Form(s) and Acceptance of Products for Testing

4.1.1 The manufacturer will submit program payment and a Product Evaluation Form (PEF) for each product planned for NTPEP testing to the NTPEP Manager. After review of the PEF(s) for completeness and accuracy, the NTPEP Manager shall advise the manufacturer/supplier within two weeks of receipt of the PEF as to the approval of the products to be tested. A test number shall be assigned to each. The test number shall indicate the year and month of submission, and a sequential sample number. (i.e., DWS-2016-01-001 (Year-Submission Cycle-Sample No.) DWS – Detectable Warning System).

Note 1 — Detectable Warning System (DWS) numbers that are assigned to a Manufacturer’s product will not change for the life of the test. The Product Name that the manufacturer gives the product at the time of application will be allowed to change until the first monthly report is issued to the vendors for review. Once this report is submitted to the vendor for review, no changes to the product name will be allowed.

4.2 Scheduling of Testing and Product Submittal

4.2.1 All complete PEFs and fees must be received from the manufacturer/supplier prior to sampling taking place. After payment, the manufacturer/supplier shall work with the NTPEP Lead State Member to schedule testing.

4.2.2 The lead state contact person will make arrangements to have the products sampled. DWS product sampling shall be performed by the manufacturer, with sampling witnessed by the testing agency or their representative. The manufacturer/supplier shall attach product/material literature and material data safety sheets to the PEF. All collected samples shall be labeled to show the manufacturer’s product code, manufacturer and type of material and shall be shipped by and at the manufacturer’s expense via a carrier with a freight tracking system. Samples shall be shipped to the NTPEP testing laboratory. Samples shall be labeled by the manufacturer with the testing center’s reference number. The labeling shall be witnessed by the testing agency or their representative. The manufacturer will then be responsible for transportation of the samples to the appropriate testing facility.

Note 2 — Product Submittal Deadlines - Product Evaluation Forms (PEF) shall be submitted to NTPEP on the fifteenth day of January, April, July, and/or October.
5. TESTING CRITERIA

5.1 Manufacturers shall provide the following
   a) Product Evaluation Form (PEF) for each product
   b) Detailed Installation instructions
   c) Color, Federal Number
   d) Identify Installation method
      (i) Wet or Dry
      (ii) Surface Mount or Ground Mount
   e) Identify Product Material Category
      (i) Concrete Pavers
      (ii) Concrete Tiles or Panels
      (iii) Polymer Concrete Tiles and Panels
      (iv) Composite Tiles, Vitrified Polymer Panels
      (v) Metal Panels
   f) Detailed Diagram of Dimensional Characteristics and Dimensions of Product
   g) Identify color integration
      (i) Surface
      (ii) Integral
   h) Identify if dome is formed integral with body
   i) Identify additional materials required for installation
      (i) Grout
      (ii) Epoxy
      (iii) Anchors

5.2 Domes and Spacing Dimensional Testing
   All measurements as defined in item 5.1 (f) shall be reported for Product Dimensions, Dome Size, Dome Spacing, and Panel or Paver Length, Width, and Thickness and shall be measured accurately within +0.01 inches (+0.1 millimeter, mm) as the dimensions reported by the manufacturer in item 5.1 (f) and in accordance with 2010 ADA Standards for Accessible Design. “Section 705 Detectable Warnings.”

5.3 Material Testing

Definitions:

1) Concrete Pavers: Products that meet or exceed the requirements established in ASTM C 936, Standard Specifications for Solid Interlocking Concrete Paving Units.
2) Concrete Tiles and Panels: Products that use a modified Portland cement based binder (non-polymeric) and fine aggregates in addition to other additives such as polymers and fibers.
3) Polymer Concrete Tiles and Panels: Products that use a polymeric based binder and fine aggregates.
4) Composite Tiles, Vitrified Polymer Panels: Products that use metallic plates with coatings.
5) Metal: Metallic products made of cast iron and stainless steel.
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<td>5.2, pass/fail</td>
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<td>Water Absorption</td>
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<td>ASTMD570, %</td>
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<td>Resistance to a minimum of 50 freeze-thaw cycles</td>
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<td>ASTM C666 % material loss, % relative dynamic modulus elasticity loss</td>
<td>ASTMC666 % material loss, % relative dynamic modulus elasticity loss</td>
<td>ASTMC1026% material loss, % relative dynamic modulus elasticity loss</td>
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<td>Abrasion resistance tests</td>
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<td>ASTM C418, psi</td>
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<td>ASTMD 2486, Average Volume loss inch³/cm³; Average thickness loss inch (mm)</td>
<td>ASTMD 2486, Average Volume loss inch³/cm³; Average thickness loss inch (mm)</td>
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<td>Anchor Adhesion Bond Strength</td>
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<td>ASTM C482, psi</td>
<td>ASTMC482, psi</td>
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Note: Pass/fail indicates the test results are considered pass or fail, depending on the specified criteria.
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<td>Average Slip Resistance, Wet and Dry</td>
<td>Appendix C: Test for Static Coefficient of Friction of ADA Warning Surface Materials by Horizontal Dynamometer Pull-Meter, Static Coefficient of Friction</td>
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<td>Appendix C: Test for Static Coefficient of Friction of ADA Warning Surface Materials by Horizontal Dynamometer Pull-Meter, Static Coefficient of Friction</td>
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<td>Impact Strength of body</td>
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<td>Average Splitting Tensile Strength</td>
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<td>ASTM C496 or C1006, psi</td>
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<td>Average Tensile Strength</td>
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<td>ASTM D638, psi</td>
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<td>Light Reflectance value (LRV)</td>
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<tr>
<td>Color Change ΔE on the panel when weathered for 2000 hours with UV light, with spray and condensation in the cycles</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>ASTM G155*, ASTM D1037,</td>
<td>ASTM G155, if it has coating.</td>
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<tr>
<td>Exposure to Salt Spray for 200 hours</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>ASTM B117, % weight loss and visual inspection</td>
<td>ASTM B117, % weight loss and visual inspection</td>
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<tr>
<td>Exposure to Chemicals Antifreeze, motor oil, gas, diesel</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>ASTM D543, visual inspection</td>
<td>ASTM D543, visual inspection</td>
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<td>Wear Resistance</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>ASTM C501, wear index</td>
<td>ASTM C501, wear index</td>
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* Spectrophotometer is used to measure the LRV using CIE Tristimulus Y, Illuminant D65 (natural daylight) and the 10° colorimetric observer. When product is available in multiple colors, Manufacturer may request additional color testing for an additional fee.

6. TEST REPORT REVIEW AND TEST RESULT APPEALS

6.1 The testing agency shall submit a draft report to the lead state contact person and the NTPEP Manager within 20 business days after completion of all testing. Each submitting organization shall receive a copy of the portion of the report dealing with their specific products. The submitting organization may appeal the results of the testing program in accordance with the AASHTO/NTPEP appeals procedures. Re-testing of the materials will be performed by the testing agency, and only on the relevant sample forwarded for testing. No additional sample material will be received for re-testing. Prior to re-test, the manufacturer/supplier making the appeal shall submit a fee to NTPEP to cover the costs of re-testing. Should the results of the re-test up-hold the appeal, the fee shall be reimbursed to the submitting organization. Upon agreement between the organization appealing the test results and the NTPEP Manager, either the original set or re-test set of data shall be published.

7. REPORTING OF TEST DATA

7.1 Evaluation data will be compiled and made available to all participating states and testing companies through the AASHTO/NTPEP DataMine. This report will include data only. No judgment as to a product’s acceptability will be made in this report. End user participants will establish individual criteria for product acceptability.

8. TESTING FREQUENCY

8.1 Following the initial testing of a product, it must be re-tested on an every-five-year cycle to remain published in the test report.
9. TESTING FEES

9.1 Testing fees are to be paid at time of application.

**Note 3** — A re-test fee for challenged results shall be paid by the manufacturer. This fee is refundable if retesting upholds the challenge. Fee is to be paid only if test results are challenged.
APPENDICES

APPENDIX A

Test for Bond Strength of Adhesives Used in Retrofit ADA Warning Surface Materials by Direct Tension (Pull-Off)

A1 Scope

A1.1 This test method is suitable for both field and laboratory use to determine bond strength of adhesives used in retrofit Detectable Warning Surface Systems in compliance with the Americans with Disabilities Act (ADA).
A1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.
A1.3 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

A2 Terminology

A2.1 For definitions of terms used in this test method refer to Terminology ASTM C 125 and ACI 503R.
A2.2 Mat Material – Any material used in the manufacture of Detectable Warning Surface System.

A3 Summary of Test Method

A3.1 This test is performed on the surface of a mat material after the mat has been bonded to a concrete surface.
A3.2 A dolly is bonded to the top surface of the mat. The test sample is formed by drilling a shallow core around the dolly, through the mat material, into and perpendicular to the surface of the concrete leaving the intact core attached.
A3.3 A tensile load is applied to the dolly until failure occurs. The failure load and the failure mode are recorded and the nominal tensile stress at failure is calculated.

A4 Significance and Use

A4.1 This test method determines the tensile strength of adhesives used to bond mat materials to concrete surfaces.
A4.2 When the test is performed on the surface of the mat material, it determines the mat materials tensile strength, mat to adhesive bond strength, adhesive to concrete bond strength or the tensile strength of the concrete, whichever is weaker.
When the test is performed on the surface of a material applied to the concrete, the measured strength is controlled by the failure mechanism requiring the least stress. Thus it is not possible to know beforehand which strength will be measured by the test. For this reason, the failure mode has to be reported for each individual test result, and test results are averaged only if the same failure mode occurs.

### A5 Apparatus

#### A5.1 Core Drill Motor, of sufficient torque to drill through mat materials and adhesives for preparing test sample.

#### A5.2 Core Barrel/ Hole Saw, with either a diamond impregnated or tungsten carbide grit bit typically 30.0mm [1.18 in.] inside diameter for a 35 mm [1.38 in.] outside diameter.

*Note 1 — It is also advantageous to use a carbide tipped hole saw typically 32 mm [1.26 in.] inside diameter for a 35 mm [1.38 in.] outside diameter on soft mat materials.*

#### A5.3 Dollies, outside diameter 0.08 inches less than the diameter of the core barrel and thick enough to transfer the load without deformation. The dolly is configured to receive the coupling device of the tensile loading device.

#### A5.4 Tensile Loading Device (Bond Tester), with a load-indicating system and nominal capacity of 22 kN (5,000 lbf) and capable of applying load at a constant rate. The loading device includes a tripod or bearing ring for distributing the force to the supporting surface.

*Note 2 — See ASTM C’900 for suitable verification schemes.*

#### A5.4.1 Within the operating range, the indicated tensile force shall be within +/-2 % of the force measured by a calibrated testing machine or load cell. Verify the tensile loading device at least once a year and after repairs and adjustments.

#### A5.4.2 A coupling device shall be used to connect the dolly to the tensile loading device. The coupling device shall be designed to withstand the tensile load capacity without yielding, and to transmit the tensile force parallel to and in line with the axis of the cylindrical test sample without imparting torsion or bending to the test sample.

### A6 Materials

#### A6.1 Epoxy adhesive material for bonding the dolly to the test sample, shall be a fast-curing paste or gel meeting the requirements of ASTM C 881/C 881M for Type IV, Grade 3, except that a shorter gel time is permitted.

*Note 3 — PermaPoxy 5 minute Epoxy (3400 psi) as manufactured by Permatex or Super Glue as manufactured by Loctite, both have been found to be sufficient bonding agents.*

#### A6.2 Concrete test sample blocks for mounting mat material test sections shall be at least 12 in. x 12 in. x 2 in. (3048 mm x 3048 mm x 51 mm). Testing blocks for this procedure may be obtained from typical Home Improvement Stores (i.e., Lowe’s, Home Depot) or from Concrete Precast Supply Companies, and are sold as patio blocks. Randomly select three test blocks to perform tensile tests. Perform three pull off tests per block, then average the test results. The resulting average of all tests shall be a minimum of 250 psi with no one test result below 200 psi.
A7  Sampling

A7.1 Select three qualified concrete blocks (per 6.2) to apply mat materials.
A7.2 Five individual test results shall be obtained from each of three prepared test sample blocks with no one result falling below the specified minimum. If a result falls below the specified minimum in mode (a), (c), or (d) as described in Section 10.4, retest.
A7.3 Locate test sites in the flat areas between the truncated domes such that the domes do not interfere with the test site or leveling device of the bond tester.
   Note 4 — Pre-positioning of the bond tester leveling device, prior to marking the test sites will aid in determining the test sites.
A7.4 The center-to-center distance of adjacent test sites shall be at least two dolly diameters. The distance from the center of a test site and a free edge of the test block shall be at least one dolly diameter. A test site may not be placed near a manufactured edge such that it would incorporate a beveled edge.

A8  Preparation of Test Surfaces

A8.1 Preparation of Concrete Test Sample Block
A8.1.1 Remove all surface contaminants including loose materials and dust to obtain a clean dry surface on the concrete sample test block.
A8.2 Preparation of Test Dolly
A8.2.1 The testing surface of the dolly must be cleaned of all foreign debris and lightly sanded using 100 grit sand paper in a cross-hatch pattern to ensure bonding characteristic. Immediately before use, the dolly shall be wiped clean with alcohol using a soft cloth.
A8.3 Preparation of Mat Material Test Sample
A8.3.1 Any texture in the test area must be removed to provide a flat surface for bonding of the dollies and shall be cleaned of any contaminants that would interfere with bonding.

A9  Preparation of Test Sample

A9.1 Attach mat material to the concrete block following manufacturer’s suggested application procedures. Allow curing of the adhesive as directed by the manufacturer’s instructions.
A9.2 Ensure that the dolly is positioned in a flat area of the mat between the truncated domes in such a way that the domes do not interfere with the leveling device. Attach the dolly to the top of the mat using the epoxy adhesive. Cure the epoxy adhesive following manufacturer’s instructions.
   Note 5 — ACI 503R provides guidance on applying and curing epoxy.
A9.3 Using the coring equipment, drill through the test mat material into and perpendicular to the concrete surface to ensure isolation of the mat material adhesive from the surrounding concrete. It is important to maintain perpendicularity while drilling over the dolly in order to not affect any adhesive bonds.

A10  Test Procedure

A10.1 Attach the tensile loading device to the dolly using the coupling device.
A10.2 Apply the tensile load to the test sample so that the force is parallel to and coincident with the axis of the sample.
A10.3 Apply and maintain the tensile load at a constant rate throughout the test.
A10.4 Record the failure load and the failure mode. Record the failure mode as:
   (a) in the concrete
   (b) at the interface between the concrete and the mat material
i) concrete and mat adhesive
ii) within the mat adhesive
iii) mat adhesive and mat material
(c) in the mat material
(d) at the bond between the mat material and the dolly.

A10.5 Calculate the tensile strength by dividing the tensile load at failure by the area of the test dolly:
\[
\text{Tensile Strength (psi [MPa])} = \frac{\text{Tensile load (lbf [N])}}{\text{Area of test dolly (in}^2 \text{[mm}^2\text{])}}
\]

A10.6 Record the individual strengths to the nearest 1 psi [0.01 MPa].

A11 Report

A11.1 The test report shall contain the following:
(a) Identification of all materials used.
(b) The failure mode for each test.
(c) The strength for each test.
APPENDIX B

Test for Bond Strength of Adhesives Used in Retrofit ADA Warning Surface Materials by Direct Tension (Pull-Off) after Sample Conditioning for Freeze/Thaw Durability

B1 Scope

B1.1 This method exposes detectable warning systems that have been cast into or applied to concrete to repetitive cycles of freezing and thawing temperatures and measuring the resulting bond strength. Freezing and thawing is carried out with the samples fully submerged in a sodium chloride solution.

B2 Test Samples

B2.1 Test samples prepared in accordance with Appendix A are required.

B3 Apparatus

B3.1 A chamber that is capable of maintaining sufficiently low temperatures to freeze the deicer salt solution. If a constant-temperature freezer is used, the samples can be removed and allowed to thaw at room temperature. A thermal cycling chamber capable of both freezing and thawing the sodium chloride solution may also be used.

B3.2 Containers, fabricated out of a corrosion-resistant material, such as plastic or stainless steel, and strong enough to support the samples submerged in sodium chloride solution. The containers may also be made out of wood with a watertight liner made of rubber or other material.

B3.2.1 The containers should be sized to fit the length and width of the samples with little additional room to reduce the amount of solution that must occupy that space. The depth of the container should be at least 2 cm (0.75 in.) higher than the tops of the domes to accommodate the solution on top of the sample.

NOTE 1 — For 86 cm by 86 cm by 10 cm (34 in. by 34 in. by 4 in.) samples, containers with interior dimensions of 90 cm by 90 cm by no less than 12 cm (35.4 in. by 35.4 in. by 4.75 in.) are suitable.

B3.2.2 The containers should be fitted with lids of a corrosion-resistant material.

B3.3 Thermocouples and a thermocouple logger, if desired, to monitor the temperature of the solution and the samples. While useful for tracking test performance, the use of thermocouples is optional. Note that if used, thermocouples will generally need to be installed in the concrete samples when originally fabricated.

B4 Reagents

B4.1 Deicer salt solution (3% sodium chloride solution)

B4.2 Reagent water

B4.3 Sodium chloride, 99% or higher purity
NOTE 2 — If desired, an alternate deicer solution, which will cause scaling on susceptible concrete may be substituted for the 3% sodium chloride solution.

B5 Procedure

B5.1 The samples should be placed in the containers with the detectable warning system side up.

B5.1.1 If a watertight liner is used, make sure the liner is in place and damage-free prior to inserting the sample.

B5.2 Fill the sample containers with solution until the level of the liquid is above the tops of the domes. Additional solution may be added, but will increase the freezing and thawing time of the samples.

NOTE 3 — Check the sample containers for leaks while adding solution. If leaks are apparent, repair as appropriate. Place lids on the containers to reduce evaporation of the solution once the solution is at the appropriate level.

NOTE 4 — Solution may be added prior to placing the samples in the freezing chamber, or after the samples are in the chamber. If adding solution after placing the samples in the freezing chamber, check for leaks first to avoid having to remove samples if leaks become apparent upon filling the containers with solution.

B5.3 Place the samples in the freezing chamber, ensuring that enough room is left above the sample to view and access the solution in order to confirm that freezing and thawing is taking place. Adjust the temperature and duration of the freezing cycle to produce complete freezing of the solution in all samples. Do not cool the air temperature in the chamber below -23ºC (-10°F).

B5.3.1 Ensure the test solution is completely frozen for at least 30 minutes during each freezing cycle. Confirm freezing of solution on all samples by visually and tactilely monitoring the solution or by remote monitoring of thermocouples placed in the solution.

B5.4 Adjust the temperature and duration of the thawing cycle to confirm complete thawing of the solution in all samples. Do not heat the air temperature in the chamber above 29ºC (85°F).

B5.4.1 Ensure the test solution is completely thawed for a minimum of 30 minutes. Confirm thawing of solution on all samples by visually and tactilely monitoring the solution or by remote monitoring of thermocouples placed in the solution.

B5.5 Periodically monitor the solution level and ensure that the tops of the domes remain submerged in 3% sodium chloride solution.

NOTE 5 — If the solution level has decreased, ascertain if the level has dropped because of evaporation or a leak. If the cause of liquid level drop is a leak, fill the sample containers with 3% sodium chloride solution to cover the tops of the domes. If the cause of the liquid level drop is evaporation, fill the sample containers with reagent water to cover the tops of the domes.

B5.6 The length of a complete freeze-thaw cycle shall be no less than 6 hours.

B5.7 Cycle the samples for 50 cycles.
B5.8 Repeat Bond Strength Testing after completion of the 50 cycles of freeze and thaw in accordance with Appendix A.

B6 Report

B6.1 The report shall include the following:

B6.1.1 The sample identification assigned according with Appendix A.

B6.1.2 Type, manufacturer, and, if known, lot number of the detectable warning system(s) tested.

B6.1.3 Air temperatures achieved in the freezing and/or thawing chambers.

B6.1.4 The duration of complete freeze and thaw and the method by which freezing and thawing was confirmed.

B6.1.5 The number of cycles.

B6.1.6 The failure mode for each test in accordance with Appendix A.

B6.1.7 The strength for each test in accordance with Appendix A.

B6.1.8 Any deviation from the procedures outlined in this method, such as if an alternative salt was used to produce the solution.
APPENDIX C

Test for Static Coefficient of Friction of ADA Warning Surface Materials by Horizontal Dynamometer Pull-Meter

C1 Scope

C1.1 This test method covers the measurement of static coefficient of friction of ceramic tile or other surfaces under both wet and dry conditions while utilizing Neolite® or an approved equal heel assemblies.

C2 Apparatus

C2.1 Dynamometer Pull Meter, horizontal capable of measuring 100 lbs.-force (lbf.), accurate to 0.1 lbf. and capable of holding the peak value.

C2.2 Weight, 25-lb (11-kg). Weight shall be either cylindrical (approximately 6 in. in diameter and approximately 4 in. tall) or of rectangular dimensions with the base measuring approximately 4 by 6 in.

Figure 2. Neolite® or approved equal Sled Assembly.
C2.3 Adjustable Neolite® or approved equal Sled Assemblies, two, one to be used for each of the wet and dry conditions.

C2.3.1 Two assemblies, constructed from 8 by 8 by 3/4 in. 6061-T6 aluminum plate or similar material, with two adjustable skids (runners) measuring 3/4 in. by 6 in. of sufficient height to clear the domes. The skids need to be adjustable to permit testing between as well as on top of the domes. The 1/8-in. thick Neolite® or approved equal material attached to the adjustable skids with contact adhesive. An example of a Neolite® or approved equal Sled Assembly is shown in Figure 2. Remove sheen from the Neolite® or approved equal surface prior to use. To prepare the assembly surface prior to initial use:

C2.3.1.1 Remove sheen from the Neolite® or approved equal surface prior to initial use. Place a sheet of 400 grit wet or dry silicon carbide paper (attached to a flat surface, such as a piece of float glass) on a flat and stable surface and sand Neolite® or approved equal material by moving the assembly once across the sandpaper towards the operator for a distance of about 4 in. (102 mm) while applying between 15-20 lbs-force to the assembly.

C2.3.1.2 Remove the sled assembly and brush off any accumulated dust from the silicon carbide paper and sled assembly using a dry brush; brush to be such that it effectively removes the dust but causes no damage to the silicon carbide paper or the Neolite® or approved equal on the sled assembly.

C2.3.1.3 Rotate the sled 90° (clockwise) and sand the Neolite® or approved equal again with the same procedure (one single pull towards the operator followed by removing the dust is considered one stroke).

C2.3.2 Repeat sanding in this fashion (rotating the sled assembly by 90°, clockwise, and brushing off the dust each time between strokes) for a total of eight (8) strokes. Eight strokes equals one (1) resurfacing cycle. Continue sanding the Neolite or approved equal until all the sheen (glossy surface produced during the manufacturing process) is removed, usually no more than 500 strokes.

C2.4 Standard Tile. Standard tiles were manufactured under controlled conditions, assigned a unique identifying number and are available from the Tile Council of North America.

C3 Materials

C3.1 Silicon Carbide Paper, wet or dry, 400 grit.

C3.2 Renovator,

C3.3 Neolite®, Standard Neolite® Cement Liner or approved equal.
C3.4  Rags, Sponge, or Paper Towels.

C3.5  Water, distilled.

C4  Calibration (Dry)

C4.1  Because many variables are associated with this test procedure, it is important that the operator calibrates the Neolite® or approved equal Heel Assembly surface with the Standard Tile each time the test is performed.

C4.2  Use a clean soft paper towel to remove any remaining dust or debris from the surface of the Neolite® or approved equal test pads before calibrating. For uses other than the initial use, resurface the assembly with 400 grit wet or dry silicon carbide paper, four cycles.

C4.3  Determine the total weight, W, of the 25-lb (11-kg) weight plus the Neolite® or approved equal Heel Assembly.

C4.4  Clean the Standard Tile with a renovator.

C4.5  Place the Neolite® or approved equal Heel Assembly and the 25-lb (11-kg) weight on the Standard Tile surface. Using a dynamometer, determine the force required to set the test assembly in motion.

C4.6  Record the highest reading.

C4.7  Make a total of four pulls, each perpendicular to the previous pull.

C4.8  Calculate the dry calibration factor as follows:

\[ X_D = 0.86 - \left( \frac{R_D}{N \times W} \right) \]

where:
X_D = dry calibration factor,
R_D = sum of the four recorded dry force readings, lb (kg),
N = number of pulls (4), and
W = weight of heel assembly plus 25-lb (11-kg) weight, lb (kg).

NOTE 1—The 0.86 factor is the static coefficient of friction value as determined by the Tile Council of North America for the standard tile (see 2.4).

C5  Test Procedure (Dry)

C5.1  Test the following surfaces:

C5.1.1  The test area or separate test samples shall not be less than 4 by 4 in. (102 by 102 mm).
C5.1.2 Test the surface in the as-received condition.

C5.2 Place the 25-lb (11-kg) weight assembly with Neolite material attached on the test surface. Using a dynamometer, determine the force required to set the test assembly in motion.

C5.3 Record the highest reading.

C5.4 Before placing 25-lb (11-kg) weight on the Neolite Sled Assembly, insure that the force gauge is horizontally and vertically centered with the Neolite Sled Assembly and stabilized to minimize any off-center (horizontal/vertical axis) forces once sled is put into motion.

C5.5 Four pulls perpendicular to the previous pull on each of three surface areas or three test samples constitute the twelve necessary readings to calculate the static coefficient of friction.

C5.6 Under no conditions should additional tiles be tested without performing a new calibration.

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C6 Calibration (Wet)

C6.1 Immerse the Neolite portion of the sled assembly in water for a minimum of 5 min. after resurfacing the sled in accordance with 4.2.

C6.2 Calibrate the assembly surface each time the test is performed. Repeat the procedure in accordance with 4.2 – 4.5 except saturate the surface with distilled water and repeat the calibration with the surface wet, keeping the surface saturated.

C6.3 Calculate the wet calibration factor as follows:

\[ X_W = 0.51 - \left( \frac{R_W}{N \times W} \right) \]

where:
- \( X_W \) = wet calibration factor,
- \( R_W \) = sum of the four recorded wet force readings, lb (kg),
- \( N \) = number of pulls (4), and
- \( W \) = weight of heel assembly plus 25-lb (11-kg) weight, lb (kg).

*NOTE 2—The 0.51 factor is the static coefficient of friction value as determined by the Tile Council of North America for the standard tile (see 2.4).*

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C7 Test Procedure (Wet)

C7.1 Repeat the procedure in accordance with 6.2.

C7.2 Record all readings.
C8 Calculation

C8.1 Calculate the static coefficient of friction as follows:

Dry:

\[ F_D = \left( \frac{R_D}{N \times W} \right) + X_D \]

Wet:

\[ F_W = \left( \frac{R_W}{N \times W} \right) + X_W \]

where:

- \( F_D \) = static coefficient of friction for dry surface,
- \( F_W \) = static coefficient of friction for wet surface,
- \( R_D \) = sum of the four recorded dry force readings, lb (kg),
- \( R_W \) = sum of the four recorded wet force readings, lb (kg),
- \( N \) = number of pulls (4), and
- \( X_D \) = dry calibration factor,
- \( X_W \) = wet calibration factor,
- \( W \) = weight of heel assembly plus 25-lb (11-kg) weight, lb (kg).

C9 Report

C9.1 Report the following information:

C9.2 Type of tile or surface, and,

C9.3 The individual and average static coefficient of friction for:

C9.3.1 Dry surfaces (both as-received and after cleaning), and,

C9.3.2 Wet surfaces (both as-received and after cleaning).