Project Work Plan for

NTPEP Laboratory Evaluation of Detectable Warning Systems

NTPEP Designation: [DWS-18-01]
NTPEP Committee Work Plan for

Evaluation of Laboratory Evaluation of
Detectable Warning Systems

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 cast-in-place, surface applied-adhesive bonded, surface applied-anchor bonded, and surface applied single domes or arrays. 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/supplier 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 (2015) - Standard Method of Test for Detectable Warning Systems


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/supplier will submit program payment and a Product Evaluation Form (PEF) for each product, and color, 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/supplier’s product will not change for the life of the test. The Product Name that the manufacturer/supplier 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/supplier, with sampling witnessed by the testing agency or their representative. The manufacturer/supplier shall provide all adhesives, anchors and/or other components necessary for installation of the DWS product. The manufacturer/supplier shall attach product/material literature, including installation instructions, and material data safety sheets to the PEF. All collected samples shall be labeled to show the manufacturer/supplier’s product code, manufacturer/supplier 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/supplier with the testing center’s reference number. The labeling shall be witnessed by the testing agency or their representative. The manufacturer/supplier will then be responsible for transportation of the samples to the appropriate testing facility.

4.2.3 When the manufacturer/supplier requires installation by a manufacturer/supplier approved, or certified, installer, the manufacturer/supplier will make arrangements with the lead state contact person to have the product installed at the manufacturer’s expense.

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) Identification of approved or certified installation requirements
d) Identify the number of colors to be tested.
   (i) Identify the Color, Federal Number for each color sample
   (ii) Identify lot or batch numbers for each color sample
e) Identify Product Installation Method
   (i) Cast-in-place
   (ii) Surface applied, adhesive bonded
   (iii) Surface applied, anchor bonded
   (iv) Surface applied single dome or array
   (v) Brick paver or similar
f) Identify Product Material Category
   (i) Concrete
   (ii) Polymer Concrete
   (iii) Polymers and Composites
   (iv) Metal
   (v) Other
g) Detailed Diagram of Dimensional Characteristics and Dimensions of Product
h) Identify color integration
   (i) Surface
(ii) Integral
i) Identify if dome is formed integral with body
j) Identify additional materials required for installation
   (i) Grout
   (ii) Epoxy
   (iii) Anchors
   (iv) Other

5.2 Material Testing

Definitions: Definitions are in accordance with AASHTO TP 103 (2015) Section 3 and as defined in this section.

1) Cast-In-Place: a detectable warning system device that is cast into plastic concrete (wet set) with or without mechanical anchors. DWS can be made of any material.

2) Surface Applied, adhesive bonded: a detectable warning system device that is applied onto the surface of cured concrete with only adhesive. DWS can be made of any material.

3) Surface Applied, anchor bonded: a detectable warning system device that is applied onto the surface of cured concrete with mechanical anchors, may be installed with or without adhesive. DWS can be made of any material.

4) Dome: the truncated dome on the detectable warning system.

5) Field: the space between the domes on the detectable warning system. The field is typically level with the surrounding concrete.

6) Surface-Applied Single Dome or Array: a single truncated dome that is adhered to a concrete substrate or the field as part of an array of separately applied domes composing a detectable warning system. Also, an array of truncated domes that are formed during installation using a stencil or other method. Domes can be made of any material and can be set in wet concrete or on cured concrete, and with or without mechanical anchors.

7) Brick Paver: a paving stone, tile, brick or brick-like piece that is set into a framed space or channel in wet or cured concrete

8) Concrete: Products that use a modified Portland cement based binder (non-polymeric) and fine aggregates in addition to other additives such as polymers and fibers.

9) Polymer Concrete: Products that use a polymeric based binder and fine aggregates.

10) Polymers and Composites: Products that use a polymeric based binder and non-aggregate materials.

11) Metal: Metallic products made of cast iron, stainless steel, or other metal material.

12) Other: Define

The Figure 1 Flowchart for Detectible Warning Systems in AASHTO TP 103 (2015) Section 1 provides a visual graphic of the scope of this work plan modified as follows: delete “(11) Impact – Snowplow” and note the test method changes to Sections (8) Slip Resistance, (10) Impact Resistance, (13) Coating & Single Dome Bond, and (17) UV.
### Tests Required by Type of Detectable Warning System

<table>
<thead>
<tr>
<th>Test Methods Required (Marked with an X)</th>
<th>Detectable Warning System Types</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cast-in-place</td>
<td>Surface applied (adhesive bonded)</td>
</tr>
<tr>
<td>Fabrication of Test Specimens in accordance with AASHTO TP 103 (2015) Section 5</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Visual and Microscopic Evaluation in accordance with AASHTO TP 103 (2015) Section 6</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Domes and Spacing Dimensional Testing in accordance with AASHTO TP 103 (2015) Section 7</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Slip Resistance Testing in accordance with Appendix C</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Color Measurement Testing in accordance with AASHTO TP 103 (2015) Section 9</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Resistance to Impact from Falling Tup Testing in accordance with AASHTO TP 103 (2015) Section 10</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Wear Resistance Testing in accordance with AASHTO TP 103 (2015) Section 12</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Adhesive, Coating, and Single Dome Bond Strength Testing in accordance with Appendix B</td>
<td>X (Tested when coated and/or adhesive used)</td>
<td>X (Tested when coated and/or adhesive used)</td>
</tr>
<tr>
<td>Test Methods Required (Marked with an X)</td>
<td>Cast-in-place</td>
<td>Surface applied (adhesive bonded)</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>---------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>High-Temperature Thermal Cycling Testing in accordance with AASHTO TP 103 (2015) Section 14</td>
<td>X X X X X</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Abrasion Exposure Testing in accordance with AASHTO TP 103 (2015) Section 15</td>
<td>X X X X X</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Freeze-Thaw Durability Testing in accordance with AASHTO TP 103 (2015) Section 16</td>
<td>X X X X X</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Ultraviolet Light Exposure Testing in accordance with AASHTO TP 103 (2015) Section 17 as modified herein</td>
<td>X X X X X</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Exposed Specimen Testing: Domes and Spacing Dimensional Testing in accordance with AASHTO TP 103 (2015) Section 7</td>
<td>X X X X X</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Exposed Specimen Testing: Slip Resistance Testing in accordance with Appendix C</td>
<td>X X X X X</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Exposed Specimen Testing: Color Measurement Testing in accordance with AASHTO TP 103 (2015) Section 9</td>
<td>X X X X X</td>
<td>X X X X X</td>
</tr>
</tbody>
</table>
### Test Methods Required (Marked with an X)

<table>
<thead>
<tr>
<th>Detectable Warning System Types</th>
<th>Cast-in-place</th>
<th>Surface applied (adhesive bonded)</th>
<th>Surface applied (anchor bonded)</th>
<th>Surface-applied single dome or array</th>
<th>Brick Paver &amp; Similar</th>
<th>Additional Color samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed Specimen Testing: Resistance to Impact from Falling Tup Testing in accordance with AASHTO TP 103 (2015) Section 10</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Exposed Specimen Testing: Adhesive, Coating and Single Dome Bond Strength Testing in accordance with Appendix B</td>
<td>X (Tested when coated and/or adhesive used)</td>
<td>X</td>
<td>X (Tested when coated and/or adhesive used)</td>
<td>X (Not tested when anchor only installation)</td>
<td>X (Tested when coated and/or adhesive used)</td>
<td>X</td>
</tr>
</tbody>
</table>

5.3 Fabrication of Test Specimens

5.3.1 Prepare samples as identified on the PEF and in accordance with AASHTO TP 103 (2015) Section 5 and manufacturer/supplier’s instructions. Provide and report photographs showing installed samples and the unique identifier in at least two views: a top view and side view.

5.3.2 For brick paver and similar DWSs, prepare the concrete in accordance with this section as a cast-in-place or surface applied installation. Form the concrete hollow as per manufacturer/supplier’s instructions. Provide and report photographs showing installed samples and the unique identifier in at least two views: a top view and side view.

5.3.3 Specimens supplied for color measurement testing may be cut to a minimum of 8 by 8 in (200 by 200 mm) in accordance with AASHTO TP 103 section 5.3.1.1 and installed on a single concrete panel for exposure and color testing. Provide and report photographs showing installed samples and the unique identifier in at least two views: a top view and side view.

5.4 Visual and Microscopic Evaluation

Perform and report product description in accordance with AASHTO TP 103 (2015) Section 6. In addition, provide and report additional close-up photos of defects.
5.5  **Domes and Spacing Dimensional Testing**
Perform and report product dimensions in accordance with AASHTO TP 103 (2015) Section 7.

5.6  **Slip Resistance Testing**
Perform slip resistance testing in accordance with Appendix C. Report measurements as defined in AASHTO TP 103 (2015) Section 8 including the following: sample identification assigned; each individual slip resistance measurement for domes and field; average of the measurements for domes; and average of the measurements for the field.

5.7  **Color Measurement Testing**
Perform and report measurements as defined and in accordance with AASHTO TP 103 (2015) Section 9. Perform and report additional colors samples using this section.

5.8  **Resistance to Impact from Falling Tup Testing**
Perform and report impact testing in accordance with AASHTO TP 103 (2015) Section 10. In accordance with Section 10.6.6, perform impacts using both 27 J and 54 J. Omit Section 10.6.7, cold exposure category testing. In accordance with Section 10.6.3, Note 17, Select testing sites randomly from both well and poorly consolidated areas when both consolidation conditions exist. In addition, provide and report photographs of dome testing results.

5.9  **Wear Resistance Testing**
Perform and report measurements as defined and in accordance with AASHTO TP 103 (2015) Section 12. Provide and report photographs of dome wear testing results.

5.10  **Bond Strength Testing**
Perform and report measurements as defined in Appendix B including the following: sample identification assigned; exposure history of samples at time of testing, report all values computed along with the nature and location of the failures in accordance with Perform and report measurements as defined in ASTM D4541, report surface preparation, the average strength to failure; and comments describing irregularities in the tested domes or system and any deviation from the test procedure. In addition, provide and report photographs of failure mode results.

5.11  **High-Temperature Thermal Cycling Testing**
Perform and report measurements as defined and in accordance with AASHTO TP 103 (2015) Section 14.

5.12  **Abrasion Exposure Testing**
Perform and report measurements as defined and in accordance with AASHTO TP 103 (2015) Section 15.

5.13  **Freeze-Thaw Durability Testing**
Perform and report measurements as defined and in accordance with AASHTO TP 103 (2015) Section 16.

5.14  **Ultraviolet Light Exposure Testing**
Perform and report measurements as defined and in accordance with AASHTO TP 103 (2015) Section 17 except limiting the exposure in Sections 18 and 19, “Hot Exposure Category” to 1000 hours.

5.15  **Exposed Specimen Testing**
Repeat tests 5.4 through 5.10 after exposure to 5.11 through 5.14 and report final results and calculated change in accordance with AASHTO TP 103 (2015) and as modified herein.

5.15 Additional Color Specimen Testing
Perform and report 5.7 before and after exposure to 5.11 through 5.14 and report final results and calculated change in accordance with AASHTO TP 103 (2015) Section 9 and as modified herein.

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. Retesting 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 uphold 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.
## APPENDIX A

### Test Methods by Work Plan Modification Year

#### A1 Test Methods by Work Plan Modification Year

<table>
<thead>
<tr>
<th>Test Method/ Year</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual and Microscopic Evaluation in accordance with AASHTO TP 103 (2015)</td>
<td>X</td>
</tr>
<tr>
<td>Domes and Spacing Dimensional Testing in accordance with AASHTO TP 103 (2015)</td>
<td>X</td>
</tr>
<tr>
<td>Slip Resistance Testing in accordance with Appendix C</td>
<td>X</td>
</tr>
<tr>
<td>Color Measurement Testing in accordance with AASHTO TP 103 (2015)</td>
<td>X</td>
</tr>
<tr>
<td>Resistance to Impact from Falling Tup Testing in accordance with ASTM D5420</td>
<td>X</td>
</tr>
<tr>
<td>Wear Resistance Testing in accordance with AASHTO TP 103 (2015)</td>
<td>X</td>
</tr>
<tr>
<td>Coating and Single Dome Bond Testing in accordance with Appendix C</td>
<td>X</td>
</tr>
<tr>
<td>High-Temperature Thermal Cycling Testing in accordance with AASHTO TP 103 (2015)</td>
<td>X</td>
</tr>
<tr>
<td>Abrasion Exposure Testing in accordance with AASHTO TP 103 (2015)</td>
<td>X</td>
</tr>
<tr>
<td>Freeze-Thaw Durability Testing in accordance with AASHTO TP 103 (2015)</td>
<td>X</td>
</tr>
<tr>
<td>Ultraviolet Light Exposure Testing in accordance with AASHTO TP 103 (2015)</td>
<td>X</td>
</tr>
<tr>
<td>Exposed Specimen Testing: Domes and Spacing Dimensional Testing in accordance with AASHTO TP 103 (2015)</td>
<td>X</td>
</tr>
<tr>
<td>Exposed Specimen Testing: Slip Resistance Testing in accordance with Appendix C</td>
<td>X</td>
</tr>
<tr>
<td>Test Method/ Year</td>
<td>2017</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Exposed Specimen Testing: Resistance to Impact from Falling Tup Testing in accordance with ASTM D5420</td>
<td>X</td>
</tr>
<tr>
<td>Exposed Specimen Testing: Coating and Single Dome Bond Testing in accordance with Appendix B</td>
<td>X</td>
</tr>
</tbody>
</table>
APPENDIX B

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

B1 Scope

B1.1 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).

B1.2 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.

B1.3 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.

B2 Terminology

B2.1 For definitions of terms used in this test method refer to Terminology ASTM C 125 and ACI 503R.

B2.2 Mat Material – Any material used in the manufacture of Detectable Warning Surface System.

B3 Summary of Test Method

B3.1 This test is performed on the surface of a mat material after the mat has been bonded to a concrete surface.

B3.2 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.

B3.3 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.

B4 Significance and Use

B4.1 This test method determines the tensile strength of adhesives used to bond mat materials to concrete surfaces.

B4.2 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.

B4.3 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.
B5  Apparatus

B10.1 Core Drill Motor, of sufficient torque to drill through mat materials and adhesives for preparing test sample.

B10.2 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.

B10.3 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.

B10.4 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.

B10.4.1 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.

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

B10.4.2 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.

B6  Materials

B6.1 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.

B6.2 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.

B7  Sampling

B7.1 Select three qualified concrete blocks (per 6.2) to apply mat materials.
B7.1.1 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. 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.*

B7.1.2 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.

### B8 Preparation of Test Surfaces

B8.1 Preparation of Concrete Test Sample Block
B8.1.1 Remove all surface contaminants including loose materials and dust to obtain a clean dry surface on the concrete sample test block.

B8.2 Preparation of Test Dolly
B8.2.1 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.

B8.3 Preparation of Mat Material Test Sample
B8.3.1 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.

### B9 Preparation of Test Sample

B9.1 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.

B9.2 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.*

B9.3 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.

### B10 Test Procedure

B10.1 Attach the tensile loading device to the dolly using the coupling device.
B10.2 Apply the tensile load to the test sample so that the force is parallel to and coincident with the axis of the sample.
B10.3 Apply and maintain the tensile load at a constant rate throughout the test.
B10.4 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.

B10.5 Calculate the tensile strength by dividing the tensile load at failure by the area of the test dolly:
\[
\text{Tensile Strength (psi [MPa])} = \frac{\text{Tensile load (lbf [N])}}{\text{Area of test dolly (in}^2 \text{ [mm}^2\text{])}}
\]

B10.6 Record the individual strengths to the nearest 1 psi [0.01 MPa].

**B11 Report**

B11.1 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 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 assembly.

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.

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. (If other material is used, friction values may not be comparable.) 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.

C6  **Calibration (Wet)**

C6.1 Immersing 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).

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:

\[ F_D = \left( R_D \div (N \times W) \right) + X_D \]

Wet:

\[ F_W = \left( R_W \div (N \times W) \right) + X_W \]

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  Sample identification assigned, 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).