FOURTH DRAFT OF THE PROPOSED STANDARD TEST METHODS FOR THE EVALUATION OF DETECTABLE WARNINGS AND DIRECTIONAL SURFACES

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California Division of the State Architect's
Evaluation of Detectable Warnings Advisory Committee

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INTRODUCTION

1 Scope

1.1 These requirements cover Detectable Warnings and Directional Surfaces intended for installation in accordance with the California Building Code, California Code of Regulations, Title 24, Part 2 and the California Referenced Standards Code, California Code of Regulations, Title 24, Part 12.

2 Units of Measurement

2.1 When a value for measurement as given in these requirements for detectable warnings and directional surfaces is followed by an equivalent value in other units, in parentheses, the second value may be only approximate. The first stated value is the requirement.

3 References

3.1 Any undated reference to a code or standard appearing in these requirements shall be interpreted as referring to the latest edition of that code or standard.

3.2 Appendix A contains a list of ASTM and ISO test procedures referenced in these requirements for detectable warnings and directional surfaces.

4 Definitions

4.1 For the purpose of the requirements in this document, the following definitions apply.

4.2 ACOUSTIC QUALITY is the sound characteristics of the material, when impacted by an object.

4.3 ATTACHMENT is the ability of a material to maintain a durable mechanical bond with a substrate when installed in accordance with manufacturers' installation instructions.

4.4 COLOR FASTNESS is the ability of the material or coating to retain its original color without significant fading or changing when exposed to environmental conditions.

4.5 CONFIRMATION, see Conformation.

4.6 CONFORMATION is the process of confirming that the detectable warning and directional surface meets dimensional specifications of the truncated domes and raised bars as specified in the California Building Code, California Code of Regulations, Title 24, Part 2 and the California Referenced Standards Code, California Code of Regulations, Title 24, Part 12.

4.7 DETECTABLE WARNING is a standardized surface or feature, consisting of truncated domes and the field surface between and surrounding the truncated domes that is built into or applied to walking surfaces or other elements to warn visually impaired persons of hazards in the path or travel.

4.8 DIRECTIONAL SURFACE is a standardized surface or feature, consisting of raised bars and the field surface between and surrounding the raised bars that is built into or applied to walking surfaces to guide visually impaired persons along the path or travel.

4.9 RESILIENCE is the capacity of a material to absorb energy when it is deformed elastically (subjected to physical force) and then upon unloading to have this energy recovered.

4.10 SHAPE is the ability of the detectable warning and directional surface material, and in particular the surface features (truncated domes and raised bars) of the material, to retain its original shape when subjected to varying degrees of temperature, moisture, pressure, or other stress.

CONSTRUCTION

5 General

5.1 All detectable warnings and directional surfaces must comply with the dimensional requirements called out in the California Code of Regulations Title 24, Part 2.

> **[NOTE to EDWAC – This section will contain or reference dimensional requirements from the California Building Code, California Code of Regulations, Title 24, Part 2 and the California Referenced Standards Code, California Code of Regulations, Title 24, Part 12. The evaluation of a Detectable Warning/Directional Surface will require adherence to these specifications before and after all Performance Tests.]**

PERFORMANCE

TEST PREPARATION

6 General

6.1 Selection of samples and test specimens

6.1.1 Samples shall be obtained from the products to be tested, taken at random when possible, and in such case shall be taken in accordance with the requirements for the particular material.

6.2 Preparation of specimens

6.2.1 When it is necessary to machine specimens, the work is to be done in accordance with the manufacturer's recommended technique for the material involved. Tools are to be kept sharp and used so that the possibility of overheating is minimized. Machined surfaces of specimens are to be finished (use No. 3/0 abrasive paper or equivalent material) to eliminate all irregularities, such as tool marks, where such finishing results in a more perfect surface than can be obtained by machining alone. Where a more perfect finish is desired, a polishing compound is to be used. For mechanical test specimens, the direction of cutting and finishing is to be at right angles to the expected line of fracture whenever possible.

6.3 Thickness and directional properties

6.3.1 The properties of plastics may vary with thickness and with orientation of the material. Therefore, when preparing specimens, consideration is to be given to the testing of specimens that are representative of both the thickest and the thinnest sections of the product, and where mechanical tests are involved, the testing of specimens that have been cut lengthwise, crosswise, and also normal to the surface of the material.

6.4 Treatment prior to test

6.4.1 Samples and specimens for tests are not to be heated, immersed in water, or subjected to any mechanical or chemical treatment prior to test except as specifically described in the individual test method.

6.5 Testing conditions

6.5.1 Unless otherwise specified in the individual test method, the standard atmospheric conditions surrounding the specimen prior to and during the test are to be between 15°C and 35°C (59°F and 95°F), and between 45 percent and 75 percent relative humidity.

6.6 Testing for temperature effects

6.6.1 When the relation of properties to temperature is to be determined, tests shall be performed at one or more of the following standard atmospheric temperatures: minus 55°C (minus 67°F), minus 40°C (minus 40°F), minus 35°C (minus 28°F), 0°C (32°F), 50°C (122°F), 70°C (158°F), and 77.0°C (170.6°F). In all cases, specimens are to be conditioned at the testing temperature and humidity for at least 24 hours immediately prior to test, unless otherwise specified in the individual test method.

6.6.2 The temperature, the relative humidity, and the period of time for conditioning are to be recorded.

6.7 Test apparatus

6.7.1 Unless otherwise specified in the individual test method, properties shall be determined in any standard type of testing machine that is calibrated and accurate to 1 percent in the range used.

6.8 Tests results

6.8.1 Unless otherwise specified in the individual test method, the average of the results for the specimens tested are to be used to determine conformance of materials tested under these requirements for detectable warnings and directional surfaces.

6.8.2 Unless otherwise specified in the individual test method, the test results of specimens that reveal a break at an obvious flaw or that do not break between the predetermined benchmarks, are to be discarded. Additional specimens are to be tested in place of the specimens with discarded test results.

6.8.3 Unless otherwise specified in the individual test method, results that deviate from the mean value of all tests are to be rejected if the deviation of the doubtful value is more than three times the standard deviation from the mean obtained by including the doubtful value. Additional specimens are to be tested in place of the specimens with discarded test results.

TEST CONDITIONS

7 Test Sequence

7.1 Specimens of Detectable Warning Surfaces and Directional Surfaces shall be subjected to one of the conditioning cycles indicated in Table 7.1 prior to being subjected to the tests indicated in 7.2. Unless otherwise noted, specimens should be subjected to the appropriate cycle 5 times prior to testing.

Table 7.1
Conditioning Cycles for the Evaluation of Detectable Warnings/Directional Surfaces

Intended Use	Cycle
Outdoor	600 Hours UV Exposure 24 Hours Chemical Reagent Exposure[a] 10 Freeze Thaw Cycles[b] 40 Hours Salt Spray Exposure[c] 100 Abrasion Cycles 24 Hours Elevated Temperature
Indoor	200 Hours UV Exposure 24 Hours Chemical Reagent Exposure[a] 100 Abrasion Cycles

[a] – In each cycle, a different chemical reagent is used. If there are more than five chemical reagents to be evaluated, additional exposures may be performed when the rest of the cycles have been completed

[b] – May be omitted from cycle if product intended only for use in areas which do not commonly experience frost

[c] – May be omitted from cycle if product intended only for use in areas which do not commonly experience frost and are not in proximity to a salt water source (coast).

7.2 Detectable Warning Surfaces and Directional Surfaces exposed to an applicable conditioning cycle as described in 7.1 shall be subjected to tests and exhibit performance as specified in Table 7.2.

Table 7.2
Tests for the Evaluation of Detectable Warnings/Directional Surfaces

Test	Requirement
a) Shape Confirmation – See Section 9.	The dimensions of the Detectable Warning/Directional Surface shall comply with the requirements for shape set forth in Section 5.

Table 7.2
Tests for the Evaluation of Detectable Warnings/Directional Surfaces

Test	Requirement
b) Impact Resistance – See Section 10.	Impact resistance shall not be reduced by more than 10 percent from the "as received" value as a result of aging. In addition, no sample shall exhibit a mean failure energy less than 3.4 J (2.5 ft-lbf).
c) Coefficient of Restitution – See Section 14.	Material shall maintain at least 90 percent of its coefficient of restitution following conditioning.
d) Bond Strength – See Section 15.	Minimum average bond strength shall be 90 percent of the "as received" value, with no value below X.
e) Edge Adhesion – See Section 17 (note – this test to be conducted only on flexible materials relying on adhesive for attachment).	Minimum average pull strength shall be 90 percent of the "as received" value, with no value below X.
f) Compressive Strength – See Section 12.	Minimum average compressive strength shall be 90 percent of the "as received" value, with no value below X.
g) Snow Clearing Load Test – See Section 16.	Minimum average load at yield shall be 90 percent of the "as received" value, with no value below X
h) Color Fastness – See Section 19.	Color shall conform with the requirements for "Federal Yellow" as defined in Section 18 both initially and following conditioning.
i) Acoustic Quality – See Section 20.	Sound spectrograph shall be easily distinguishable over the audible range from standard concrete and asphalt sound spectrographs both initially and following conditioning.
j) Slip Resistance – See Section 21.	Material shall demonstrate a coefficient of friction of not less than 0.5 both initially and following conditioning.

7.3 The tests indicated in Table 7.3 shall be performed on specimens which have not undergone the cycling exposures indicated in 7.1.

Table 7.3
Tests Performed Independent of aging cycles

Test	Requirement
Cold Impact [a]	Samples subjected to cold impact shall withstand an impact of 3.4 J (2.5 ft-lbf) without cracking or separating from the substrate.
Ball Pressure [a, b]	Polymeric materials shall comply with the ball pressure test at 75°C in the as received condition
Hot Adhesion [a, c]	Adhesive peel strength in the hot condition shall not be less than 90% of the "as received" value.
[a] – This test need not be conducted for materials intended for indoor use only [b] – This test need only be conducted on polymeric materials [c] – This test need only be conducted on flexible materials relying on an adhesive for attachment	

7.4 Special considerations

7.4.1 Certain conditions and/or tests may be waived when certain conditions are met

7.4.2 UV Conditioning need not be performed on physical test specimens of materials which have no polymeric components. UV conditioning is still required on such materials for color fade testing.

7.4.3 UV Conditioning need not be performed on Bond Strength Samples when the edge of the adhesive bond will not be exposed to light in installation and the minimum thickness between adhesive and surface of the detectable warning is greater than 3.0 mm

8 Environmental Conditioning

8.1 General

8.1.1 Detectable Warning/Directional Surfaces are to be subjected to a cyclic combination of conditions prior to performing certain tests as noted in section 7.

8.1.2 Unless otherwise specified, the cycle should be repeated five times, such that each sample is subjected to each condition five times.

8.1.3 Prior to testing, the samples are to be conditioned at 48 hours at 23ºC ±2ºC, with a relative humidity of 50 ±5 percent.

8.2 Freeze-thaw cycling

8.2.1 The exposure method for determination of the resistance to freezing and thawing of detectable warning/directional surfaces is to be as described in the Standard Test Method for Evaluating the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units, ASTM C 1262.

8.2.2 This exposure method is intended to evaluate the freeze/thaw resistance of the detectable warning/directional surface.

8.2.3 The apparatus used shall be in accordance with ASTM C 1262.

8.2.4 The freeze thaw sequence is to be conducted a total of 50 times, or 10 times per cycle.

8.3 Salt spray exposure

8.3.1 The exposure method for determining the resistance of detectable warning/directional surfaces to salts is described in the Standard Practice for Operating Salt Spray (Fog) Apparatus Salt Spray, ASTM B 117.

8.3.2 This exposure method is intended to evaluate the resistance of the detectable warning/directional surface to salts, which may be encountered in de-icing or coastal applications.

8.3.3 The apparatus used is to be accordance with ASTM B 117.

8.3.4 The total duration of the salt fog exposure is to be 200 hours, or 40 hours per cycle. Prior to being moved to the next portion of the cycle, specimens should be rinsed with water at room temperature to remove any salt crystallized on the surface.

8.4 Chemical resistance

8.4.1 The exposure method for determining the resistance of detectable warning/directional surfaces when exposed to chemical reagents, is described in the Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents, ASTM D 543.

8.4.2 This exposure method is intended to evaluate the resistance of the detectable warning/directional surface to chemicals, which may be encountered during service.

8.4.3 The apparatus shall be in accordance with ASTM D 543, though no strain jigs are to be used. The wet patch method of exposure is preferred.

8.4.4 The duration of exposure for each chemical reagent shall be 24 hours. A different chemical reagent is to be used in each cycle of conditioning. The following chemical reagents are to be used on all surfaces.

a) Hydrochloric acid (10 percent),

b) Ammonium hydroxide (10 percent),

c) Soap solution (1 percent pure white soap flakes in water),

d) Turpentine,

e) Urea (5 percent),

f) Fuel, Diesel,

g) Standard Dirt

8.4.5 The detectable warning/directional surface may be exposed to additional chemicals as deemed necessary depending on the conditions that the particular product may encounter in service.

8.4.6 Prior to being moved to the next portion of the cycle, specimens should be rinsed with water at room temperature to remove any reagent remaining on the surface

8.5 Accelerated weathering

8.5.1 Specimens are to be exposed to ultraviolet light and water spray using a Xenon-arc in accordance with the Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices That Use Laboratory Light Sources, ASTM G 151, and the Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials, ASTM G 155. The spectral power distribution of

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the xenon lamp shall conform to the requirement in Table 1 in ASTM G 155 for a xenon lamp with daylight filters. A programmed cycle of 120 minutes consisting of a 102-minute light exposure and an 18-minute exposure to water spray with light shall be used. The apparatus is to operate with a spectral irradiance of 0.35 W/m^2 nm at 340 nm and black-panel temperature of 63 ±3°C (145 ±5°F).

8.5.2 This exposure method is intended to evaluate the resistance of the detectable warning/directional surface to ultraviolet radiation.

8.5.3 Materials intended for outdoor use are to be subjected to a total of 3000 hours of xenon-arc ultraviolet light and water exposure, or 600 hours per cycle

8.5.4 Materials intended for indoor use are to be subjected to a total of 1000 hours of xenon-arc ultraviolet light and water exposure, or 200 hours per cycle

8.6 Abrasion

8.6.1 The method for determination of abrasion resistance is to be as described in the Standard Test Method for Granule Adhesion to Mineral Surfaced Roofing by Abrasion, ANSI/ASTM D 4977 [a].

8.6.2 This method is intended to evaluate the abrasion resistance of the surface of the detectable warning/directional surface.

8.6.3 The apparatus used shall be in accordance with ASTM D 4977.

8.6.4 Samples shall be subjected to 500 total abrasion cycles (each cycle consisting of one stroke back and forth horizontally across the specimen), or 100 abrasion cycles per conditioning cycle.

8.6.5 Prior to being moved to the next portion of the cycle, specimens should be rinsed with water at room temperature to remove any loose material on the surface.

8.7 Elevated temperature

8.7.1 Each specimen is to be subjected to elevated temperature conditioning as part of the conditioning cycle

8.7.2 This conditioning method is intended to evaluate the resistance of the specimen to elevated temperatures and to artificially age the material in question.

8.7.3 Specimens are to be conditioned in a full draft air-circulating oven, minimum of 5 air changes per hour, maintained at 70±1°C for a total of 120 hours total, or 24 hours per cycle

8.7.4 Prior to being moved to the next portion of the cycle, specimens should be allowed to cool to room temperature

TESTING FOR SHAPE

9 Shape

9.1 General

9.1.1 Evaluation of Shape shall be made using appropriate calibrated measurement tools.

9.1.2 Samples are to be measured as follows for truncated domes, before and after being subjected to the conditioning cycles indicated in Section 7:

a) Dome height,

b) Dome width at base,

c) Dome width at top of truncation,

d) Center to center spacing of truncated domes

e) Edge to edge spacing of truncated domes

9.1.3 Samples are to be measured as follows for directional surfaces before and after conditioning:

a) Bar height,

b) Bar width at base,

c) Bar width at top of truncation,

d) Center to center spacing of directional bars

e) Edge to edge spacing of directional bars.

9.1.4 All measurements shall be in accordance with the requirements indicated in Section 5.

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10 Impact Resistance

10.1 General

10.1.1 The test method for determination of impact resistance is described in the Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimens by Means of a Striker Impacted Falling Weight, ASTM D 5420 [a].

10.1.2 The test method in ASTM D 5420 is intended to evaluate the impact resistance of the surface of the detectable warning/directional surface by measuring the energy required to break the specimens by impacting the specimen with a falling weight.

10.2 Apparatus

10.2.1 A calibrated test machine is to be used, in accordance with ASTM D 5420.

10.2.2 The striker shall conform to geometry “GE” as noted in the standard. The test apparatus support shall consist of a flat surface capable of supporting the test specimen.

10.3 Specimens

10.3.1 Samples measuring approximately 100 by 100 mm (4 by 4 inches) installed in a cement substrate having a thickness of at ¾ inch, are to be utilized.

10.3.2 Materials which have an inherent thickness of ¾ inch or more need not be installed in substrate.

10.4 Conditioning

10.4.1 Three specimens are to be subjected to the conditioning cycle described in sections 7 and 8.

10.4.2 Twenty-six specimens are to be conditioned at 23 ± 2°C and 50 ± 5% relative humidity for not less than 40 hours prior to test.

10.5 Test procedure

10.5.1 The twenty-six specimens noted in 10.4.2 are subjected to a test sequence whereby the mean failure height is determined (described in ASTM D 5420, Section 11). The first six specimens are used to determine an appropriate starting point of the test. If the approximate mean-failure height is known, testing of these six samples may be omitted.

10.5.2 The mean failure height shall be determined for both a high point of the specimen (top of truncated dome or directional bar) and a low point of the specimen (valley between truncated dome or directional bar). The same specimens may be tested for both determinations, so long as the targeted impact points are separated by at least 2 inches.

Exception: Testing of the field may be omitted in detectable warning surfaces in which the truncated dome/directional bar and the field are homogenous with regard to material of construction.

10.5.3 The test method for the determination of the mean failure height and the mean failure energy is described in the Standard Test Method of Impact Resistance of Flat, Rigid Plastic Specimens by Means of a Striker Impacted Falling Weight, ASTM D 5420.

10.5.4 Once the mean failure height and mean failure energy have been determined for the appropriate parts of the specimen, the drop height which will result in an impact energy of 90 percent of the mean failure energy is calculated for each.

10.5.5 The specimens noted in 10.4.1 are subjected to impact from the heights calculated in 10.5.4, then examined visually for failure.

10.6 Report

10.6.1 The report is to include each of the following:

a) Description of the material, including the type, source, manufacturer's code numbers, or equivalent identification code.

b) Type and dimensions of specimens, striker and strike plate.

c) Temperature, humidity, and length of conditioning period.

d) Calculated mean failure energy.

e) Number of specimens utilized to determine mean failure height.

f) Type(s) of failure observed for as received specimens

g) 90 percent mean failure energy and respective height

h) Type(s) of failure for conditioned specimens, if observed

i) Any further information that might be considered pertinent, particularly with reference to unexpected behavior.

j) A brief, identifying description of the testing apparatus.

11 Cold Impact

11.1 This test method is intended to determine if a minimum impact strength is maintained when the specimens are evaluated at low temperatures.

11.2 Each of three samples of the detectable warning or directional surface, measuring approximately 100 by 100 mm (4 by 4 inches) and installed in a cement substrate having a thickness of ¾ inch, shall be cooled to a temperature of minus 35.0 ±2.0°C and maintained at that temperature for 3 hours.

11.3 Materials which have an inherent thickness of ¾ inch or more need not be embedded in substrate.

11.4 While the specimen is still cold, within one minute of removal from the conditioning chamber, it is to be subjected to a 3.4 joule (2.5 ft-lb) impact, achieved by dropping a 50.8 mm (2 inch) diameter steel ball weighing 0.535 kg (1.18 lb) from a height of 0.65 meters (2.125 ft).

11.5 Each specimen is to be permitted to return to room temperature, then examined visually for cracks and/or separation from the substrate.

12 Compressive Strength

12.1 General

12.1.1 The test method for determination of Compressive strength is intended to evaluate the ability of the specimen to remain functional during and following application of compressive loading.

12.2 Apparatus

12.2.1 Testing machine – Standard hydraulic or mechanical compression testing machine of suitable capacity, and capable of operating at the specified constant rate of motion of the moveable head. Accuracy of the testing machine is to be verified in accordance with ASTM Practices E 4.

12.2.2 Loading surfaces – The lower loading surface is to consist of a flat block capable of supporting the entire specimen. The upper loading surface is to be a circular plate or cylinder having a 31.75 mm (1.25 inch) diameter. Surfaces shall be designed to remain plane within 0.25 mm/m (0.003 in/ft) under all conditions of load.

12.2.3 Load indicator – Load indicating mechanism that will permit measurements with an accuracy of ±1 % of the total load

12.2.4 Diplacement indicator – Displacement indicating mechanism that will permit measurements with an accuracy of ±25.4 microns (±0.001 inches)

12.3 Specimens

12.3.1 Samples measuring approximately 100 by 100 mm (4 by 4 inches) installed in a cement substrate having a thickness of ¾ inch are to be utilized

12.3.2 Materials which have an inherent thickness of ¾ inches or more need not be installed in substrate.

12.4 Conditioning

12.4.1 Three specimens are to be subjected to the conditioning cycle described in sections 7 and 8.

12.4.2 Three specimens are to be conditioned at 23 ± 2°C and 50 ± 5% relative humidity for not less than 40 hours prior to test.

12.5 Test Procedure

12.5.1 Test specimens are to be placed in the apparatus such that the upper loading surface is centered over the truncated dome or directional bar closest to the specimen's center.

12.5.2 The upper loading surface shall be brought close to the top of the dome or directional bar being tested, and then the testing machine started with a crosshead speed of X until a load of 1000 pounds of force has been applied.

12.5.3 If yield is observed prior to reaching 1000 pounds of force, the test may be stopped.

12.5.4 The displacement at 1000 pounds of force is to be noted, and then the upper loading surface should be withdrawn from the specimen at a crosshead speed of X until the load returns to 0 pounds of force.

12.5.5 The displacement at 0 pounds of force is to be noted.

12.6 Report

12.6.1 The report is to include each of the following:

a) Description of the material, including the type, source, manufacturer's code numbers or equivalent identification code.

b) Type and dimensions of specimens.

c) Temperature, humidity, and length of conditioning period.

d) Maximum load at yield (if observed).

e) Displacement at yield (if observed).

f) Displacement at 1000 lbf.

g) Displacement at 0 lbf following unloading.

h) Any further information or observations that might be considered pertinent, particularly with reference to unexpected behavior.

i) A brief, identifying description of the testing apparatus, including the type of testing machine and dimensions of the loading surfaces.

13 Ball Pressure

13.1 General

13.1.1 The test method for determination of Ball Pressure is described in IEC 695-10-2.

13.1.2 This method is intended to evaluate polymeric materials for softening at a temperature of 75°C in order to confirm that they will not soften under severe service conditions.

13.2 Apparatus

13.2.1 An apparatus in accordance with IEC 695-10-2 is to be used.

13.3 Specimens

13.3.1 Three samples approximately 4 inches-square are to be prepared. If the thickness of the polymeric portion of the material is greater than 2.5 mm, then the polymeric portion may be tested on its own. Otherwise, the specimens should be installed in ¾ inches of concrete substrate according to the manufacturer's instructions.

13.4 Procedure

13.4.1 The Ball Pressure test method described in IEC 695-10-2 is to be used except as noted below.

13.4.2 Instead of testing at many temperatures to determine what temperature results in a penetration of 2 mm, as is generally indicated in IEC 695-10-2, the test shall be conducted at 75°C.

13.4.3 The diameter of the impression shall be measured following the required conditioning and application of the test force for the prescribed duration. To comply with this test, the impression shall be 2.0 ± 0.1mm or less. Surface texture is to be disregarded when making this measurement.

TESTING FOR RESILIENCE

14 Coefficient of Restitution (COR)

14.1 The test method for the determination of coefficient of restitution is described in Ceramic Tiles – Part 5: Determination of impact resistance by measurement of coefficient of restitution, ISO 10545-5.

14.2 Specimens shall be in accordance with ISO 10545-5, but the detectable warning/directional surface should be applied to the concrete substrate following the manufacturer's recommended installation method.

14.3 The test should be conducted such that the steel ball impacts a flat portion of the specimen between truncated domes/directional bars.

14.4 From the data obtained, the coefficient of restitution can be determined.

TESTING FOR ATTACHMENT

15 Bond Strength

15.1 The test method for the determination of bond strength is described in the Standard Test Method for Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method), ASTM C1583.

15.2 Specimens shall be in accordance with ASTM C1583, but need only measure 12 inches by 12 inches. The detectable warning/directional surface should be attached to a concrete substrate 2 inches thick, unless the material itself already exceeds 2 inches.

15.3 Three specimens are to be subjected to the conditioning cycle described in sections 7 and 8, except that UV exposure may be omitted.

15.4 Three specimens are to be conditioned at 23 ± 2°C and 50 ± 5% relative humidity for not less than 40 hours prior to test.

15.5 The test should be conducted such that the 2-inch diameter steel disk is attached to a portion of the sample, which includes at least one truncated dome, or a portion of a directional bar. (NOTE: We may wish to allow for testing on a flat portion when the dome/bar is continuous with the flat surface and not attached separately).

15.6 When the product being tested is intended for perimeter installation, the test specimen should be prepared such that the junction of two units is observed in the center of the specimen (the test area). The 2 inch diameter steel disk should be attached centered on the junction of the two units.

15.7 From the data obtained, the tensile load at failure and the failure mode can be determined.

16 Snow Clearing Load Test

16.1 General

16.1.1 This test method is intended to evaluate the durability of the truncated domes on detectable warnings or raised bars on directional surfaces.

16.2 Apparatus

16.2.1 The basic components of the test apparatus are to consist of the following:

a) A testing machine, properly calibrated, that can be operated at constant rates of crosshead motion, and in which the error in the load measuring system shall not exceed ±1% of maximum load expected to be measured. The load indicating mechanism shall be essentially free from inertial lag at the crosshead rate used.

b) A steel specimen support designed to support a specimen at a 60° angle from horizontal (See fig. 1) NOTE: Figure 1 is forthcoming

c) A steel blade of 6.35 mm (0.25 inch) thickness, 25.4 mm (1 inch) wide with a beveled edge, installed in the testing machine to apply a load to the specimen.

16.3 Specimens

16.3.1 Three specimens approximately 76 mm by 127 mm (3 inches by 5 inches) are to be prepared. In the case of directional bars, the bars should be aligned with the long edge of the specimen.

16.4 Conditioning

16.4.1 Three specimens are to be subjected to the conditioning cycle described in sections 7 and 8.

16.4.2 Three specimens are are to be conditioned at 23 ± 2°C and 50 ± 5% relative humidity for not less than 40 hours prior to test.

16.5 Test Procedure

16.5.1 The sample is to be loaded into the fixture and the blade positioned such that the leading edge contacts the center of a truncated dome or directional bar 2 mm (0.078 inches) above the field surface of the specimen.

16.5.2 The blade is lowered with a crosshead speed of X until the load cannot be sustained (yield). The maximum load at yield is recorded.

16.6 Report

16.6.1 The report is to include each of the following:

a) Description of the material, including the type, source, manufacturer's code numbers or equivalent identification code.

b) Type and dimensions of specimens

c) Temperature, humidity, and length of conditioning period.

d) Maximum load at yield

e) Displacement at yield

Any further information or observations that might be considered pertinent, particularly with reference to unexpected behavior.

f) A brief, identifying description of the testing apparatus, including the type of testing machine and dimensions of the blade.

17 Edge Adhesion

17.1 General

17.1.1 This test method is intended to evaluate the adhesion strength of flexible detectable warnings applied to substrate using adhesive.

17.2 Apparatus

17.2.1 Testing machine – Standard hydraulic or mechanical tension testing machine of suitable capacity, and capable of operating at the specified constant rate of motion of the moveable head. Accuracy of the testing machine is to be verified in accordance with ASTM Practices E4.

17.2.2 Specimen support – a lower specimen support capable of rendering the bulk of the specimen immobile during testing

17.2.3 Grip – an upper grip capable of clamping firmly and holding the peel specimen without slipping.

17.2.4 Load indicator – Load indicating mechanism that will permit measurements with an accuracy of ±1% of the total load

17.3 Specimens

17.3.1 Specimens are to consist of an approximately 100 mm by 100 mm (4 inches by 4 inches) concrete substrate having a thickness of ¾ inch and a one inch wide strip of detectable warning applied using the appropriate adhesive system across the diagonal of the substrate. Adhesive shall not be applied to one corner of the specimen to facilitate the gripping of the flexible surface.

17.4 Conditioning

17.4.1 Three specimens are to be subjected to the conditioning cycle described in sections 7 and 8.

17.4.2 Three specimens are are to be conditioned at 23 ± 2°C and 50 ± 5% relative humidity for not less than 40 hours prior to test.

17.5 Test Procedure

17.5.1 Test specimens are to be placed in the apparatus such that the upper grip is clamped on the free corner of the flexible surface and the lower surface is held immobile.

17.5.2 The load is applied at a constant head speed of X in/min

17.5.3 During the peel test, make an autographic recording of load versus distance peeled.

17.5.4 Determine the peel resistance over at least a 75 mm (3 inch) length of the bond line after the initial peak

17.6 Report

17.6.1 The report is to include the following information:

a) Description of the material, including the type, source, manufacturer's code numbers or equivalent identification code.

b) Type and dimensions of specimens.

c) Temperature, humidity, and length of conditioning period.

d) Crosshead separation rate used.

e) Method of recording load and determining average load.

f) Average, maximum, and minimum peeling load values for each individual specimen.

g) Average peel strength in pounds per inch of width for each combination of materials under test.

h) Any further information or observations that might be considered pertinent, particularly with reference to unexpected behavior.

i) A brief, identifying description of the testing apparatus, including the type of testing machine and dimensions of the loading surfaces.

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18 Hot Adhesion

18.1 The test method described in Section 17 shall be conducted with the following changes

18.2 One set of three specimens shall be conditioned at 75°C for at least one hour prior to testing.

18.3 Immediately following removal of the specimen from the oven, it shall be subjected to the test method described in Section 17. The time elapsed between removal from the oven and commencement of testing shall not exceed 3 minutes.

18.4 The report prepared shall be similar to the report indicated in Section 17.

TESTING FOR COLOR FASTNESS

19 Color Fastness

19.1 General

19.1.1 The test method for the determination of Color Fastness is described by the Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates, ASTM D2244.

19.1.2 The test method in ASTM D2244 is intended to determine the difference in color between two specimens through the use of tristimulus data of the two specimens in combination with a known white object.

19.2 Apparatus

19.2.1 The apparatus shall consist of a Colorimetric Spectrometer capable of measuring CIE tristimulus values under standard illuminant D_{65}. (and/or C)

19.2.2 A 16 mm aperture is recommended, though other sizes may be used so long as consistency is maintained within a sample set.

19.2.3 A color chip of federal color 33538 (Federal Yellow), less than five years of age and kept in relative darkness except for during testing, shall be used as the reference.

19.3 Specimens

19.3.1 Specimens shall be approximately 4 inches by 4 inches and need not be embedded in substrate.

19.4 Conditioning

19.4.1 One specimen is to be subjected to the conditioning cycle described in sections 7 and 8.

19.4.2 One specimen is to be conditioned at 23 ± 2°C and 50 ± 5% relative humidity for not less than 40 hours prior to test.

19.5 Test Procedure

19.5.1 The test should be conducted on a relatively flat portion of the specimen between truncated domes or bars if possible. If the sample configuration does not allow for testing between domes or bars, then the test should be conducted at the peak of the dome or bar. The test locations must be consistent between samples subjected to different conditions.

19.5.2 The 10° (2°) observer and standard D65 (or C) illuminate shall be used

19.5.3 At least three color measurements shall be taken from each sample to determine CIELAB values for a given specimen. Testing of the reference sample (Federal Yellow) shall be performed at the same time that the conditioned specimens.

19.6 Report

19.6.1 The report is to include each of the following:

a) Description of the material, including the type, source, manufacturer's code numbers, or equivalent identification code.

b) The CIELAB values for the reference specimen and each conditioned specimen along with temperature, humidity, and length of conditioning period.

c) The total color difference from the reference (ΔE^*_{ab})shall be calculated for each conditioned sample

d) The portion of the specimen tested (valley, peak of dome, peak of bar, etc)

e) A brief, identifying description of the testing apparatus, including aperture size.

TESTING FOR ACOUSTIC QUALITY

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20 Acoustic Quality

20.1 General

20.1.1 This method is intended to approximate sound on cane acoustic quality of a given detectable warning product or directional surface. The results of the test program can be used to determine if a given product retains a significant difference in acoustic response from materials, which typically surround the product in the field.

20.2 Apparatus

20.2.1 The basic components of the test apparatus are to consist of the following:

a) A striker, consisting of a nylon 6/6 ball having a diameter of 19 mm (¾ inches).

b) A microphone having a sensitivity/frequency response of at least ???

c) A computer equipped with audio hardware capable of recording digital audio at a sample rate of 44.1Khz and 16 bit resolution.

d) Software capable of rendering a sound spectrograph in the audible frequency range.

20.3 Specimens

20.3.1 Samples measuring approximately 4 by 4 inches, installed in a concrete substrate having a thickness of at least ¾ inch, are to be utilized.

20.4 Conditioning

20.4.1 One specimen is to be subjected to the conditioning cycle described in sections 7 and 8.

20.4.2 One specimen is to be evaluated in the as received condition.

20.4.3 All specimens are to be conditioned at 23 +/- 2°C and 50 +/- 5% relative humidity for not less than 40 hours prior to testing.

20.5 Test Procedure

20.5.1 Each sample is to be placed on a hard surface, with the microphone situated in an appropriate position to capture the sound of impact.

20.5.2 The striker should be dropped onto the sample from a height of 3 feet, and the resulting sound of impact recorded. Care should be taken to minimize the amount of ambient noise in the test area.

20.5.3 If possible, the resulting sound file should be cropped to include only the first impact. Subsequent impacts caused by bouncing of the striker should be discarded, unless the time between impacts is so small that the sounds overlap.

20.5.4 A sound spectrograph of the impact is to be generated

20.5.5 The test procedure is to be repeated on a standard specimen of concrete, ¾ inch thick and 4 inches by 4 inches and used as a reference.

20.6 Report

20.6.1 The report is to include each of the following:

a) Description of the material, including the type, source, manufacturer's code numbers, or equivalent identification code.

b) Type and dimensions of the striker

c) Description of conditioning applied to the specimen

d) Sound spectrograph of the specimen being impacted by the striker

e) Any further information that might be considered pertinent, particularly with reference to unexpected behavior.

f) A brief, identifying description of the testing apparatus.

21 Slip Resistance – Static Friction Test

21.1 General

21.1.1 The test method for determination of slip resistance is described in UL 410.

21.1.2 This method is intended to evaluate the slip resistance of a the detectable warning surface

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21.2 Apparatus

21.2.1 A James machine in accordance with UL 410 is to be used.

21.3 Specimens

21.3.1 Specimens shall be at least 150 mm x 150 mm (6 inches x 6 inches) and need not be embedded in substrate. If a substrate is to be used, then the specimen thickness (including detectable warning) should not exceed ¾ inch.

21.4 Conditioning

21.4.1 Three specimens are to be subjected to the conditioning cycle described in sections 7 and 8.

21.4.2 Three specimens are to be conditioned at 23 ± 2°C and 50 ± 5% relative humidity for not less than 40 hours prior to test.

21.5 Test Procedure

21.5.1 The test shall be conducted on each specimen as described in UL 410 in accordance with the requirements for Walkway Construction Materials (WCM), except that testing while coated with cooking oil may be omitted.

21.6 Report

21.6.1 The report is to include each of the following:

a) Description of the material, including the type, source, manufacturer's code numbers, or equivalent identification code.

b) Type and dimensions of the test sensor.

c) The calculated Coefficient of Friction for each specimen, both dry and wet.

d) Any further information that might be considered pertinent, particularly with reference to unexpected behavior

e) A brief, identifying description of the testing apparatus.

APPENDIX A

Reference List of Applicable ASTM and ISO Test Procedures

ASTM Standards

ASTM B 117	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C 241	Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic
ASTM C 650	Standard Test Method for Resistance of Ceramic Tile to Chemical Substances
ASTM C 902	Standard Specification for Pedestrian and Light Traffic Paving Brick
ASTM C 1026	Standard Test Method for Measuring the Resistance of Ceramic Tile to Freeze-Thaw Cycling
ASTM C 1262	Standard Test Method for Evaluating the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units
ASTM C 1583	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)
ASTM D 543	Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
ASTM D 2244	Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D 4977	Standard Test Method for Granule Adhesion to Mineral Surfaced Roofing by Abrasion
ASTM D 5420	Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact)

ASTM G 151	Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources
ASTM G 155	Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

ISO Standards

ISO 10545-5	Ceramic Tiles – Part 5: Determination of Impact Resistance by Measurement of Coefficient of Restitution

IEC Standards

IEC 695-10-2	Abnormal Heat – Ball Pressure Test