Designation: D8367 − 21

Standard Practice for Making a Laboratory Pavement Marking Sample Using a Pavement Marking and Drop-on Particles[1]

This standard is issued under the fixed designation D8367; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers a procedure and apparatus for producing a representative laboratory pavement marking sample by applying a pavement marking material onto a suitable substrate, followed immediately with an application of drop-on particles consisting of retroreflective optics or other functional particles such as skid resistance particles suitable for laboratory testing or display. Examples of pavement marking materials appropriate for this practice would include waterborne traffic paint, solvent borne traffic paint, and plural component pavement markings such as epoxy, modified epoxy, polyurea, methyl methacrylate, and thermoplastic pavement markings. Plural component materials with extremely fast gel times might not be appropriate for this practice because the material gels too quickly to allow proper embedment of the drop-on particles.

1.2 The finished sample will consist of a pavement marking material applied in a liquid state to a sample substrate at the prescribed film thickness, with drop-on particles applied at the prescribed drop rate and embedment level on the surface of the pavement marking material, and then properly cured. The drop-on particles may consist of retroreflective optics such as glass beads or composite optics, or non-retroreflective particles such as skid resistant particles, or several of these items in combination.

1.3 The values stated in inch-pound units are to be regarded as the standard except where noted in the practice. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D823 Practices for Producing Films of Uniform Thickness of Paint, Coatings and Related Products on Test Panels
D2205 Guide for Selection of Tests for Traffic Paints
D4060 Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
D4414 Practice for Measurement of Wet Film Thickness by Notch Gages
D6628 Specification for Color of Pavement Marking Materials
D7307 Practice for Sampling of Thermoplastic Pavement Marking Materials
D7308 Practice for Sample Preparation of Thermoplastic Pavement Marking Materials
D8008 Practice for Representative Field Sampling of Traffic Paints
E303 Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester
E1349 Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional (45°:0° or 0°:45°) Geometry
E1710 Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer
E2177 Test Method for Measuring the Coefficient of Retroreflected Luminance (R_L) of Pavement Markings using the Bucket Method in a Condition of Wet Recovery
E2302 Test Method for Measurement of the Luminance Coefficient Under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer

[1] This practice is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.44 on Traffic Coatings.

Current edition approved Nov. 1, 2021. Published December 2021. DOI: 10.1520/D8367-21.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

E2832 Test Method for Measuring the Coefficient of Retroreflected Luminance of Pavement Markings in a Standard Condition of Continuous Wetting (R_{L-2})

2.2 *AASHTO Standards:*[3]

AASHTO TP-130-18 Producing Draw Down Panels and Measuring the Coefficient of Retroreflected Luminance (RL) of Pavement Markings in a Laboratory Panel

3. Terminology

3.1 *Definitions:*

3.1.1 *application rate, n*—the weight of particles per unit area (drop area) applied to the pavement marking sample.

3.1.2 *applicator blade/wet film applicator, n*—a device used to apply the pavement marking material to the substrate.

3.1.3 *drop area, n*—the area under the drop box where particles fall.

3.1.4 *drop-on particles, n*—small particles applied to the surface of a pavement marking material in an uncured condition, which when said pavement marking is fully cured, provides the pavement marking with a characteristic such as retroreflectivity, skid resistance, color, etc.

3.1.4.1 *non-retroreflective particles, n*—assorted particles or aggregates that are not retroreflective; this could include particles used to color the line or for skid resistant applications.

3.1.4.2 *retroreflective composite optics (RCO), n*—a multi-component retroreflective optical construction for use with pavement marking materials to provide retroreflective properties to the marking; constructions including but not limited to:

(1) A core covered with a pigmented adhesive and small glass or ceramic optical beads.

(2) A cluster of optical ceramic or glass beads distributed in a polymeric matrix.

(3) An optical glass bead core, covered with a pigmented adhesive and small glass or ceramic optical beads.

3.1.4.3 *retroreflective glass bead optics, n*—spherical glass manufactured for use with pavement marking materials to provide retroreflective properties to the marking.

3.1.4.4 *skid resistance particles, n*—particles or aggregate that is dropped on the highway marking lines or skid resistance adhesive that is used to provide friction between the vehicle or pedestrian and the road.

3.1.5 *particle drop box, n*—a laboratory device used to uniformly drop a defined quantity of particles onto an uncured pavement marking material draw down to create a pavement marking sample for laboratory testing purposes.

3.1.6 *particle drop box sample base, n*—a laboratory device used with the particle drop box to align the pavement marking sample area with the particle drop area.

3.1.7 *pavement marking material, n*—a pigmented binder system used for lane delineation for highways, parking lots, and other areas subject to vehicular traffic; applicable pavement marking materials include waterborne traffic paint, solvent borne traffic paint, plural component such as epoxy, modified epoxy, polyurea, methyl methacrylate, and thermoplastic.

3.1.8 *pavement marking sample, n*—a properly cured pavement marking of specified width, length, and thickness applied to an appropriate substrate; the pavement marking has drop-on particles embedded in the surface of the marking to provide various performance characteristics such as retroreflectivity, color, and skid resistance.

3.1.9 *sample area, n*—surface area of the substrate to be coated with particles.

4. Summary of Practice

4.1 A practice for making a representative pavement marking sample in the laboratory utilizing:

4.1.1 A pavement marking material applied at the designated length, width, and thickness to the appropriate substrate utilizing an applicator blade/wet film applicator,

4.1.2 Drop-on particles uniformly applied at the correct application rate to the uncured pavement marking draw down, and

4.1.3 Curing or drying the pavement marking sample according to the manufacturer's recommendations.

5. Significance and Use

5.1 The method described in this practice provides a procedure to rapidly generate pavement marking samples in the laboratory, suitable for the testing of applied pavement marking properties.

5.2 This practice is intended to provide uniform laboratory pavement marking samples that reduce the variability associated with obtaining pavement marking samples in the field.

5.3 This practice is particularly useful for directly comparing applied pavement marking properties as impacted by variations in materials, film thickness, and drop-on particle application rates for quality control or development purposes.

5.4 This practice can be used in evaluating pavement marking materials formulated and produced in the laboratory and for drop-on particles specifically made and prepared in the laboratory. It can also be used for testing materials that are already manufactured and either stored as work-in-process or placed in its final packaging. When testing manufactured materials in the finished goods state, it is extremely important that a representative sample of the pavement marking material and the drop-on particles are obtained for use, in order to draw the proper conclusions from any testing done on pavement marking samples made from these materials. For proper sampling of thermoplastic pavement markings in a finished good state, it is recommended to follow Practices D7307 and D7308. For proper sampling of liquid pavement marking with both single and multicomponent materials, it is recommended to follow Practice D8008.

6. Interferences

6.1 Samples made in the laboratory do not represent the full range of variability experienced in a field application resulting

[3] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.

from variations in weather, road roughness, cleanliness, equipment, and operators.

6.2 In the field, pavement markings are applied using a variety of application methods including spray, ribbon extrude, and conventional extrusion methods. Creating a pavement marking sample in the laboratory with lab application equipment may produce unexpected results not seen in the field when applied under field conditions with standard application equipment. Some pavement markings may harden too quickly, preventing proper drop-on particle embedment, making this method unacceptable for use. Pavement marking samples created using this practice should be evaluated for the proper embedment of the drop-on particles after complete curing of the pavement marking film (see Appendix X1 for details on how to evaluate embedment). If the drop-on particles are not properly embedded, adjustments to the process should be made to achieve proper embedment.

7. Apparatus and Equipment

7.1 *Particle Drop Box,* see Annex A1.

7.2 *Particle Drop Box Sample Base.*

7.3 *Applicator Blade.*

7.4 *Substrate Panel* (asphalt, concrete, aluminum, glass, plastic, wood, coated card stock, cardboard, drawdown cards, etc.).

7.5 *Scale,* for weighing (0.1 g accuracy).

7.6 *Container,* for mixing and pouring pavement marking in a liquid state onto the substrate.

7.7 *Water, Solvent, or Other Appropriate Cleaner,* in a container, and appropriate tools for immediate cleaning of the applicator blade.

7.8 *Drying Oven* (optional).

7.9 *Wet Film Thickness Gauge,* per Practice D4414 for measuring wet film thickness.

7.10 *Dry Film Thickness Gauge,* for measuring dry film thickness.

8. Reagents and Materials

8.1 *Substrate Panel* (asphalt, concrete, aluminum, glass, plastic, drawdown cards, etc.).

NOTE 1—Substrate should not warp or deform after marking cures.

NOTE 2—For retroreflectivity measurements the panel needs to be large enough to fit under the retroreflectometer. Refer to the retroreflectometers manufacturers recommendations.

8.2 *Water or Solvent,* for use with wash bucket and brush.

8.3 *Pavement Marking Material.*

8.4 *Drop-on Particles:*

8.4.1 Retroreflective optics.

8.4.2 Non-retroreflective particles (skid resistant particles, colored particles, etc.).

9. Procedure

9.1 Select appropriate applicator blade and quantity of pavement marking material for the required pavement marking sample length, width, and film thickness.

NOTE 3—Applicator blade gap size does not equal wet film thickness. Many variables affect the wet film thickness achieved using an applicator blade. It is recommended to use a wet film thickness gauge to verify wet film thickness per Practice D4414, or another appropriate method suitable for validating film thickness for materials after curing.

NOTE 4—Practice making pavement marking samples to determine the appropriate applicator blade gap size for the desired film thickness and the appropriate pavement marking sample size. Verify required film thickness and adjust gap size as necessary. Use only a slight excess of pavement marking material as this provides enough material to make a pavement marking sample of the desired area and thickness without creating a mess. For liquid pavement marking materials such as paint, epoxy, and polyurea applied at a wet film from 15 mils to 30 mils, a bird film applicator or similar device can be used. For methyl methacrylate and thermoplastic pavement markings applied at a dry film thickness of 40 mils to 150 mils (or in some cases greater), an appropriate drawdown device can be used.

9.2 Determine the desired drop-on particle application rate for the optics or non-retroreflective particles to be applied to the pavement marking sample. Refer to the manufacturer's recommendations for recommended application rates.

9.3 Weigh out the exact quantity of drop-on particles for the desired particle application rate, based on the particle drop box area, and set aside. For a double drop system weigh out the exact quantity of each drop-on particle type based on the particle box drop area, and set each sample aside.

General Formula:

$$\text{Particle Weight} = (\text{Desired Drop-on Particle Application Rate expressed in weight per unit area}) \times (\text{Particle Drop Box Area}) \quad (1)$$

NOTE 5—The pavement marking draw down must fit within the particle drop area under the particle drop box. Draw downs of any size within the particle drop area will receive the same drop rate of particles assuming the drop box produces a uniform distribution in the particle drop area.

9.3.1 *Example*—Determine the weight of optics in grams required for making a pavement marking sample with a recommended drop rate of 0.1 lb/ft^2 with the drop box in Fig. 1. The inside length of the box is dimension F = 20 in. The inside width of the box is dimension G = 5 in.

Calculations:

$$W = (R) \times 454 \times .00694 \times (A) \quad (2)$$

where:

W = required weight of drop-on particles expressed in grams,
R = desired application rate of particles expressed in pounds per square foot (lb/ft^2), and
A = inside area of drop box expressed in square inches ($in.^2$).

$$W = (0.1 \times 454 \times .00694 \times 100) = 31.5 \text{ g} \quad (3)$$

NOTE 6—This calculation includes the conversion of the desired application rate from lb/ft^2 to $g/in.^2$ for easier application of the method in the laboratory.

9.4 Place particle drop box within reach but not in the way of particle drop box sample base.

9.5 Uniformly distribute the drop-on particles in the trough on the particle drop box. For a double drop system, place each particle type in the designated trough on top of the particle drop box.

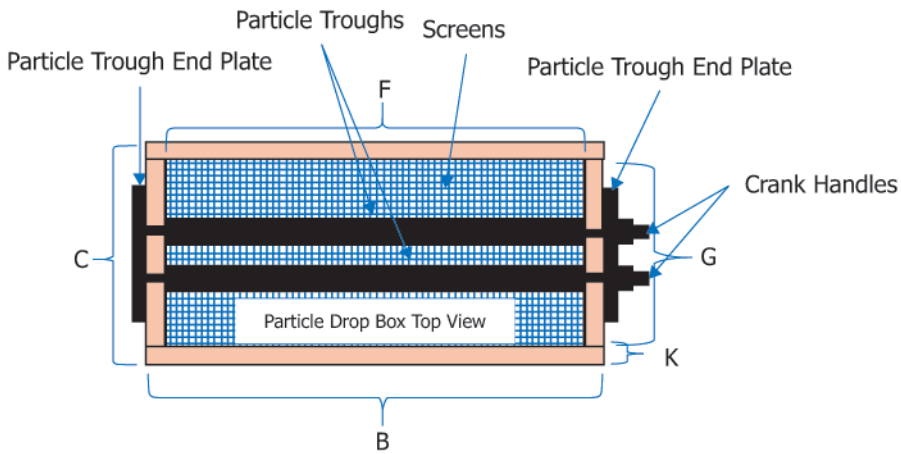


FIG. 1 Top View of a Double Drop Particle Drop Box

9.6 Prepare the appropriate amount of pavement marking required to construct the desired drawdown into an appropriate container for applying onto the substrate using the applicator blade.

NOTE 7—For two-component markings, ensure the correct mix ratio is achieved and mix sufficiently before using. Different two-component systems will have different gel times, so it is important to prepare the draw down as quickly as possible after adequately mixing, followed by the application of the drop-on particles as quickly as possible. For two-component systems that have gel times less than 3 to 5 min, this practice might not be applicable if proper embedment is not achievable. For single component liquid markings, make sure the container is sufficiently mixed before extracting sample for use.

NOTE 8—For thermoplastic pavement markings, the material should be applied to the substrate at the recommended application temperature, or at a temperature that has been identified to result in the proper embedment depth of the drop-on particles. Due to the nature of thermoplastic pavement markings, the selection of the substrate, the conditioning of the substrate, and the application temperature of the thermoplastic material will affect the embedment depth of the drop-on particles. For example, (*1*) conditioning a concrete panel to be used as a substrate at elevated temperatures will result in greater embedment of the drop-on particles compared to a concrete panel at room temperature; (*2*) application of thermoplastic pavement markings to a cardboard substrate at room temperature will result in greater embedment of the drop-on particles compared to application to a concrete substrate at room temperature; (*3*) thermoplastic pavement marking applied at 420 °F will result in greater drop-on particle embedment than thermoplastic pavement marking applied at 380 °F, on the same substrate under the same conditioning.

9.7 Place labeled substrate panel between the guide rails on the particle drop box sample base.

9.8 Place applicator blade at top end of substrate panel in the correct direction.

9.9 Pour enough liquid pavement marking in front of applicator blade and apply to coat the entire length of the panel.

9.10 Carefully, yet quickly, position the particle drop box over the pavement marking sample in the particle drop box sample base.

9.11 Dump the particles through the particle drop box onto the pavement marking sample. For single drop particle applications, both particle troughs can be dumped at the same time or consecutively. For double drop particle applications, the particle trough that contains the particles intended to be applied first should be dumped first, and then immediately followed by dumping the trough containing the particles intended to be applied as the second drop. Typically, the larger sized particles should be applied as the first drop.

9.12 Remove the panel and dry or cure per manufacturer's recommendations. Take care to keep the panel horizontal while the film is uncured to prevent the coating and drop-on particles from moving.

9.13 Visually inspect pavement marking samples for film quality, loose particles, particle distribution, and particle embedment level. If the particle embedment is not acceptable, adjustments to the procedure are required in order to achieve the proper embedment. If the embedment is too shallow, some adjustments are needed to increase the embedment depth of the particles. For liquid coatings, increasing particle embedment may require reducing the time between the application of the pavement marking to the substrate and the application of the drop-on particles to the pavement marking, increasing film thickness and or increasing material temperature. For thermoplastic, it may require the selection of a different substrate, increasing the application temperature of the thermoplastic, conditioning the substrate to an elevated temperature, or a combination of these things. If the particle embedment is too deep, then adjustments will also be needed to address the issue. For liquid coatings, this may require increasing the time between the application of the pavement marking material to the substrate and the application of the drop-on particles to the pavement marking sample. For thermoplastic, it may require the selection of a different substrate, reducing the application temperature of the thermoplastic, conditioning the substrate to lower temperatures, or a combination of these things.

9.14 Once the marking dries, brush off loose particles with a dry paint brush.

9.15 *Tests*—Testing may include but is not limited to the following test methods:

9.15.1 Dry retroreflectivity (Test Method E1710),

9.15.2 Wet retroreflectivity (Test Method E2832 or Test Method E2177, or both), 9.15.3 Qd diffuse daytime luminance (Test Method E2302),

9.15.4 Cap Y luminance factor (Specification D6628 and Test Method E1349),

9.15.5 Color (Specification D6628 and Test Method E1349),

9.15.6 Skid resistance (Test Method E303), and

9.15.7 Taber abrasion resistance (Test Method D4060).

10. Keywords

10.1 beads; coating; composite optics; epoxy; methyl methacrylate; paint; pavement marking; polyurea; retroreflectivity; thermoplastic

ANNEX

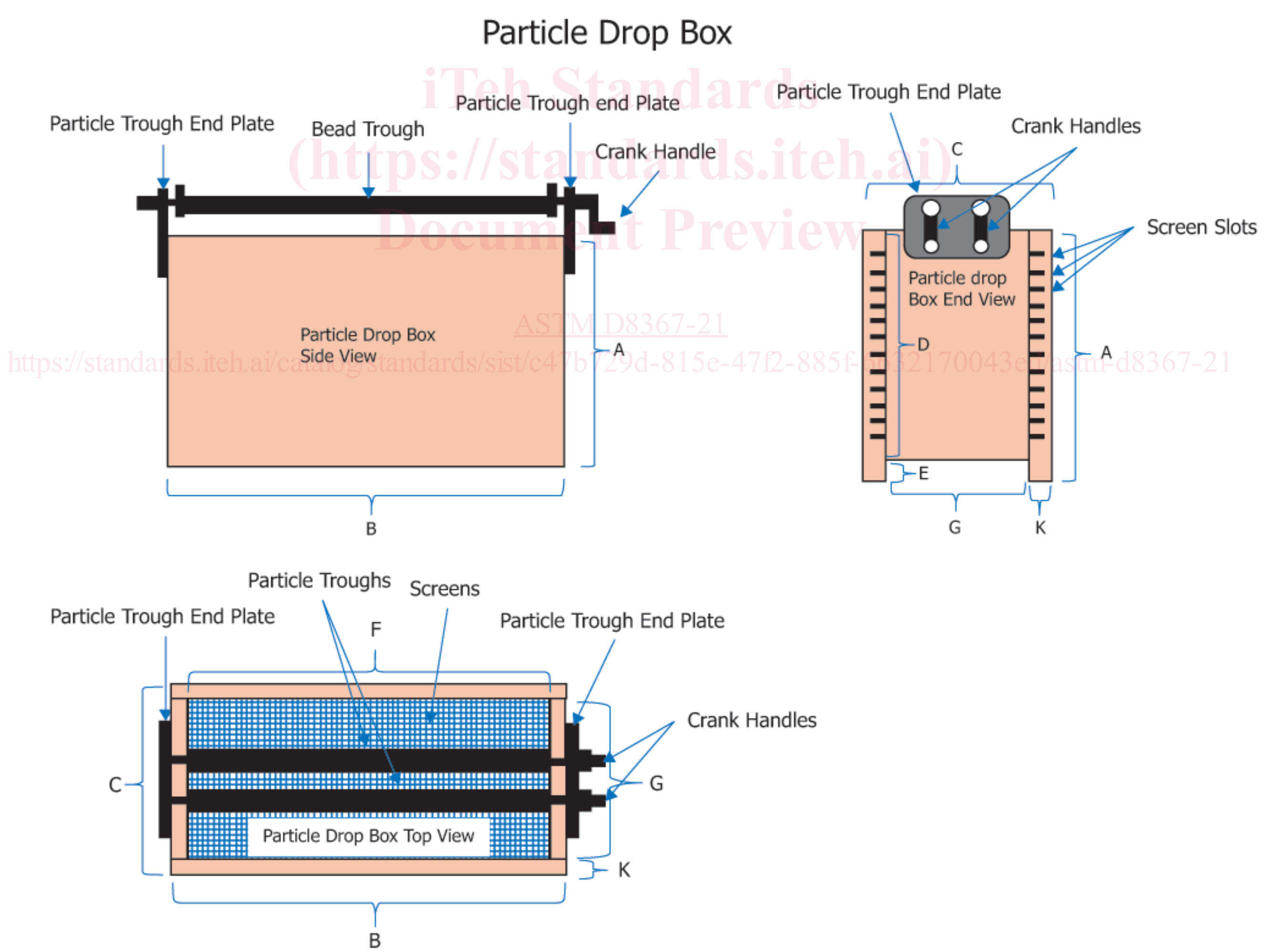
(Mandatory Information)

A1. APPARATUS DESIGN

A1.1 Particle Drop Box Design

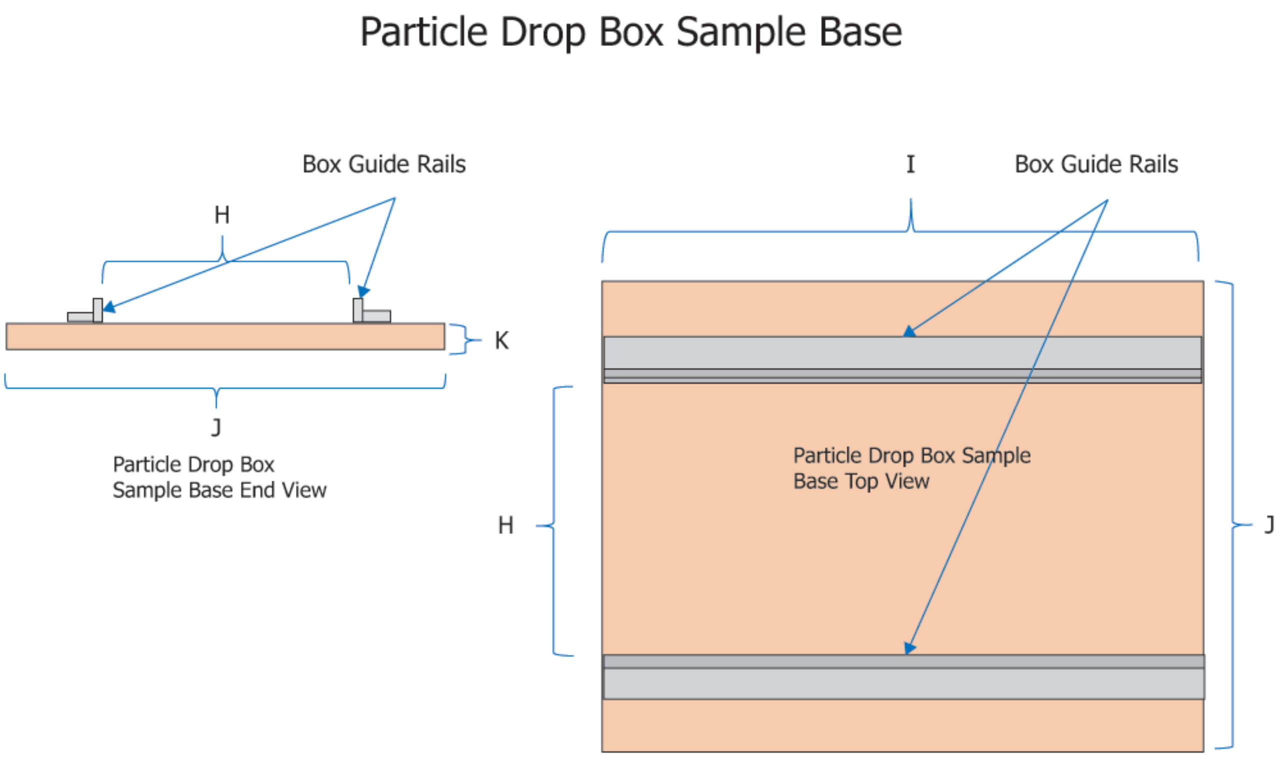
A1.1.1 The following section contains a basic design for a particle drop box. The dimensions can vary depending on size of the marking sample desired. The dimensions provided below are for a 24 in. by 6 in. wide drop box which is useful for making lines up to 24 in. long by 6 in. wide.

A1.1.2 The apparatus design can be modified to suit the user's needs as long as the basic function is not impaired. Modifications may include single or double particle troughs, box feet, particle drop box sample base design etc. See examples Fig. A1.1 and Fig. A1.2.



NOTE 1—See A1.2 for legend.

FIG. A1.1 Particle Drop Box



NOTE 1—See A1.2 for legend.

FIG. A1.2 Particle Drop Box Sample Base

A1.2 Dimensions for a 24 in. by 6 in. Drop Box

A = Box side height = 15.0 in.
B = Particle box outside length = 24 in. + 2 × (dimension K) in.
C = Particle box outside width = 6 in. + 2 × (dimension K) in.
D = Particle end height = 14.0 in.
E = End gap = 1 in.
F = Particle box inside length = 24 in.
G = Particle box inside width = 6 in.
H = Sample base guide rail width = 6.5 in. + 2 × (dimension K) in.
I = Sample base length = 26 in.
J = Sample base width = 12 in.
K = Construction material thickness (this can vary).
Space screen slots 1 in. apart beginning 2 in. from top with a total of 12 slots.
The screening is welded galvanized steel, with an internal opening dimension of 0.225 in. square and a wire diameter of 0.025 in.

A1.3 Examples

A1.3.1 In the following segment there are two particle drop box designs supplied by two different laboratories. The first design is for a single particle drop and the second is for a double particle drop. Each box is similar in design but has subtle differences to accomplish the task.

A1.3.2 The designs consist of a particle drop box with rotating particle channels and a sample frame. The particle drop channel is essentially angle iron that is enclosed on the ends. There are pivot rods on each end of the channel to allow it to rotate to drop the particles. A drawdown is made on the substrate using the substrate frame. Then the box is placed over the wet drawdown and the particles are dropped by pivoting the drop channel via the attached pivot arm at the end of the channel. The result is a pavement marking sample with particles dropped onto the surface with the correct drop rate, evenly distributed.

A1.4 Single Particle Drop Box Design

A1.4.1 A single particle drop box for an 18 in. long substrate measures 14 in. high. The internal dimensions are 6.5 in. width by 18.25 in. length. Construction is ¾ in. plywood. To get uniform distribution across the drawdown, there are 12 layers of screening inside the drop box at 1 in. intervals, starting 2 in. from the top. The screening is welded galvanized steel, with an internal opening dimension of 0.225 in. square and a wire diameter of 0.025 in. The screens rest on through dado joints on all four surfaces on the inside of the box.

A1.5 Double Particle Drop Apparatus Design

A1.5.1 *Bead Box Dimensions*—20 in. by 14.25 in. by 8 in.

A1.5.2 *Screens:*

A1.5.2.1 Total of 12 screens, spaced 1 in. apart. See Fig. A1.7.

A1.5.2.2 Screen openings are 0.2 in. by 0.2 in. squares.

A1.5.3 *Sample Frame/Track Dimensions*—50.5 in. by 13.5 in. (with 1.5 in. grooves for wheels).

FIG. A1.3 General View

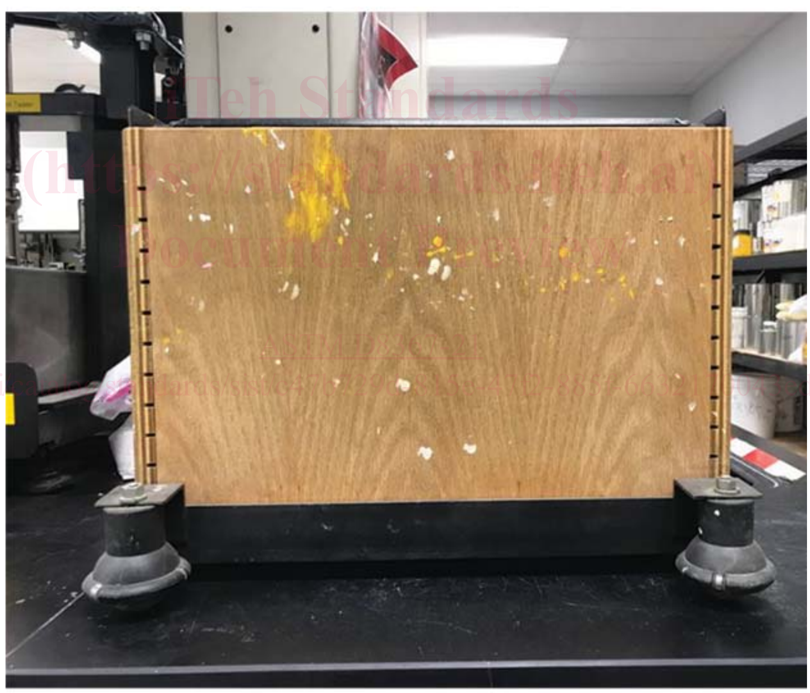


FIG. A1.4 Side View