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**American National Standard Test Method
for Measuring Dynamic Coefficient of
Friction of Hard Surface Materials**

American National Standard Test Method for Measuring Dynamic Coefficient of Friction of Hard Surface Materials

Secretariat

Tile Council of North America, Inc.

Approved

American National Standards Institute, Inc. (ANSI)

Abstract

This publication is a voluntary standard for dynamic coefficient of friction testing of hard surface flooring materials. This standard describes the test method for measuring DCOF in the laboratory and in the field. This standard also provides guidance on specifying hard surface flooring materials as relevant to slip resistance.

American National Standard

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Foreword

This foreword is not part of American National Standard A326.3.

American National Standard A326.3 describes the test method for measuring dynamic coefficient of friction (DCOF) of hard surface flooring materials in the laboratory and in the field. The standard also includes specifications for DCOF and guidance on specifying hard surface flooring material. This standard is intended to serve as a guide to the general public, manufacturers, distributors, specifiers, architects, contractors, testing laboratories, building owners, and other businesses and professionals.

While the existence of this standard does not in any respect preclude anyone, including those who have accepted it, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to this standard, producers of hard surface flooring materials measured per A326.3 and users of the standard in general are encouraged individually to indicate such conformance in advertising, promotion, and labeling.

ASC A108 Committee Members

This standard was processed and approved for submittal to ANSI by the Accredited Standards Committee (ASC) on Ceramic Tile A108. Committee approval of a standard does not necessarily imply that all committee members voted for its approval.

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**ANSI
A326.3**

**American National Standard Test Method
for Measuring Dynamic Coefficient of Friction
of Hard Surface Materials—2017**

Introduction

This introduction is not part of the American National Standard Test Method for Measuring Dynamic Coefficient of Friction of Hard Surface Flooring Materials, ANSI A326.3.

The coefficient of friction (COF) measurement provided in this standard is an evaluation of a hard surface flooring material under known conditions using a standardized sensor material prepared according to a specific protocol. As such it can provide a useful comparison of surfaces, but it does not predict the likelihood a person will or will not slip on a hard surface flooring material.

There are many factors that affect the possibility of a slip occurring on a surface, including, by way of example, but not in limitation, the following: the material of the shoe sole and the degree of its wear; the presence and nature of surface contaminants; the speed and length of stride at the time of a slip; the physical and mental condition of the individual at the time of a slip; whether the floor is flat or inclined; how the hard surface flooring material is used and maintained; and the COF of the material, how the flooring surface is structured, and how drainage takes place if liquids are involved. Because many variables affect the risk of a slip occurring, the COF shall not be the only factor in determining the appropriateness of a hard surface flooring material for a particular application.

The presence on installed hard surface flooring materials of water (including standing water as can exist on floors which are not properly sloped for drainage or on exterior flooring surfaces immediately after a rain storm or on which snow is melting), oil, grease, and/or any other elements which reduce traction, creates slippery conditions where the risk of a slip cannot be completely eliminated. Applications with exposure to such elements require extra caution in product selection, use, and maintenance.

While specifying products with higher COF for use under contaminated conditions can be considered, higher COF can lead to maintenance/cleanliness issues and hard to remove contaminants and films, which can cause hazardous and unfavorable conditions. In addition to maintenance issues, a surface with a high COF can create a difficult walking condition for that subset of the elderly and disabled who slide their feet on the floor. For them, smooth and dry flooring is needed, specifically flooring with a low wet COF that is kept dry when in use.

END OF INTRODUCTION

1.0 Scope

This standard describes the test method for measuring dynamic coefficient of friction (DCOF) of hard surface flooring materials. This method can be used in the laboratory or in the field.

2.0 Definition of Terms

Dynamic Coefficient of Friction (DCOF): Sometimes called kinetic coefficient of friction. This is the ratio of the force necessary to keep a surface already in motion sliding over another divided by the weight (or normal force) of an object. This ratio is a materials property of the two surfaces.* DCOF is usually less than SCOF for the same materials. Contaminants such as dirt, water, soap, oil, or grease can change this value.

*The laboratory values determined by this test method reflect the dynamic friction between the test foot using SBR rubber and the hard surface flooring being tested under specific controlled conditions. No claim of correlation to actual footwear or human ambulation is made.

3.0 Specification

3.1 Unless otherwise specified, hard surface flooring materials suitable for level¹ interior spaces expected to be walked upon when wet with water shall have a wet DCOF of 0.42 or greater when tested using SBR sensor material and SLS solution as per this standard. However, hard surface flooring materials with a DCOF of 0.42 or greater are not necessarily suitable for all projects. The specifier shall determine materials appropriate for specific project conditions, considering by way of example, but not in limitation, type of use, traffic, expected contaminants, expected maintenance, expected wear,² and manufacturers' guidelines and recommendations.

3.2 When tested using SBR sensor material and SLS solution as per the procedure in this standard, hard surface flooring materials with a wet DCOF of less than 0.42 (including by way of example, but not in limitation, polished surfaces), shall only be installed when the surface will be kept dry when walked upon and proper safety procedures will be followed when cleaning the hard surface flooring materials. Surfaces not intended to be walked upon when wet shall have a dry DCOF of 0.42 or greater when tested per Section 9.0 of this standard.

INFORMATIVE NOTE: Hard surface flooring materials with a wet DCOF less than 0.42 are often used in areas such as shopping malls (outside the food court), hotel lobbies, office buildings, etc. where appearance and ease of cleaning are highly desired and measures are in place to keep the floor dry when walked upon.

INFORMATIVE NOTE: Hard surface flooring materials which have a coating applied shall only be used in areas that can be kept dry, unless otherwise specified by the coating's manufacturer. If testing data is required after a coating is applied, use the test method specified by the manufacturer, or the dry testing procedure in this standard if no test method is suggested by the manufacturer of the coating.

INFORMATIVE NOTE: Wet DCOF limit values are not provided in this standard for exterior applications, interior ramps and inclines, or flooring that is contaminated with material other than water.

For exterior applications, the suitability of the installed hard surface flooring materials depends significantly on drainage of the assembly, physical structure of the hard surface flooring, expected footwear, intended use, and the variety of contaminants present, in addition to other factors already discussed. Accordingly, a single DCOF limit value for exterior applications is not provided.

For interior ramps and inclines, the suitability of the installed hard surface flooring materials depends significantly on the degree of incline, the nature of any non-pedestrian use, and the physical structure of the hard surface flooring, in addition to other factors already discussed. Accordingly, a single DCOF limit value for ramps and inclines is not provided.

Similarly, a single DCOF limit value for hard surface flooring contaminated with materials other than water is not provided due to the variety of possible contaminants and the effect of such on traction.

¹ Hard surface flooring materials appropriate for pedestrian inclines shall be chosen for the specific properties and use of the incline and require a wet DCOF greater than 0.42 if the inclined pathway will be used under wet conditions. Specifier shall determine materials appropriate for specific project conditions, considering by way of example, but not in limitation, type of use, traffic, grade of ramp, expected contaminants, expected maintenance, expected wear, and manufacturers' guidelines and recommendations.

² The COF of installed hard surface flooring materials can change over time as a result of wear and surface contaminants. In addition to regular cleaning, deep cleaning and traction-enhancing maintenance may be needed periodically to maintain DCOF values.

4.0 Apparatus

- 4.1 **BOT 3000E³**: Automated testing device capable of testing dynamic coefficient of friction. Verify the strain gauge daily using the verification mass provided by the manufacturer. The upper measurement limit for the BOT 3000E is 1.00. If while testing, the BOT 3000E measures a value of 1.00, report the value as ≥ 1.00 .
- 4.2 **SBR sensors⁴**: With a new sensor rubber thickness of $4.0 \text{ mm} \pm 0.2$ ($0.16 \text{ in.} \pm 0.01$) and a Shore A hardness of 95 ± 3 . Discontinue use when sensor thickness is less than 2.5 mm (0.10 in.).
- 4.3 **Sensor reconditioning tool**: A device used to resurface the sensor in a uniform fashion. The reconditioning tool should be provided by the manufacturer of the BOT 3000E.
- 4.4 **BOT 3000E sensor validation surface⁵**.

5.0 Reagents and Materials

- 5.1 **0.05% Sodium-Lauryl Sulfate (SLS)**: Commercially available at higher concentrations than required for this testing. Dilute with distilled or de-ionized water to reach 0.05% SLS solution. For example, if SLS solution is purchased at 29% concentration, mix 6.54 mL of 29% SLS solution with 1 gallon of distilled water to obtain 0.05% SLS solution.
- 5.2 **Renovator #120⁶**: Diluted per manufacturer's instructions sufficient to fully remove surface contaminants.
- 5.3 **Additional cleaners**: As necessary for field testing to remove topical coatings, waxes, or contaminants. These cleaners include, but are not limited to, citrus degreasers, solvents, sealer strippers, or other appropriate cleaners specified for the floor being tested. Cleaners shall be non-etching, suitable for the surface being tested, and used per manufacturer's instructions.
- 5.4 **Cloth or paper towel**: That does not leave lint or residue after use.
- 5.5 **Soft bristle brush, stiff bristle brush, and/or scrubbing pad.**
- 5.6 **Sand paper**: Waterproof, 400 grit, super fine, silicon carbide.
- 5.7 **Paint brush.**

6.0 Sensor Reconditioning Procedure

- 6.1 Attach fresh sand paper to the sensor reconditioning tool before testing begins.
- 6.2 Insert sensor into the reconditioning tool.
- 6.3 Recondition the sensor, periodically removing the sensor to view the rubber surface. Brush sand paper and sensor with a dry paint brush to remove excess material.
- 6.4 Once the sensor no longer has a wear line across the center and the surface of the sensor appears uniform, it is ready for use (Figures 1 and 2.)

³ The BOT 3000E or an equivalent has been found satisfactory. The BOT 3000E is manufactured by Regan Scientific Instruments, Inc., 901 S. Kimball Ave., Southlake, TX 76092, and has been extensively studied by the committee.

⁴ The SBR sensor or equivalent has been found satisfactory. The SBR sensors are available from Regan Scientific Instruments, Inc., 901 S. Kimball Ave. Southlake, TX 76092. The SBR rubber on a new sensor shall conform to the following specifications: $4.0 \pm 0.2 \text{ mm}$ thickness, $1.23 \pm 0.2 \text{ g/cm}^3$ density, 95 ± 3 Shore A hardness, $>10 \text{ MPa}$ tensile strength, $>250\%$ flexibility, and $<250 \text{ mm}^3$ wearability.

⁵ The BOT 3000E sensor validation surface or the equivalent has been found satisfactory. The sole source of supply of the sensor verification surface known to the committee at this time is Regan Scientific Instruments, Inc., 901 S. Kimball Ave., Southlake, TX 76092.

⁶ Renovator #120 or equivalent has been found satisfactory. Renovator #120 is available from Hillyard, 302 North 4th St., P.O. Box 909, St. Joseph, MO 64501.

7.0 Sensor Validation

- 7.1** The sensor validation surface shall be free of contamination prior to use.
- 7.2** If cleaning is required use Renovator #120 or the equivalent, diluted per manufacturer's instructions sufficient to fully remove surface contaminants, and warm tap water, to clean the verification surface and scrub using a soft bristle scrubbing pad to remove any dust, debris, and contaminants that have collected on the surface. Rinse thoroughly to remove all the detergent.
- 7.3** Allow to air dry or dry with a hair dryer or a cloth or paper towel that does not leave residue.
- 7.4** Wet the path that the sensor will follow with 0.05% SLS water.
- 7.5** Make one measurement then turn the BOT 3000E 180° and make the second measurement on the sensor validation surface. Calculate the average.
- 7.6** If the average is ± 0.03 of the value stated on the validation surface, proceed with testing. If the value falls above or below that range, repeat Sections 6.2-6.4. If after multiple attempts of reconditioning the sensor, the result does not fall within the stated range, the sensor is considered invalid and shall be set aside. A new sensor should be used or the sensor validation surface should be re-cleaned or replaced.
- 7.7** Repeat Sections 6.2-6.4 after sensor validation before proceeding with testing.

8.0 Test Procedure—Dynamic COF with 0.05% SLS Water

8.1 Laboratory Test

- 8.1.1** All test specimens shall be cleaned prior to testing.
- 8.1.1.1** Using Renovator #120 or equivalent, diluted per manufacturer's instructions sufficient to fully remove surface contaminants, and warm tap water, clean the material and scrub using a soft bristle scrubbing pad to remove any dust, debris, and contaminants that have collected on the surface. Rinse thoroughly to remove all the detergent.
- 8.1.1.2** Allow to air dry or dry with a blow dryer or a cloth or paper towel that does not leave residue.
- 8.1.2** Place the specimens on a solid surface. If necessary, place specimens on either side of the specimen being tested to accommodate the wheels of the test device as it travels over the surface.
- 8.1.3** Wet the path that the sensor will follow with enough 0.05% SLS water such that the sensor will remain within the wetted path throughout the entire test.
- 8.1.4** Set the test travel distance of the BOT 3000E device to 10 in. (254 mm). If the material being tested is less than 10 × 10 in. (254 × 254 mm) and greater than 4 × 4 in. (101.6 × 101.6 mm), run the test with the longest possible travel distance that fits on the surface. For mosaics, bond enough pieces of the specimen to a solid surface to provide a 10 × 10 in. (254 × 254 mm) or larger specimen and test with 10 in. (254 mm) travel distance⁷.
- 8.1.5** Make a total of four dynamic measurements on the specimen. Make one measurement then turn the BOT 3000E 180° and make the second measurement. Remove the SLS solution

⁷ Bond mosaics in sheet form without grouting. For loose mosaics, bond with the joints not exceeding 1/8 in. (3.18 mm) and do not grout.

from the surface with a cloth or paper towels that do not leave a residue. Re-wet the surface in a path 90° to the previous one. Take the final two measurements, along the new path, in the same fashion as above.

- 8.1.6** Record all four dynamic measurements, then calculate the average.
- 8.1.7** Repeat Sections 8.1.2-8.1.6 on two additional specimens, repeating Sections 6.2-6.4 before each specimen.
- 8.1.8** After testing all specimens, recondition the SBR sensor (Sections 6.2-6.4) then recheck and record the sensor validation surface (Sections 7.4-7.6). If the value falls outside the range in Section 7.6 determine the source of error, take corrective action, and repeat the entire testing procedure.

8.2 Field Test

8.2.1 Determine the area(s) to be tested based on the test objective. An area is a contiguous space with hard surface flooring of the same or similar type.

8.2.2 Determine test locations required per area based on the test objective.

INFORMATIVE NOTE: The following are typical locations that should be considered for testing: Locations that are representative of both high and low traffic conditions, locations that evaluate varying material sizes or textures, and locations commonly exposed to contaminants or other risks.

8.2.3 Per each test location, choose a minimum of three test samples of size sufficient to accommodate the test travel distance (see Section 8.1.4).

8.2.4 Determine if the test will be conducted under clean conditions or under prevailing conditions (without pre-cleaning the surface before testing).

INFORMATIVE NOTE: If the test objective is to measure a contaminant-free floor, clean the surface prior to testing. If the test objective is to measure floor under prevailing conditions, test the floor “as is” without cleaning.

8.2.5 When testing the prevailing conditions, the test shall be conducted in the “as-is” condition. Remove any obvious solid contaminants (e.g., dirt, crumbs, coffee grounds, peanut shells, etc.) from the surface prior to testing. Take note of any solid contaminants which are removed from the surface.

8.2.6 When results are required under clean conditions, use cleaning chemicals as listed in Sections 5.2 and 5.3 as needed to remove surface contaminants. Additional scrubbing using a stiff bristle brush or scrubbing pad may also be required as long as such does not damage the flooring material. Rinse thoroughly to remove residual cleaning chemicals.

8.2.6.1 Remove rinse water with a cloth or paper towels that do not leave a residue. Inspect cloth or paper towels. If any contaminants are visible from the rinse water, conduct another cleaning cycle. Repeat until the towels appear clean after removing the rinse water.

8.2.7 Wet the path that the sensor will follow with enough 0.05% SLS water such that the sensor will remain within the wetted path throughout the entire test.

8.2.8 Take a total of four dynamic measurements at each test sample being measured. Take one measurement then turn the BOT 3000E 180° and take the second measurement. Remove the SLS solution from the surface with a cloth or paper towels that do not leave a residue. Re-wet the surface in a path 90° to the previous one. Take the final two measurements along the new path in the same fashion as above.

8.2.9 Repeat Sections 6.2-6.4 before each test sample.

8.2.10 Record all four dynamic measurements then calculate an average for each test sample.

INFORMATIVE NOTE: DCOF measurements of installed materials may not match measurements that were made on new, uninstalled samples. DCOF values can be impacted by various factors. These include, but are not limited to, contaminants present, sealers or coatings applied after installation, build-up of cleaning chemical residues, and wear due to traffic, soil type, and/or cleaning equipment. For the factors listed above, the recommended best practice is to test unused samples (attic stock) to determine if product meets manufacturer's specifications. However, field testing can be a tool to help determine other aspects of the installation, such as, but not limited to, effectiveness of maintenance or to gauge the current condition of the installed product.

9.0 Dry Dynamic Coefficient of Friction (DCOF)—If Desired

9.1 Repeat Sections 6.0-8.0, except recondition the sensor and run the test and sensor validation in the dry condition. All specimens/test areas must be completely dry before conducting the test. For sensor validation, use a range of ± 0.04 of the value stated on the validation surface.

10.0 Report

10.1 Report the following information:

10.1.1 Type of surface, including unique identifying name or number.

10.1.2 Temperature during testing and relative humidity if testing in the dry condition.

10.1.3 Calibration due date of BOT 3000E device.

10.1.4 Sensor material.

10.1.5 Cleaning chemicals used.

10.1.6 SLS water concentration (wet DCOF testing only).

10.1.7 Statement of sensor validation including actual dynamic coefficient of friction values measured on the sensor validation surface before and after testing and whether or not each fell within the appropriate range.

10.1.8 Individual and average wet dynamic coefficient of friction for specimen/test area.

10.1.9 Individual and average dry dynamic coefficient of friction for each specimen/test area (if desired).

10.2 Additional reporting for field testing:

10.2.1 Note if the measurements were made in areas that had been cleaned or in an "as-is" condition.

10.2.2 Description/photographs of test areas sufficient to re-locate the test areas.

10.2.3 Note general environmental conditions, such as (but not limited to): contaminant type present, coatings or sealers present, traffic conditions, maintenance equipment, and presence of walk off mats.

11.0 Discussion of Wet DCOF Method Precision

11.1 Precision: The precision of this test method is based on an interlaboratory study conducted in May 2011. Each of six laboratories tested seven different materials. Every “test result” was calculated using the average of four individual wet dynamic coefficient of friction measurements. The laboratories obtained three replicate test results for each material.

11.1.1 Repeatability: Two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the “r” value for that material; “r” is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment on the same day.

11.1.1.1 “Sr” represents the repeatability standard deviation.

11.1.2 Reproducibility: Two test results shall be judged not equivalent if they differ by more than the “R” value for that material; “R” is the interval representing the difference between two test results for the same material, obtained by different operators using different equipment.

11.1.2.1 “SR” represents the reproducibility standard deviation.

11.1.3 Any judgment in accordance with these two statements would have an approximate 95% probability of being correct.

11.2 The precision statement was determined through statistical examination of 126 results, from six laboratories, representing six different BOT 3000 devices, on seven materials. Descriptions of the seven surfaces tested are as follows:

Surface 1: Polished porcelain

Surface 2: Glazed porcelain, lightly textured

Surface 3: Glazed porcelain, heavily textured

Surface 4: Standard tile, glazed ceramic, smooth

Surface 5: Unglazed mosaics

Surface 6: Unglazed porcelain, textured

Surface 7: Glazed porcelain, smooth

Table 1: Dynamic Coefficient of Friction with 0.05% SLS Water

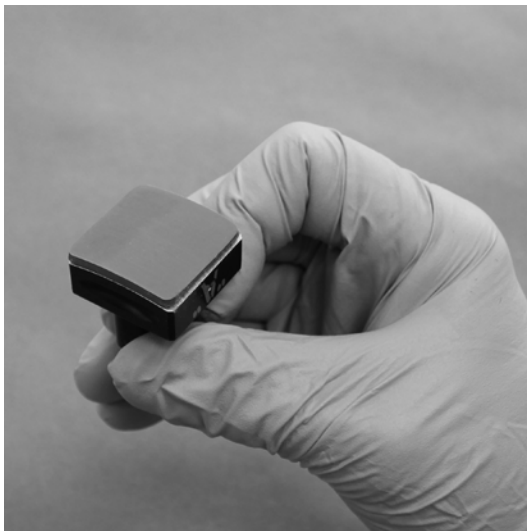
Surface	Average (x)	Standard Deviation (Sx)	Repeatability Standard Deviation (Sr)	Reproducibility Standard Deviation (SR)	Repeatability (r)	Reproducibility (R)
1	0.36	0.02	0.02	0.02	0.05	0.05
2	0.44	0.02	0.01	0.02	0.03	0.05
3	0.43	0.02	0.02	0.02	0.06	0.06
4	0.27	0.01	0.01	0.01	0.03	0.03
5	0.63	0.02	0.01	0.03	0.04	0.07
6	0.65	0.03	0.01	0.03	0.03	0.08
7	0.24	0.01	0.01	0.01	0.02	0.02

ANSI A326.3 | FIGURES

Figure 1: SBR sensor with wear line.



Figure 2: SBR sensor without wear line.



END OF ANSI A326.3

THIS STANDARD IS UNDER CONTINUOUS MAINTENANCE AND ALWAYS OPEN FOR COMMENT AND PROPOSED REVISIONS. PLEASE SUBMIT COMMENTS AND PROPOSED REVISIONS TO THE COMMITTEE SECRETARY, KATELYN SIMPSON, KSIMPSON@TCNATILE.COM.

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