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# Standard Practice for the Accelerated Polishing of Aggregates Using the British Wheel[1]

This standard is issued under the fixed designation D3319; 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 laboratory procedure by which an estimate may be made of the extent to which different coarse aggregates may polish.

~~1.2The values stated in inch-pound units are to be regarded as the standard.~~

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard. Regarding sieves, per Specification E11, "The values stated in SI units shall be considered standard for the dimensions of the wire cloth openings and the diameter of the wires used in the wire cloth." When sieve mesh sizes are referenced, the alternate inch-pound designations are provided for information purposes and enclosed in parentheses.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

C778 Specification for Sand

D75 Practice for Sampling Aggregates

D1415 Test Method for Rubber PropertyInternational Hardness

D3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

E303 Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester

E501 Specification for Rib Tire for Pavement Skid-Resistance Tests



## 3. Terminology

3.1 *Definitions:*

3.1.1 *initial friction value (PV-i)*—the initial British Pendulum Tester readings on the test specimens before they are polished in the accelerated polishing machine.

3.1.2 *polish value (PV-n)*—a measure of the state of polish reached by a test specimen subjected to the specified hours (n) of accelerated polishing using the materials, equipment, and procedures described in this method. The measurement is made using the British Pendulum Tester as described in 5.3 and Test Method E303.

3.1.3 *residual polish value, (RPV-n)*—the residual polish value is obtained when a constant *PV-n* is ~~acheived~~achieved four consecutive times with repeated swings of the pendulum.

## 4. Significance and Use

4.1 This practice simulates the polishing action of vehicular traffic on coarse aggregates used in bituminous pavements.

4.2 A polish value is determined that may be used to rate or classify coarse aggregates for their ability to resist polishing under traffic.

NOTE 1—The quality of the results produced by this standard are dependant upon the competence of the personnel performing the procedure and the capability, calibration, and the maintenance of the equipment used. Agencies that meet the criteria of Standard Practice D3666 are generally considered

[1] This practice is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.51 on Aggregate Tests.

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[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.

capable of competent and objective testing / sampling / inspection / etc. Users of this standard are cautioned that compliance with D3666 alone does not completely assure reliable results. Reliable results depend on many factors: following the suggestions of D3666 or similar acceptable guideline provides a means of evaluating and controlling some of those factors.

## 5. Apparatus

5.1 *Accelerated Polishing Machine*[3]—An accelerated polishing machine, also known as the British Wheel, and based upon a 1958 design by the Road Research Laboratory of Great Britain. This machine shall be mounted on a firm, rigid, and level base. The equipment shall include the following:

5.1.1 *Cylindrical Wheel*—Hereafter referred to as the road wheel, and having a flat-surface periphery and of such size and shape as to permit 14 specimens described below to be clamped onto the periphery to form a continuous surface of aggregate particles, 1¾ in. (44.45 mm) wide and 16 in. (406.4 mm) in diameter.

5.1.2 A means of rotating the road wheel about its own axis at a speed of 320 ± 5 rpm.

5.1.3 A means of bringing the surface of a rubber-tired wheel 8 in. (203.2 mm) in diameter and 2 in. (50.8 mm) wide to bear on the aggregate specimens mounted on the surface of the road wheel with a total load of 88 ± 1 lbf (391.44 ± 4.45 N). The tire shall be treated, if necessary, to obtain a true running surface. The tire shall be free to rotate about its own axis, which should be parallel to the axis of the road wheel. The plane of rotation of the tire shall coincide with that of the road wheel. Before a new tire is used on a test, it shall be conditioned by a preliminary run of 6 h with a 150-grit silicon carbide using dummy specimens (extra or used) on the road wheel.

5.1.3.1 *Alternate Tire No. 1*—An industrial 8 by 2 pneumatic smooth-tread hand-truck tire (~~Note 1~~Note 2). The tire rubber hardness shall be 55 ± 5 IRHD measured in accordance with Test Method D1415. The tire shall be inflated to a pressure of 45 ± 2 psi (310.26 ± 13.79 kPa).

NOTE~~1—This~~ 2—This is the tire originally supplied with the Accelerated Polishing Machine[3] and known by the tire manufacturer's designation Dunlop RLI 8 by 2. Dunlop discontinued manufacturing of this tire in February 1979. It is retained as an alternate in this practice for those users who may still have a supply and in the event that Dunlop should resume manufacturing it in the future.

5.1.3.2 *Alternate Tire No. 2*—An industrial 2.80 by 4 (8 in. OD by 4 in. ID), 4 NHS-4 ply, cross-hatch pattern tread hand-truck tire (Notes ~~2 and 3~~3 and 4). The tire shall be inflated to a pressure of 35 ± 2 psi (241.32 ± 13.79 kPa).

NOTE~~2—When~~ 3—When it became known that the Dunlop tire (5.1.3.1) was no longer being manufactured, the necessity of finding a replacement tire for the practice was evident. A search and study by the Texas State Department of Highways and Public Transportation culminated in finding this tire, a Goodyear Industrial All Weather Hand-Truck tire size 2.80 by 4 (Goodyear Product Code 202-008-002), to give Polish Values equal to those obtained with the Dunlop tire.[4] A suitable inner tube such as Goodyear G250-4 (Product Code 199-010-700) is necessary. It was also found necessary to modify the 4-in. (101.6-mm) wheel furnished with the Accelerated Polish Machine[3] to facilitate mounting the Goodyear tire. Approximately 0.10 in. (2.54 mm) should be removed from the wheel diameter and a larger hole provided for the value stem. This did not affect mounting and use of the Dunlop tire. Goodyear is no longer manufacturing this tire.

NOTE~~3—A1998~~ 4—A1998 study conducted by the Texas Department of Transportation shows that the use of cross-hatch tire results in differential wear of the test specimen surface that mirrors the pattern of the tire. This differential wear pattern produces falsely higher polish values, particularly for softer aggregates. Other research has shown that increased tire wear has an effect of accentuating the polishing of the test specimens and resulting in lower polish values. Laboratory control specimens should be used to monitor the effect of the tire wear on accelerated polishing and tests results.

5.1.3.3 *Alternate Tire No. 3*—An 8-in. (203.2-mm) diameter solid rubber tire (Note ~~4~~5). The tire rubber hardness shall be 69 ± 3 IRHD measured in accordance with Test Method D1415. It is necessary to move the cylindrical wheel approximately 3/16 in. (4.76 mm) away from the polishing machine to allow the tire to center over the test specimens. The tire shall be replaced when the *RPV-10* of the control specimens described in 7.2have decreased by more than four points from the *RPV-10* obtained from a new tire.

NOTE~~4—This~~ 5—This is the tire presently supplied by the manufacturer of the Accelerated Polishing Machine.[3] Research has shown that increased tire wear has an effect of accentuating the polishing of the test specimens and resulting in lower polish values. Laboratory control specimens should be used to monitor the effect of the tire wear on accelerated polishing and test results.

5.1.4 A means to feed the 150-grit silicon carbide abrasive at the rate given in 8.5. The grit shall be fed continuously and with a uniform distribution across the width of the specimens. The grit shall be applied directly onto the road wheel surface ahead of the point of contact with the rubber-tired wheel.

5.1.5 A means to feed the water at the rate given in 8.5 in such a way that the water is spread continuously and uniformly over the surface of the road wheel ahead of the point of contact with the rubber-tired wheel.

5.2 *Metal Molds*—A number of accurately machined metal molds for preparing specimens. The specimen formed is 3.5 by 1.75 by 0.63 in. (88.90 by 44.45 by 16.0 mm) and shall be curved to fit on a surface having an 8-in. (203.2-mm) radius of curvature.

5.3 *British Pendulum Tester*—A friction-measuring device. The British Pendulum Tester used shall conform to Method E303.

[3] Available from Wessex Engineering and Metal Craft Co., Ltd., Merchants Barton, Frome, Somerset, England. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

[4] Supporting Data are available from ASTM Headquarters. Request RR:D04-1002.

5.3.1 The slider contact path shall be 3 ± 1⁄16 in. (76.20 ± 1.59 mm).
5.3.2 The slider width shall be 1¼ in. (31.75 mm).
5.3.3 The rubber that is bonded to the slider shall be ¼ by 1 by 1¼ in. (6.35 by 25.4 by 31.75 mm).
5.3.4 The rubber shall meet the requirements of Specification E501.
5.3.5 The zero adjustment shall be checked before and after testing the specimens and as often as the operator deems necessary.
5.3.6 The calibration procedures of Test Method E303 shall be used. However, after calibration the small slider shall be inserted.
5.3.7 *Sanding Block*—A rigid metal block with a planed surface of 7.5-in. (190.5-mm) radius of curvature that is consistent with the radius of curvature of the road wheel bearing surface.

## 6. Materials and Supplies

6.1 *Water*—A supply of tap water for use where water is required for any purpose in this method.
6.2 *Fine Sand*—A supply of fine sand for sifting into the interstices of the aggregate prior to placing of the bonding material. Standard sand conforming to Specification C778 has been found suitable for this purpose.
6.3 *Mold Release Agent*—The use of a mold release agent is optional. A mold release agent may be used to prevent bonding between the mold and the bonding material. Silicon release agent and paste wax as used for automobiles and floors has been found suitable. The user should use care to prevent this agent from being absorbed by the aggregate as it could affect the measured polish value.
6.4 *Silicon Carbide Grit*—~~A supply of silicon carbide grit (150-grit size) to be used as the polishing agent. Grit should be checked for gradation using Nos. 100 (150 µm), 140 (106 µm) and 200 (75 µm) sieves and separated if necessary to maintain a uniform gradation passing the 100 (150 µm) sieve and retained on the 200 (75 µm) sieve.~~ —A supply of silicon carbide grit (150-grit size) to be used as the polishing agent. Grit should be checked for gradation using Nos. 150µm (No. 100), 106 µm (No. 140) and 75 µm (No. 200) sieves and separated if necessary to maintain a uniform gradation passing the No. 150 µm (No. 100) sieve and retained on the No. 75 µm (No. 200) sieve.
6.5 *Bonding Agent*—A supply of polyester resin and catalyst (or another suitable bonding material, such as an epoxy resin) having a pot life of 20 to 30 min and a curing time of 3 to 6 h. This bonding agent shall not be so fluid as to flow through the fine sand.
6.5.1 An optional bonding agent may be used to eliminate use of the fine sand. This bonding agent must be quite viscous so that it will not flow completely around the aggregate particles and become part of the surface of the test specimen. Examples of suitable materials are given in Appendix X1.
6.5.2 Follow the manufacturer's precautions concerning storage and use of resin and catalyst.
6.6 *Coarse Aggregate*—Approximately a ½ ft $^3$(0.014 m$^3$) supply of coarse aggregate to be tested and sampled in accordance with Practice D75. The aggregate shall be normal plant run but laboratory-crushed material may be tested, if so identified.

## 7. Test and Control Specimens

7.1 Five test specimens for each coarse aggregate shall be tested.
7.2 Standard laboratory control specimens shall be included in each run to develop consistency in specimen preparation and polishing. Four control specimens shall be included with two sets containing five test specimens each for each run. Aggregates used for fabrication of control specimens should be of consistent property and *RPV-10* test history.

NOTE ~~5—It~~ 6—It has been found that the polishing surface of control specimen can be successfully replicated by filling the bottom of the metal mold with a uniform mixture of 4 parts 20-30 grade Ottawa sand and 1 parts polyester resin. The backing of the Ottawa sand control specimens should be 100% polyester resin to facilitate preparation of the surface bearing against the road wheel.

7.3 The aggregate to be tested shall pass the 12.5–mm (½~~-in (12.7-mm)~~ -in) sieve and shall be retained on a ~~-in. (9.5-mm)~~9.5-mm (⅜-in.) sieve.

NOTE ~~6~~7—Aggregate gradation may be varied to meet the needs of the user if reported with the test results. However, aggregates larger than ~~in. (12.7 mm)~~12.5 mm (½ in.) may not be accommodated by the mold, and aggregates smaller than ~~in. (9.5 mm)~~9.5 mm (⅜ in.) may not be adequately bonded in the specimen molding process to be retained for the duration of the test. For laboratories and agencies evaluating and monitoring multiple aggregate sources, an alternate aggregate size of passing 9.5 mm (⅜~~-in (9.5-mm)~~ in.) sieve and retained on a 6.3-mm (¼~~-in. (6.4-mm)~~ -in.) sieve may be used to represent the critical size of the bituminous mixture. The two aggregate sizes described should not be used alternately for quality monitoring of friction aggregates.

7.4 Thoroughly wash and dry the aggregate to be tested at ~~110~~230° ± 9°F (110 ± 5°C) to essentially constant weight.
7.5 Coat the mold with mold-release agent.
7.6 Each specimen shall contain a single layer of dry aggregate placed by hand as densely as possible with a flat surface down to cover the bottom 3.5 by 1.75-in. (88.9 by 44.45-mm) surface of the mold.

NOTE ~~7~~8—Particles selected should be representative of the material to be evaluated. Flat, elongated, or unusually shaped particles can cause difficulty in placement and bonding. Misleading polish values can result from inadequate surface area for polishing.

7.7 Fill the interstices between the aggregate with the fine sand, described in 6.2, from one fourth to one half of the aggregate depth.
7.7.1 An optional method eliminates the sand by using a viscous polyester resin. This material is described in 6.5.