

COMMITTEE ON MATERIALS AND PAVEMENTS

Meeting (Annual or Mid-Year)	Annual
Date	8/7/2019
Scheduled Time	3:15 pm
Technical Subcommittee & Name	TS 1c – Aggregates
Chair Name and (State)	Matt Beeson (IN)
Vice Chair Name and (State)	Temple Short (SC)
Research Liaison Name and (State)	

I. Introduction and Housekeeping

II. Call to Order and Opening Remarks

A. Brief Summary of Activities

(Briefly explain the goals of today's meeting and what you hope to accomplish. Get everyone up to speed and on the same page.)

III. Roll Call of Voting Members

Present	Member Name	State	Present	Member Name	State
<input type="checkbox"/>	Steven Ingram	AL	<input type="checkbox"/>	John Staton	MI
<input type="checkbox"/>	Michael San Angelo	AK	<input type="checkbox"/>	Curt Turgeon	MN
<input type="checkbox"/>	Jesus Sandoval-Gil	AZ	<input type="checkbox"/>	Mick Syslo	NE
<input type="checkbox"/>	Michael Benson	AR	<input type="checkbox"/>	Darin Tedford	NV
<input type="checkbox"/>	Robert Lauzon	CT	<input type="checkbox"/>	Steve Heiser	NY
<input type="checkbox"/>	Wasi Khan	DC	<input type="checkbox"/>	Mickey Cronin	OH
<input type="checkbox"/>	John Shoucair	FL	<input type="checkbox"/>	Matt Romero	OK
<input type="checkbox"/>	Peter Wu	GA	<input type="checkbox"/>	Becca Lane	ON
<input type="checkbox"/>	Mike Santi	ID	<input type="checkbox"/>	Magdy Beshara	SK
<input type="checkbox"/>	Andrew Stolba	IL	<input type="checkbox"/>	Michael Doran	TN
<input type="checkbox"/>	Richard Barezinsky	KS	<input type="checkbox"/>	William Lawrence	UT
<input type="checkbox"/>	Rick Bradbury	ME	<input type="checkbox"/>	Charles Babish	VA
<input type="checkbox"/>	Sejal Barot	MD	<input type="checkbox"/>	Paul Farley	WV

Quorum Rules Met?

Annual Meeting: Simple majority of voting members (☐y/ ☐n) | Mid-Year Meeting: Voting members present (☐y/ ☐n)

A. Review of Membership (New members, exiting members, etc.)

IV. Approval of Technical Subcommittee Minutes

ATTACHMENT 1 - Mid-Year Meeting (Webinar) 2/6/19 Minutes

V. Old Business

Chair is recommending a voice vote be taken on the following three items following presentation and discussion:

A. T 27 – Sieve Analysis of Fine and Coarse Aggregates

1. Changes made to align as well as possible with recently adopted T 30 changes. Includes some changes since last seen to address negative comments from fall ballot.

ATTACHMENT 2 – T 27 – July 2019 Draft

- B. T 21 – Organic Impurities in Fine Aggregates for Concrete
2. *Changes to reflect recently adopted edits to ASTM C40. Corrects errors found in the alignment of Gardiner color scale and circular number plate.*

ATTACHMENT 3 – T 21 – July 2019 Draft

- C. T 11 – Materials Finer Than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
3. *Already approved at 2017 Annual Meeting. Since changes were never implemented, the chair wanted TS another chance to review.*

ATTACHMENT 4 – T 11 changes (updated with newest standard)

- D. T 112 - Clay Lumps and Friable Particles in Aggregate
4. *Need more clarification*

- E. TP XX – Determining the Relative Density (Specific Gravity) and Absorption of Lightweight Aggregate
5. *Going to TS ballot (you’ve already seen this but we haven’t had a TS ballot since)*

ATTACHMENT 5 – Draft LWA Centrifuge Method

F. Task Force Reports

Task Force #	Title	Members	Status/Update
TF 17-01	Friction Practice	MD – Sejal Barot, TN, LA, FL, WV, others	Standards ready to go – TS ballot forthcoming ATTACHMENT 6 – Asphalt Std draft 6-11-2019 ATTACHMENT 7 – Aggregate Standard Practice

VI. New Business

- A. AASHTO re:source/CCRL/NTPEP (*Observations from assessments, as applicable.*)
- B. Presentation by Industry/Academia
- C. Revisions/Work on Standards for Coming Year
 1. T103 proposed revisions from WisDOT
- D. Review of Stewardship List
(*List of subcommittee’s standards flagging those requiring action; include as separate attachment.*)
- E. Proposed New Standards
 1. See above
- F. NCHRP Issues
- G. Correspondence, Calls, Meetings
- H. Proposed New Task Forces (*Include list of volunteers to lead and/or join TF.*)
- I. New TS Ballots
 1. Three new standards, T 112
 2. Reconfirmation
 - a. M 29, M 45, R 76, T 104, T 304, T 327, TP 120

VII. Open Discussion

VIII. Adjourn

TS Meeting Summary

Meeting Summary		
Items Approved by the TS for Ballot <i>(Include reconfirmations.)</i>		
Standard Designation	Summary of Changes Proposed	Ballot Type
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
New Task Forces Formed		
Task Force Name	Summary of Task	TF Member Names and (States)
Research Proposals <i>(Include number/title/states interested.)</i>		
Other Action Items		



COMMITTEE ON MATERIALS & PAVEMENTS

2019 Mid Year Meeting (*Webinar*)

Wednesday February 6, 2019

11:00 – 12:30 PM EST

TECHNICAL SUBCOMMITTEE 1c

Aggregates

I. Introduction and Housekeeping (*AASHTO Liaison*)

II. Call to Order and Opening Remarks

- A. Brief summary of activities (*Please briefly explain the goals of today's meeting and what you hope to accomplish. Get everyone up to speed and on the same page.*)

III. Roll Call

Last Name (v) = voting	First Name	Email
(v) Barezinsky	Rick	rick.barezinsky@ks.gov
(v) Beeson	Matt (C)	mbeeson@indot.in.gov
(v) Benson	Michael	michael.benson@ardot.gov
Bergold	Desna	desna@dbconllc.com
(v) Bradbury	Rick	richard.bradbury@maine.gov
(v) Burch	Paul	pburch@azdot.gov
(v) Cronin	Mickey	Mickey.Cronin@dot.ohio.gov
Dees	Amanda	amanda.dees@ky.gov
(v) Doran	Michael	michael.doran@tn.gov
Egan	Brian	TN
Kerstetter	Joseph	TN
Festa	Tom	thomas.festa@dot.ny.gov
(v) Heiser	Steven	steve.heiser@dot.ny.gov
(v) Lawrence	Bill	BillLawrence@utah.gov
Nussbaum	Scott	UT
(v) Metcalfe	Oak	rmetcalfe@mt.gov
Puterbaugh	Sonya	sputerbaugh@ashtoresource.org
Wagner	Mike	Re:source
Ramirez	Timothy	tramirez@pa.gov
Johnson	Brian	Re:source
(v) Santi	Mike	mike.santi@itd.idaho.gov
Schumaker	Clayton	cschumaker@nd.gov

(v) Short	Temple (VC)	shorttk@scdot.org
Zwanka	Merrill	SC
(v) Shoucair	John	john.shoucair@dot.state.fl.us
Speer	Daniel	dan.speer@dot.ca.gov
Stanford	Michael	michael.stanford@state.co.us
(v) Stolba	Andrew	andrew.stolba@illinois.gov
(v) Tedford	Darin	dtedford@dot.nv.gov
Trepanier	Jim	james.trepanier@illinois.gov
WELDERUFAEL	AMANUEL	awelderufael@sha.state.md.us
Wieden	Craig	craig.wieden@state.co.us
Wilson	Craig	cwilson2@azdot.gov

IV. Approval of Technical Subcommittee Minutes

- A. Approval of Annual Meeting minutes, August 8, 2018 **ATTACHMENT 1**
Motion by IL to approve minutes; 2nd by UT – no discussion and minutes pass as written

V. Old Business

- A. COMP Ballot Items (Including any ASTM Changes/equivalencies)
1. Outstanding items from Annual Meeting?
 2. Review of Ballots

a. T 27 – Sieve Analysis of Fine and Coarse Aggregates

Item Number	12
Description	COMP Ballot for T 27 – Sieve Analysis of Fine and Coarse Aggregates. The changes mainly include moving adequacy of sieving and sieve overload determination instructions to a newly-created Annex.
Decisions	Affirmative: 42 of 51 Negative: 1 of 51 No Vote: 8 of 51
Comments	Illinois Department of Transportation (Andrew J. Stolba) (Non-Voting) - All reference to ASTM C 136-06 should be changed to ASTM C 136-14. Chair Comments: Agree, references have been changed. Missouri Department of Transportation (Brett Steven Trautman) (Voting) - Recommend an affirmative vote with two editorial comments: 1) In Section 8.2, the fourth line contains a references to Annex A2 (regulate material on a sieve) and the eighth line contains a reference to Annex A1 (adequacy of sieving). Recommend the Annex's be referenced in numerical order as you go through the section. Hence, the fourth line would reference Annex A1 and the eighth line would reference Annex A2. This change would also involve changing the order of Section A1 and A2 in Annex A.

2) Section number 8.3.1.3 has been deleted but the information was not. Note 5 was deleted but Section No. 8.3.1.3 was added but no information was added. Not sure what the intent is.

Chair Comments:

Agree with comment 1, Section A1 and A2 have been reversed in section 8.2 and in the Annex.

Agree with comment 2, it appears section 8.3.1.3 was included in error.

Pennsylvania Department of Transportation (Timothy Ramirez) (Non-Voting) –

1) The sieve overloading criteria should not be moved from the body of the standard to Annex A2. This criteria is to be evaluated during each test and needs to be readily available and known by the technician who is performing the test.

2) Moving the sieve timing or shaker efficiency criteria is OK to move to an Annex A1 as this should be done prior to performing any tests.

3) In Section A1.1, revise from "should be evaluated" to "shall be evaluated". Using "should" seems to send a mixed message as the Annex A is identified as "mandatory information".

Chair Comments:

Agree with comment 3, the edit has been made to change “should” to “shall.”

Florida Department of Transportation (Timothy J. Ruelke) (Voting) - Note "NCHRP Project 20-07/Task 421“Evaluating the Effectiveness of Mechanical Sieve and Screen Shakers”, will likely reexamine methods used in this test and apply findings to subsection 8.4.

Tennessee Department of Transportation (Brian K. Egan) (Voting) –

Negative comment does not reflect moving the time evaluation to the annex. Note 2 states more than 10 minutes of shaking time is excessive and may result in degradation of the sample. However A.1.1 states "Shake the sample over nested sieves for approximately 10 minutes." This could as stated in note 2 result in degradation of the sample. We suggest starting at a lower value such as 5 minutes and follow the rest of the annex procedures until less than 0.5% of mass is achieved. We suggest clarifying A.1.2. Does a technician have to scrap the sample after attaining a mass of greater than 0.5%? If you are not scraping the sample then what is meant by recheck? Is this additional hand sieving to achieve <0.5% mass or does it mean mechanically shaking the sample again?

Chair finds the negative from Tennessee persuasive. Draft edits were prepared to attempt to address negative comments, however, more work is still needed. Draft changes are shown in ATTACHMENT 2.

Chair had a phone conversation with Tennessee 1/31/19. We still need to resolve:



- If 0.5% mass check fails, do you mechanically shake the same sample again? This disagrees with Note 2.
- 0.5% mass could be confusing to users of this method, and might be perceived as 0.5% passing rather than 0.5% by total mass.

TN responded that this sufficiently addresses their negative as found persuasive. FL wants to clarify what to do when 0.5% can't be established? If the sample fails do you use a new sample? Add another minute? ...there are several questions to be answered to clarify this standard.

- FL: Wants to know if this hand-check is supposed to be completed during every single gradation or only for the annual calibration
- OH agrees. They establish a shake time for each kind of material and take shake time into consideration if there's ever a disagreement with a contractor or have disputed results
- TN thinks the sieving sufficiency depends on the kind of material that you're using. FL establishes a different shake time for each material type.
- AI: Matt will continue to work internally and with TN to resolve the negative and make additional edits.

B. TS Ballots

- Really Old Business – T 11 changes were approved by TS at 2017 Annual Meeting, but never went to ballot, regarding how long mechanical washing device can run. Changes are shown in **ATTACHMENT 3**.
 - The changes were approved. The chair would like the group to have another chance to look through this ballot item before sending it to COMP ballot.

C. Reconfirmation Ballots

- Original Reconfirmation Ballot sent out in September was erroneous. Correct Reconfirmation Ballot is currently open, closing 2/8/19.

D. Task Force Reports

- TF 11-01: T112 Revision (KS – Rick Barezinsky, NE, AK, AMRL)
 - Draft edits to T 112 for clay lumps and friable particles sent to chair. See **ATTACHMENT 4**.
 - This will go to TS ballot.
- TF 15-03: Centrifuge method for LWA (LA, FL, KS, Jeff Speck)
 1. Draft standard for specific gravity of Light Weight Aggregate sent to chair. See **ATTACHMENTS 5 AND 6**.
- TF 16-01: T27 Sieving Sufficiency - *Sunsetted. A research project through NCHRP is ongoing. Once the report is published, the task force will reconvene.*
 - The results of this may impact changes to T27.
- TF 17-01: Friction Practice (MD –Sejal Barot, TN, LA, FL, WV, FHWA)
 1. Much work going on - finalizing specifications for Standard Practice of Sample Preparation and Polishing of Unbound Aggregates and HMA for Dynamic Friction Test. (DFT).

VI. New Business

- A. Research Proposals -
- B. AASHTO Re:source/CCRL/NTPEP - Observations from Assessments, as applicable? – OH mentioned something that came up in T 104. They were looking for sodium sulfate salt and are looking for a certain level of purity. TN: there was previously a suggested change to remove “reagent grade” to specify 99% purity. OH: There are 2 suppliers that are claiming to have 99+% pure but the prices are astronomically different. Discussion: there may be no difference in the material itself so much as possibly the way that the purity is determined. This standard is coming up for reconfirmation in the 2020 ballot cycle. OH volunteers to be steward of these standards.
- C. NCHRP Issues
- D. Correspondence, calls, meetings



- Correspondence from John Yzenas (Kelly Cook) with ASTM C09 showing changes that passed for ASTM C40. **ATTACHMENT 7**
 - C40 has been changed. Chair recommends making companion changes to T 21. At some point the Gardiner Scale and the circular number plate got misaligned and have been corrected.
 - E. Presentation by Industry/Academia
 - F. Revisions/Work on Standards for Coming Year
 - T 27; T 104; T 21
 - G. Proposed New Standards - none
 - H. Proposed New Task Forces - none
(Include list of volunteers to lead and/or join TF)
 - I. New TS Ballots?
 - T 11 - Materials Finer Than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
 - T 112 – Clay Lumps and Friable Particles
 - Specific Gravity of Lightweight Aggregate
 - T 27 – Sieving sufficiency
 - T 21 – Organic Impurities
 - Mickey Cronin (OH) volunteers to be steward of T 104. TN will help with this
 - FL is steward T 96
 - J. Technical Subcommittee membership
 - If anyone would like to be a member of the TS please email Matt and Casey
- VII. Open Discussion**
- None
- VIII. Adjourn**

Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates

AASHTO Designation: T 27-14 (2018)¹

Technical Subcommittee: 1c, Aggregates

Release: Group 3 (July)

ASTM Designation: C136-06



**American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001**

Standard Method of Test for

Sieve Analysis of Fine and Coarse Aggregates

AASHTO Designation: T 27-14 (2018)¹
Technical Subcommittee: 1c, Aggregates
Release: Group 3 (July)
ASTM Designation: C136-06



1. SCOPE
- 1.1.

This method covers the determination of the particle size distribution of fine and coarse aggregates by sieving.
- 1.2.

Some specifications for aggregates, which reference this method, contain grading requirements including both coarse and fine fractions. Instructions are included for sieve analysis of such aggregates.
- 1.3.

The values stated in SI units are to be regarded as the standard. The values in parentheses are provided for information purposes only.
- 1.4.

This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user of this procedure to consult and establish appropriate safety and health practices and to determine the applicability of regulatory regulations prior to its use.

2. REFERENCED DOCUMENTS
- 2.1.

AASHTO Standards:

■ M 231, Weighing Devices Used in the Testing of Materials

■ R 76, Reducing Samples of Aggregate to Testing Size

■ R 90, Sampling Aggregate Products

■ T 11, Materials Finer Than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
- 2.2.

ASTM Standards:

■ C125, Standard Terminology Relating to Concrete and Concrete Aggregates

■ C670, Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

■ E11, Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves
- 2.3.

~~IEEE/ASTM Standard:~~

~~■ SI 10, American National Standard for Metric Practice~~
- Commented [BM1]:** According to the AASHTO Style Manual, only references used in the body should be listed. (From WAQTC)
- TS-1c

T 27-1

AASHTO

3. TERMINOLOGY

- 3.1. *Definitions*—For definitions of terms used in this standard, refer to ASTM C125.

4. SUMMARY OF METHOD

- 4.1. A sample of dry aggregate of known mass is separated through a series of sieves of progressively smaller openings for determination of particle size distribution.

5. SIGNIFICANCE AND USE

- 5.1. This method is used primarily to determine the grading of materials proposed for use as aggregates or being used as aggregates. The results are used to determine compliance of the particle size distribution with applicable specification requirements and to provide necessary data for control of the production of various aggregate products and mixtures containing aggregates. The data may also be useful in developing relationships concerning porosity and packing.
- 5.2. Accurate determination of material finer than the 75- μm (No. 200) sieve cannot be achieved by use of this method alone. T 11 for material finer than the 75- μm (No. 200) sieve by washing should be employed.

6. APPARATUS

- 6.1. *Balance*—The balance shall have sufficient capacity, be readable to 0.1 percent of the sample mass, or better, and conform to the requirements of M 231.
- 6.2. *Sieves*—The sieve cloth shall be mounted on substantial frames constructed in a manner that will prevent loss of material during sieving. The sieve cloth and standard sieve frames shall conform to the requirements of ASTM E11. Nonstandard sieve frames shall conform to the requirements of ASTM E11 as applicable.
Note 1—It is recommended that sieves mounted in frames larger than standard 203.2 mm (8 in.) diameter be used for testing coarse aggregate to reduce the possibility of overloading the sieves. See Section 8.3.
- 6.3. *Mechanical Sieve Shaker*—A mechanical sieving device, if used, shall create motion of the sieves to cause the particles to bounce, tumble, or otherwise turn so as to present different orientations to the sieving surface. The sieving action shall be such that the criterion for adequacy of sieving described in Section 8.4 is met in a reasonable time period.
Note 2—Use of a mechanical sieve shaker is recommended when the size of the sample is 20 kg (44 lb) or greater, and may be used for smaller samples, including fine aggregate. Excessive time (more than approximately 10 min) to achieve adequate sieving may result in degradation of the sample. The same mechanical sieve shaker may not be practical for all sizes of samples because the large sieving area needed for practical sieving of a large nominal size coarse aggregate very likely could result in loss of a portion of the sample if used for a smaller sample of coarse aggregate or fine aggregate.
- 6.4. *Oven*—An oven of appropriate size capable of maintaining a uniform temperature of $110 \pm 5^\circ\text{C}$ ($230 \pm 9^\circ\text{F}$).

7. SAMPLING

- 7.1. Sample the aggregate in accordance with R 90. The mass of the field sample shall be the mass shown in R 90 or four times the mass required in Sections 7.4 and 7.5 (except as modified in Section 7.6), whichever is greater.
- 7.2. Thoroughly mix the sample and reduce it to an amount suitable for testing using the applicable procedures described in R 76. The sample for test shall be the approximate mass desired when dry and shall be the end result of the reduction. Reduction to an exact predetermined mass shall not be permitted.
- Note 3**—Where sieve analysis, including determination of material finer than the 75- μ m (No. 200) sieve, is the only testing proposed, the size of the sample may be reduced in the field to avoid shipping excessive quantities of extra material to the laboratory.
- 7.3. *Fine Aggregate*—The size of the test sample of aggregate, after drying, shall be 300 g minimum.
- 7.4. *Coarse Aggregate*—The mass of the test sample of coarse aggregate shall conform with the following:

Nominal Maximum Size Square Openings, mm (in.)	Minimum Mass of Test Sample, kg (lb)
9.5 (³ / ₈)	1 (2)
12.5 (¹ / ₂)	2 (4)
19.0 (³ / ₄)	5 (11)
25.0 (1)	10 (22)
37.5 (1 ¹ / ₂)	15 (33)
50 (2)	20 (44)
63 (2 ¹ / ₂)	35 (77)
75 (3)	60 (130)
90 (3 ¹ / ₂)	100 (220)
100 (4)	150 (330)
125 (5)	300 (660)

- 7.5. *Coarse and Fine Aggregates Mixtures*—The mass of the test sample of coarse and fine aggregate mixtures shall be the same as for coarse aggregate in Section 7.4.
- 7.6. *Samples of Large-Size Coarse Aggregate*—The size of sample required for aggregate with 50-mm (2-in.) nominal maximum size or larger is such as to preclude convenient sample reduction and testing as a unit except with large mechanical splitters and sieve shakers. As an option when such equipment is not available, instead of combining and mixing sample increments and then reducing the field sample to testing size, conduct the sieve analysis on a number of approximately equal sample increments such that the total mass tested conforms to the requirements of Section 7.4.
- 7.7. In the event that the amount of material finer than the 75- μ m (No. 200) sieve is to be determined by T 11, use the procedure described in Section 7.7.1 or 7.7.2, whichever is applicable.
- 7.7.1. For aggregates with a nominal maximum size of 12.5 mm (¹/₂ in.) or less, use the same test sample for testing by T 11 and this method. First test the sample in accordance with T 11 through the final drying operation, then dry sieve the sample as stipulated in Sections 8.2 through 8.6 of this method.

- 7.7.2. For aggregates with a nominal maximum size greater than 12.5 mm ($1/2$ in.), a single test sample may be used as described in Section 7.7.1 or separate test samples may be used for T 11 and this method.
- 7.7.3. Where the specification requires determination of the total amount of material finer than the 75- μ m (No. 200) sieve by washing and dry sieving, use the procedure described in Section 7.7.1.

8. PROCEDURE

- 8.1. If the test sample has not been subjected to testing by T 11, dry it to constant mass at a temperature of $110 \pm 5^\circ\text{C}$ ($230 \pm 9^\circ\text{F}$). Determine and record the mass of material that will be placed on the sieves to the accuracy of the balance as defined in Section 6.1.
- Note 4**—For control purposes, particularly where rapid results are desired, it is generally not necessary to dry coarse aggregate for the sieve analysis test. The results are little affected by the moisture content unless (1) the nominal maximum size is smaller than about 12.5 mm ($1/2$ in.), (2) the coarse aggregate contains appreciable material finer than 4.75 mm (No. 4), or (3) the coarse aggregate is highly absorptive (a lightweight aggregate, for example). Also, samples may be dried at the higher temperature associated with the use of hot plates without affecting results, provided steam escapes without generating pressures sufficient to fracture the particles, and temperatures are not so great as to cause chemical breakdown of the aggregate.
- 8.2. Select sieves with suitable openings to furnish the information required by the specifications covering the material to be tested. Use additional sieves as desired or necessary to provide other information, such as fineness modulus, or to regulate the amount of material on a sieve *to meet the requirements of Annex A1*. Nest the sieves in order of decreasing size of opening from top to bottom and place the sample, or portion of the sample if it is to be sieved in more than one increment, on the top sieve. Agitate the sieves by hand or by mechanical apparatus for a sufficient period, established by trial or checked by measurement on the actual test sample, to meet the criterion for adequacy of sieving described in *Section 8.4 Annex A2*.
- 8.3. Limit the quantity of material on a given sieve so that all particles have opportunity to reach sieve openings a number of times during the sieving operation. *For sieves with openings smaller than 4.75 mm (No. 4), the quantity retained on any sieve at the completion of the sieving operation shall not exceed 7 kg/m² (4 g/in.²) of sieving surface area (Note 5). For sieves with openings 4.75 mm (No. 4) and larger, the quantity retained in kg shall not exceed the product of 2.5 \times (sieve opening, mm \times (effective sieving area, m²)). This quantity is shown in Table 1 for five sieve-frame dimensions in common use. In no case shall the quantity retained be so great as to cause permanent deformation of the sieve cloth.*
- 8.3.1. *Prevent an overload of material on an individual sieve as described in Table A1 by one or a combination of the following methods:*
- 8.3.1.1. Insert an additional sieve with opening size intermediate between the sieve that may be overloaded and the sieve immediately above that sieve in the original set of sieves.
- 8.3.1.2. Split the sample into two or more portions, sieving each portion individually. Combine the masses of the several portions retained on a specific sieve before calculating the percentage of the sample on the sieve.
- 8.3.1.3. Use sieves having a larger frame size and providing greater sieving area.
- Note 5**—The 7 kg/m² amounts to 200 g for the usual 203.2-mm (8 in.) diameter sieve (with effective sieving surface diameter of 190.5 mm (7.5 in.)).

Commented [BM2]: Moved to Annex

Commented [BM3]: Moved to Annex

8.3.1.4. In the case of coarse and fine aggregate mixtures, the portion of the sample finer than the 4.75-mm (No. 4) sieve may be distributed among two or more sets of sieves to prevent overloading of individual sieves.

8.3.1.5. Alternatively, the portion finer than the 4.75-mm (No. 4) sieve may be reduced in size using a mechanical splitter according to R 76. If this procedure is followed, compute the mass of each size increment of the original sample as follows:

$$A = \frac{W_1}{W_2} \times B \quad (1)$$

where:

A = mass of size increment on total sample basis;

W_1 = mass of fraction finer than 4.75-mm (No. 4) sieve in total sample;

W_2 = mass of reduced portion of material finer than 4.75-mm (No. 4) sieve actually sieved; and

B = mass of size increment in reduced portion sieved.

Table 1—Maximum Allowable Quantity of Material Retained on a Sieve, kg

Sieve Opening Size	Nominal Dimensions of Sieve ^a				
	203.2-mm, dia ^b	254-mm, dia ^b	304.8-mm, dia ^b	350 by 350, mm	372 by 580, mm
	Sieving Area, m ²				
	0.0285	0.0457	0.0670	0.1225	0.2158
125 mm (5 in.)	†	†	†	†	67.4
100 mm (4 in.)	†	†	†	30.6	53.9
90 mm (3 1/2 in.)	†	†	15.1	27.6	48.5
75 mm (3 in.)	†	8.6	12.6	23.0	40.5
63 mm (2 1/2 in.)	†	7.2	10.6	19.3	34.0
50 mm (2 in.)	3.6	5.7	8.4	15.3	27.0
37.5 mm (1 1/2 in.)	2.7	4.3	6.3	11.5	20.2
25.0 mm (1 in.)	1.8	2.9	4.2	7.7	13.5
19.0 mm (3/4 in.)	1.4	2.2	3.2	5.8	10.2
12.5 mm (1/2 in.)	0.89	1.4	2.1	3.8	6.7
9.5 mm (3/8 in.)	0.67	1.1	1.6	2.9	5.1
4.75 mm (No. 4)	0.33	0.54	0.80	1.5	2.6

^a—Sieve frame dimensions in inch units: 8.0 in. diameter; 10.0 in. diameter; 12.0 in. diameter; 13.8 by 13.8 in. (14 by 14 in. nominal); 14.6 by 22.8 in. (16 by 24 in. nominal).

^b—The sieve area for round sieves is based on an effective diameter 12.7 mm (1/2 in.) less than the nominal frame diameter, because ASTM E11 permits the sealer between the sieve cloth and the frame to extend 6.35 mm (1/4 in.) over the sieve cloth. Thus the effective sieving diameter for a 203.2-mm (8.0 in.) diameter sieve frame is 190.5 mm (7.5 in.). Sieves produced by some manufacturers do not infringe on the sieve cloth by the full 6.35 mm (1/4 in.).

^c—Sieves indicated have less than five full openings and should not be used for sieve testing.

8.4. Continue sieving for a sufficient period and in such manner that, after completion, not more than 0.5 percent by mass of the total sample passes any sieve during 1 min of continuous hand sieving performed as follows: Hold the individual sieve, provided with a snug-fitting pan and cover, in a slightly inclined position in one hand. Strike the side of the sieve sharply and with an upward motion against the heel of the other hand at the rate of about 150 times per minute; turn the sieve about one sixth of a revolution at intervals of about 25 strokes. In determining sufficiency of sieving for sizes larger than the 4.75-mm (No. 4) sieve, limit the material on the sieve to a single layer of particles. If the size of the mounted testing sieves makes the described sieving motion impractical, use 203.2-mm (8 in.) diameter sieves to verify the sufficiency of sieving.

Commented [BM4]: Moved to Annex

8.5.8.4. Unless a mechanical sieve shaker is used, hand sieve particles ~~obtained-retained~~ on the 75 mm (3 in.) by determining the smallest sieve opening through which each particle will pass by rotating the particles, if necessary, in order to determine whether they will pass through a particular opening; however, do not force particles to pass through an opening.

8.6.8.5. Determine the mass of each size increment on a scale or balance conforming to the requirements specified in Section 6.1 to the nearest 0.1 percent of the total original dry sample mass. The total mass of the material after sieving should check closely with the total original dry mass of the sample placed on the sieves. If the two amounts differ by more than 0.3 percent, based on the total original dry sample mass, the results should not be used for acceptance purposes.

9. CALCULATION

9.1. Calculate percentages passing, total percentages retained, or percentages in various size fractions to the nearest 0.1 percent on the basis of the total mass of the initial dry sample. If the same test sample was first tested by T 11, include the mass of material finer than 75- μ m (No. 200) sieve by washing in the sieve analysis calculation; and use the total dry sample mass prior to washing in T 11 as the basis for calculating all the percentages.

9.1.1. When sample increments are tested as provided in Section 7.6, total the masses of the portion of the increments retained on each sieve, and use these masses to calculate the percentage as in Section 9.1.

9.2. Calculate the fineness modulus, when required, by adding the total percentages of material in the sample that are coarser than each of the following sieves (cumulative percentages retained), and dividing the sum by 100; 150 μ m (No. 100), 300 μ m (No. 50), 600 μ m (No. 30), 1.18 mm (No. 16), 2.36 mm (No. 8), 4.75 mm (No. 4), 9.5 mm ($3/8$ in.), 19.0 mm ($3/4$ in.), 37.5 mm ($1\frac{1}{2}$ in.), and larger, increasing the ratio of 2 to 1.

10. REPORT

10.1. *Depending on the form of the specifications for use of the material under test, the report shall include one of the following:*

10.1.1. Total percentage of material passing each sieve, or

10.1.2. Total percentage of material retained on each sieve, or

10.1.3. Percentage of material retained between consecutive sieves.

10.2. Report percentages to the nearest whole number, except if the percentage passing the 75- μ m (No. 200) sieve is less than 10 percent, it shall be reported to the nearest 0.1 percent.

10.3. Report the fineness modulus, when required, to the nearest 0.01.

11. PRECISION AND BIAS

11.1. *Precision*—The estimates of precision for this test method are listed in Table 2. The estimates are based on the results from the AASHTO Materials Reference Laboratory Proficiency Sample Program, with testing conducted by T 27 and ASTM C136. The data are based on the analyses of test results from 65 to 233 laboratories that tested 18 pairs of coarse aggregate proficiency test samples, and test results from 74 to 222 laboratories that tested 17 pairs of fine aggregate

proficiency test samples (Samples No. 21 through 90). The values in the table are given for different ranges of total percentage of aggregate passing a sieve.

Table 1—Estimates of Precision

	Total Percentage of Material Passing		Standard Deviation (1s), ^a %	Acceptable Range of Two Results (d2s), ^a %
Coarse Aggregate: ^b	100	≥95	0.32	0.9
Single-operator precision	<95	≥85	0.81	2.3
	<85	≥80	1.34	3.8
	<80	≥60	2.25	6.4
	<60	≥20	1.32	3.7
	<20	≥15	0.95	2.7
	<15	≥10	1.00	2.8
	<10	≥5	0.75	2.1
	<5	≥2	0.53	1.5
Multilaboratory precision	<2	0	0.27	0.8
	100	≥95	0.35	1.0
	<95	≥85	1.37	3.9
	<85	≥80	1.92	5.4
	<80	≥60	2.82	8.0
	<60	≥20	1.97	5.6
	<20	≥15	1.60	4.5
	<15	≥10	1.48	4.2
Fine Aggregate:	<10	≥5	1.22	3.4
	<5	≥2	1.04	3.0
	<2	0	0.45	1.3
	100	≥95	0.26	0.7
	<95	≥60	0.55	1.6
	<60	≥20	0.83	2.4
	<20	≥15	0.54	1.5
	<15	≥10	0.36	1.0
Single-operator precision	<10	≥2	0.37	1.1
	<2	0	0.14	0.4
Multilaboratory precision	100	≥95	0.23	0.6
	<95	≥60	0.77	2.2
	<60	≥20	1.41	4.0
	<20	≥15	1.10	3.1
	<15	≥10	0.73	2.1
	<10	≥2	0.65	1.8
	<2	0	0.31	0.9

^a These numbers represent, respectively, the (1s) and (d2s) limits as described in ASTM C670.

^b The precision estimates are based on aggregates with nominal maximum size of 19.0 mm (¾ in.).

11.1.1. The precision values for Fine Aggregate in Table 2 are based on nominal 500-g test samples. Revision of ASTM C136 in 1994 permitted the fine aggregate test sample size to be 300 g minimum. Analysis of results of testing of 300-g and 500-g test samples from Aggregate Proficiency Test Samples 99 and 100 (Samples 99 and 100 were essentially identical) produced the precision values in Table 3, which indicate only minor differences due to test sample size.

Note 5—The values for Fine Aggregate in Table 2 will be revised to reflect the 300-g test sample size when a sufficient number of Aggregate Proficiency Tests have been conducted using that sample size to provide reliable data.

Table 2—Precision Data for 300-g and 500-g Fine Aggregate Test Samples

Fine Aggregate Proficiency Sample Test Result	Sample Size	Number of Labs	Average	Within Laboratory		Among Laboratories	
				1s	d2s	1s	d2s
AASHTO T 27/ASTM C136:							
Total material passing the 4.75-mm (No. 4) sieve (%)	500 g	285	99.992	0.027	0.066	0.037	0.104
	300 g	276	99.990	0.021	0.060	0.042	0.117
Total material passing the 2.36-mm (No. 8) sieve (%)	500 g	281	84.10	0.43	1.21	0.63	1.76
	300 g	274	84.32	0.39	1.09	0.69	1.92
Total material passing the 1.18-mm (No. 16) sieve (%)	500 g	286	70.11	0.53	1.49	0.75	2.10
	300 g	272	70.00	0.62	1.74	0.76	2.12
Total material passing the 600-µm (No. 30) sieve (%)	500 g	287	48.54	0.75	2.10	1.33	3.73
	300 g	276	48.44	0.87	2.44	1.36	3.79
Total material passing the 300-µm (No. 50) sieve (%)	500 g	286	13.52	0.42	1.17	0.98	2.73
	300 g	275	13.51	0.45	1.25	0.99	2.76
Total material passing the 150-µm (No. 100) sieve (%)	500 g	287	2.55	0.15	0.42	0.37	1.03
	300 g	270	2.52	0.18	0.52	0.32	0.89
Total material passing the 75-µm (No. 200) sieve (%)	500 g	278	1.32	0.11	0.32	0.31	0.85
	300 g	266	1.30	0.14	0.39	0.31	0.85

11.2. *Bias*—Because there is no accepted reference material suitable for determining the bias in this test method, no statement on bias is made.

12. KEYWORDS

12.1. Aggregate gradation; fineness modulus.

ANNEX A

(Mandatory Information)

A1. OVERLOAD DETERMINATION

A1.1. Do not exceed a mass of 7 kg/m² (4 g/in²) of sieving surface for sieves with openings smaller than 4.75 mm (No. 4) at the completion of the sieving operation.

Commented [BM5]: From T 30

Commented [BM6]: From T 30

A1.2. Do not exceed a mass in kg of the product of 2.5 x (sieve opening in mm) x (effective sieving area) for sieves with openings 4.75 mm (No. 4) and larger. This mass is shown in Table A1 for five sieve-frame dimensions in common use. Do not cause permanent deformation of the sieve cloth due to overloading.

Commented [BM7]: From T 30

Note A1—The 7 kg/m² (4 g/in²) amounts to 200 g for the usual 203-mm (8-in.) diameter sieve [with effective or clear sieving surface diameter of 190.5 mm (7 1/2 in.)] or 450 g for a 305-mm (12-in.) diameter sieve [with effective or clear sieving surface diameter of 292.1 mm (11 1/2 in.)]. The amount of material retained on a sieve may be regulated by: (1) the introduction of a sieve with larger openings immediately above the given sieve, (2) testing the sample in multiple increments, or (3) testing the sample over a nest of sieves with a larger sieve-frame dimension.

Table A3—Maximum Allowable Mass of Material Retained on a Sieve, kg

Sieve Opening Size	Nominal Dimensions of Sieve ^a				
	203.2 mm, dia ^b	254 mm, dia ^b	304.8 mm, dia ^b	350 by 350, mm	372 by 580, mm
	Sieving Area, m ²				
	0.0285	0.0457	0.0670	0.1225	0.2158
125 mm (5 in.)	ε	ε	ε	ε	67.4
100 mm (4 in.)	ε	ε	ε	30.6	53.9
90 mm (3 1/2 in.)	ε	ε	15.1	27.6	48.5
75 mm (3 in.)	ε	8.6	12.6	23.0	40.5
63 mm (2 1/2 in.)	ε	7.2	10.6	19.3	34.0
50 mm (2 in.)	3.6	5.7	8.4	15.3	27.0
37.5 mm (1 1/2 in.)	2.7	4.3	6.3	11.5	20.2
25.0 mm (1 in.)	1.8	2.9	4.2	7.7	13.5
19.0 mm (3/4 in.)	1.4	2.2	3.2	5.8	10.2
12.5 mm (1/2 in.)	0.89	1.4	2.1	3.8	6.7
9.5 mm (3/8 in.)	0.67	1.1	1.6	2.9	5.1
4.75 mm (No. 4)	0.33	0.54	0.80	1.5	2.6

^a Sieve-frame dimensions in inch units: 8.0-in. diameter; 10.0-in. diameter; 12.0-in. diameter; 13.8 by 13.8 in. (14 by 14 in. nominal); 14.6 by 22.8 in. (16 by 24 in. nominal).

^b The sieve area for round sieves is based on an effective or clear diameter of 12.7 mm (1/2 in.) less than the nominal frame diameter because ASTM E11 permits the sealer between the sieve cloth and the frame to extend 6.35 mm (1/4 in.) over the sieve cloth. Thus, the effective or clear sieving diameter for a 203.2-mm (8.0-in.) diameter sieve frame is 190.5 mm (7 1/2 in.). Sieves produced by some manufacturers do not infringe on the sieve cloth by the full 6.35 mm (1/4 in.).

^c Sieves indicated have less than five full openings and should not be used for sieve testing.

A2. TIME EVALUATION

A2.1. The minimum time requirement ~~should~~ shall be evaluated for each shaker at least annually by the following method:

Commented [BM8]: From fall ballot comments.

A2.1.1. Shake the sample over nested sieves for approximately 10 minutes.

Commented [BM9]: Was changed to 5 minutes based on ballot response. However, T 30 published with 10 minutes. Proposed to remain 10 minutes to limit confusion.

Note A2—If the sample material may be prone to degradation, reduce the initial shaking time in A2.1.1 to 5 minutes, and begin each re-check with a new sample.

Commented [BM10]: Added this note to address degradable sample concerns.

A2.1.2. Provide a snug-fitting pan and cover for each sieve and hold the items in a slightly inclined position in one hand.

Commented [BM11]: From T 30.

A2.1.3. Hand-shake each sieve continuously for 60 s by striking the side of the sieve sharply and with an upward motion against the heel of the other hand at the rate of about 150 times per minute, turning the sieve about one sixth of a revolution at intervals of about 25 strokes.

A2.2. If more than 0.5 percent by mass of the total sample before sieving passes any sieve after one minute of continuous hand sieving, adjust the shaker time and repeat Section A2.1.

Commented [BM12]: From T 30

A2.3. In determining sieving time for sieve sizes larger than 4.75 mm (No. 4), limit the material on the sieve to a single layer of particles.

Commented [BM13]: From fall ballot comments.

A2.4. If the size of the mounted testing sieves makes the described sieving motion impractical, use 203-mm (8-in.) diameter sieves to verify the adequacy of sieving.

A2.5. If the mass retained on any sieve exceeds the maximum allowable mass per Table A1, select a different sample and repeat section A2.

Commented [BM14]: New addition based on comments from South Carolina

¹ Similar but not identical to ASTM C136-06.

Standard Method of Test for

**Organic Impurities in Fine
Aggregates for Concrete**

AASHTO Designation: T 21M/T 21-15 (2019)^{1,2}

Technical Subcommittee: 1c, Aggregates

Release: Group 3 (July)

ASTM Designation: C40/C40M-11



**American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001**

Standard Method of Test for

Organic Impurities in Fine Aggregates for Concrete

AASHTO Designation: T 21M/T 21-15 (2019)^{1,2}



Technical Subcommittee: 1c, Aggregates

Release: Group 3 (July)

ASTM Designation: C40/C40M-11

1. SCOPE

- 1.1. This test method covers two procedures for an approximate determination of the presence of injurious organic compounds in fine aggregates that are to be used in hydraulic cement mortar or concrete. One procedure uses a glass color standard and the other uses a standard color solution.
- 1.2. The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.
- 1.3. *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user of this procedure to consult and establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to its use.*

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
- M 6, Fine Aggregate for Hydraulic Cement Concrete
 - R 76, Reducing Samples of Aggregate to Testing Size
 - R 90, Sampling Aggregate Products
 - T 71, Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
- 2.2. *ASTM Standard:*
- D1544, Standard Test Method for Color of Transparent Liquids (Gardner Color Scale)
- 2.3. *Federal Standard:*
- Fed. Std. No. 29, CFR 1910.1200 OSHA Hazard Communication Standard; see also Permissible Exposure Limits—Annotated Tables, available at <https://www.osha.gov/dsg/annotated-pels/>

3. SIGNIFICANCE AND USE

- 3.1. This test method is of significance in making a preliminary determination of the acceptability of fine aggregates with respect to the requirements of M 6.
- 3.2. The principal value of this test method is to furnish a warning that organic impurities may be present. When a sample subjected to this test produces a color darker than the standard color, it is advisable to perform the test for the effect of organic impurities on the strength of mortar in accordance with T 71.

4. APPARATUS

- 4.1. *Glass Bottles*—Colorless glass graduated bottles, approximately 240- to 470-mL (8- to 16-oz) nominal capacity, equipped with watertight stoppers or caps, not soluble in the specified reagents. In no case shall the maximum outside dimension of the bottles, measured along the line of sight used for the color comparison, be greater than 60 mm (2.5 in.) or less than 40 mm (1.5 in.). The graduations on the bottles shall be in milliliters or ounces (U.S. fluid), except that unmarked bottles may be calibrated and scribed with graduations by the user. In such case, graduation marks are required at only three points as follows:
- 4.1.1. *Standard Color Solution Level*—75 mL, (2½ oz) (U.S. fluid);
- 4.1.2. *Fine Aggregate Level*—130 mL, (4½ oz) (U.S. fluid); and
- 4.1.3. *NaOH Solution Level*—200 mL, (7 oz) (U.S. fluid).
- 4.2. *Glass Color Standard*:
- 4.2.1. Glass color standard shall be used as described in Table 1 of ASTM D1544.
- Note 1**—A suitable instrument consists of five glass color standards mounted in a plastic holder. Only the glass identified as Gardner Color Standard No. 11, corresponding to organic plate No. 3, is to be used as the glass color standard in Section 9.1.1.

5. REAGENT AND STANDARD COLOR SOLUTION

- 5.1. Regulatory information for the reagent and color solution can be found in 29 CFR 1910.1200.
- 5.2. *Reagent Sodium Hydroxide Solution (3 percent)*—Dissolve 3 parts by mass of sodium hydroxide (NaOH) in 97 parts of water.
- 5.3. *Standard Color Solution*—Dissolve reagent grade potassium dichromate (K₂Cr₂O₇) in concentrated sulfuric acid (sp gr 1.84) at the rate of 0.250 g/100 mL of acid. The solution must be freshly made for the color comparison, using gentle heat if necessary to effect solution. Preparation of the reference standard color solution is unnecessary when the Glass Color Standard Procedure is used to determine the color value.

6. SAMPLING

- 6.1. The sample shall be selected in general accordance with R 90.

7. TEST SAMPLE

7.1. Obtain a test sample of fine aggregate of about 450 g (approximately 1 lb) in accordance with R 76. Sample drying prior to testing, if necessary, shall be done by air drying only.

8. PROCEDURE

- 8.1. Fill a glass bottle to the 130-mL (approximately 4½-fluid oz) level with the sample of the fine aggregate to be tested.
- 8.2. Add a 3-percent NaOH solution in water until the volume of the fine aggregate and liquid, indicated after shaking, is 200 mL (approximately 7 fluid oz).
- 8.3. Stopper the bottle, shake vigorously, and then allow to stand for 24 h.

9. DETERMINATION OF COLOR VALUE

- 9.1. *Glass Color Standard Procedure*—At the end of the 24-h standing period, visually compare the color standards to the color of the supernatant liquid above the test specimen. Report the organic plate number corresponding to the Gardner Color Standard number that is nearest the color of the supernatant liquid. When using this procedure, it is not necessary to prepare the standard color solution.
- 9.1.1. To define the color of the liquid of the test sample, use five glass standard colors as described in Table 1 of ASTM D1544, using the following colors:

Gardner Color Standard No.	Organic Plate No.
5	4
8	2
11	3 (standard)
14	4
16	5

	Gardner Color Standard Number	Circular Disk Number ^a	Organic Plate Number ^b
	5	5	
	8	8	1
	11	11	2
Standard Color Solution	14	14	3
	16	16	4
	18		5

^a Manufactured by Lovibond

^b Manufactured by Hellige or Orbeco Tester

- 9.2. *Standard Color Solution Procedure*—At the end of the 24-h standing period, fill a glass bottle to the 75-mL level (approximately 2½ fluid oz.) with the fresh standard color solution, prepared not longer than 2 h previously, as prescribed in Section 5.3. Hold the bottle with the test solution and the bottle with the standard color solution side by side and compare the color of light transmitted through the supernatant liquid above the test sample with the color of light transmitted through the standard color solution. Record whether it is lighter, darker, or of equal color to that of the reference standard.

10. INTERPRETATION OF RESULTS

10.1. If the color of the supernatant liquid is darker than that of ~~the glass color Circular Disk No. 14,~~ standard organic plate No. 3, ~~4~~ Gardner Color Standard No. ~~14~~14¹, or the standard color solution, the fine aggregate under test shall be considered to possibly contain injurious organic compounds, and further tests should be made before approving the fine aggregate for use in concrete.

11. PRECISION AND BIAS

11.1. Because this test produces no numerical values, determination of the precision and bias is not necessary.

12. KEYWORDS

12.1. Color standard; fine aggregate; organic impurities.

¹ First published in dual units in 2015.

² This method agrees with ASTM C40/C40M-11 except for shifting of text between Sections 5.3 and 9.2.

Standard Method of Test for

**Materials Finer Than 75- μ m
(No. 200) Sieve in Mineral
Aggregates by Washing**

AASHTO Designation: T 11-05 (2018)¹

Technical Subcommittee: 1c, Aggregates

Release: Group 3 (July)

ASTM Designation: C117-13

**American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001**

Standard Method of Test for

Materials Finer Than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing

AASHTO Designation: T 11-05 (2018)¹



Technical Subcommittee: 1c, Aggregates

Release: Group 3 (July)

ASTM Designation: C117-13

1. SCOPE

- 1.1. This test method covers determination of the amount of material finer than a 75-µm (No. 200) sieve in aggregate by washing. Clay particles and other aggregate particles that are dispersed by the wash water, as well as water-soluble materials, will be removed from the aggregate during the test.
- 1.2. Two procedures are included, one using only water for the washing operation, and the other including a wetting agent to assist the loosening of the material finer than the 75-µm (No. 200) sieve from the coarser material. Unless otherwise specified, Procedure A (water only) shall be used.
- 1.3. The values stated in SI units are to be regarded as the standard.
- 1.4. *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to its use.*

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
 - M 231, Weighing Devices Used in the Testing of Materials
 - R 76, Reducing Samples of Aggregate to Testing Size
 - R 90, Sampling Aggregate Products
 - T 27, Sieve Analysis of Fine and Coarse Aggregates
- 2.2. *ASTM Standards:*
 - C670, Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
 - E11, Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. SUMMARY OF METHOD

- 3.1. A sample of the aggregate is washed in a prescribed manner, using either plain water or water containing a wetting agent, as specified. The decanted wash water, containing suspended and dissolved material, is passed through a 75- μm (No. 200) sieve. The loss in mass resulting from the wash treatment is calculated as mass percent of the original sample and is reported as the percentage of material finer than a 75- μm (No. 200) sieve by washing.

4. SIGNIFICANCE AND USE

- 4.1. Material finer than the 75- μm (No. 200) sieve can be separated from larger particles much more efficiently and completely by wet sieving than through the use of dry sieving. Therefore, when accurate determinations of material finer than 75 μm in fine or coarse aggregate are desired, this test method is used on the sample prior to dry sieving in accordance with T 27. The results of this test method are included in the calculation in T 27, and the total amount of material finer than 75 μm by washing, plus that obtained by dry sieving the same sample, is reported with the results of T 27. Usually the additional amount of material finer than 75 μm obtained in the dry-sieving process is a small amount. If it is large, the efficiency of the washing operation should be checked. A large amount of material could also be an indication of the degradation of the aggregate.
- 4.2. Plain water is adequate to separate the material finer than 75 μm from the coarser material in most aggregates. In some cases, the finer material is adhered to the larger particles, such as in some clay coatings and coatings on aggregates that have been extracted from bituminous mixtures. In these cases, the fine material will be separated more readily with a wetting agent in the water.

5. APPARATUS AND MATERIALS

- 5.1. *Balance*—The balance shall have sufficient capacity, be readable to 0.1 percent of the sample mass or better, and conform to the requirements of M 231.
- 5.2. *Sieves*—A nest of two sieves, the lower being a 75- μm (No. 200) sieve and the upper being a sieve with openings in the range of 2.36 mm (No. 8) to 1.18 mm (No. 16), both conforming to the requirement of ASTM E11.
- 5.3. *Container*—A pan or vessel of a size sufficient to contain the sample covered with water and to permit vigorous agitation without loss of any part of the sample or water.
- 5.4. *Oven*—An oven of sufficient size, capable of maintaining a uniform temperature of $110 \pm 5^\circ\text{C}$ ($230 \pm 9^\circ\text{F}$).
- 5.5. *Wetting Agent*—Any dispersing agent, such as liquid dishwashing detergents, that will promote separation of the fine materials.

- 5.6. *Mechanical Washing Apparatus (Optional)*—A mechanical washing apparatus (Note 1).
- Note 1**—A sample should not be washed for more than 10 minutes when using a mechanical washing apparatus. Wash intervals greater than 10 minutes have been shown to cause significant amounts of degradation depending upon aggregate type. (NCHRP Digest 389)

Note 1—The use of a mechanical apparatus to perform the washing operation is not precluded, provided the results are consistent with those obtained using manual operations. The use of some mechanical washing equipment with some samples may cause degradation of the sample.

Commented [WAQTC1]: The use is alluded to in the note but it was not listed under apparatus.

Commented [BM2]: Need to state Note 1?

Commented [GN3]: Revised option

6. SAMPLING

- 6.1. Sample the aggregate in accordance with R 90. If the same test sample is to be tested for sieve analysis according to T 27, comply with the applicable requirements of that method.
- 6.2. Thoroughly mix the sample of aggregate to be tested and reduce the quantity to an amount suitable for testing using the applicable methods described in R 76. If the same test sample is to be tested according to T 27, the minimum mass shall be as described in the applicable sections of that method. Otherwise, the mass of the test sample, after drying, shall conform with the following:

Nominal Maximum Size	Minimum Mass, g
4.75 mm (No. 4) or smaller	300
9.5 mm (3/8 in.)	1000
19.0 mm (3/4 in.)	2500
37.5 mm (1 1/2 in.) or larger	5000

The test sample shall be the end result of the reduction. Reduction to an exact predetermined mass shall not be permitted. If the nominal maximum size of the aggregate to be tested is not listed above, the next larger size listed shall be used to determine sample size.

7. SELECTION OF PROCEDURE

- 7.1. Procedure A shall be used, unless otherwise specified by the specification with which the test results are to be compared, or when directed by the agency for which the work is performed.

8. PROCEDURE A—WASHING WITH PLAIN WATER

- 8.1. Dry the test sample to constant mass at a temperature of $110 \pm 5^{\circ}\text{C}$ ($230 \pm 9^{\circ}\text{F}$). Determine the mass to the nearest 0.1 percent of the mass of the test sample.
- 8.2. If the applicable specification requires that the amount passing the 75- μm (No. 200) sieve shall be determined on a portion of the sample passing a sieve smaller than the nominal maximum size of the aggregate, separate the sample on the designated sieve and determine the mass of the material passing the designated sieve to 0.1 percent of the mass of this portion of the test sample. Use this mass as the original dry mass of the test sample in Section 10.1.
- Note 2**—Some specifications for aggregates with a nominal maximum size of 50 mm or greater, for example, provide a limit for material passing the 75- μm (No. 200) sieve determined on that portion of the sample passing the 25.0-mm sieve. Such procedures are necessary because it is impractical to wash samples of the size required when the same test sample is to be used for sieve analysis by T 27.
- 8.3. After drying and determining the mass, place the test sample in the container and add sufficient water to cover it. No detergent, dispersing agent, or other substance shall be added to the water. Agitate the sample with sufficient vigor to result in complete separation of all particles finer than the 75- μm (No. 200) sieve from the coarser particles, and to bring the fine material into suspension. The use of a large spoon or other similar tool to stir and agitate the aggregate in the wash water has been found satisfactory. Immediately pour the wash water containing the suspended and dissolved solids over the nested sieves, arranged with the coarser sieve on top. Take care to avoid, as much as feasible, the decantation of coarser particles of the sample.
- 8.4. Add a second charge of water to the sample in the container, agitate, and decant as before. Repeat this operation until the wash water is clear.

Note 3—If mechanical washing equipment is used, the charging of water, agitating, and decanting may be a continuous operation.

Note 4—A spray nozzle or a piece of rubber tubing attached to a water faucet may be used to rinse any of the material that may have fallen onto the sieves. The velocity of water, which may be increased by pinching the tubing or by use of a nozzle, should not be sufficient to cause any splashing of the sample over the sides of the sieve.

- 8.5. Return all material retained on the nested sieves by flushing into the container containing the washed sample. Dry the washed aggregate to constant mass at a temperature of $110 \pm 5^{\circ}\text{C}$ ($230 \pm 9^{\circ}\text{F}$) and determine the mass to the nearest 0.1 percent of the original mass of the sample.

Note 5—Following the washing of the sample and flushing any materials retained on the 75- μm (No. 200) sieve back into the container, no water should be decanted from the container except through the 75- μm sieve, to avoid loss of material. Excess water from flushing should be evaporated from the sample in the drying process.

9. PROCEDURE B—WASHING USING A WETTING AGENT

- 9.1. Prepare the sample in the same manner as for Procedure A.
- 9.2. After drying and determining the mass, place the test sample in the container. Add sufficient water to cover the sample, and add wetting agent to the water (Note 6). Agitate the sample with sufficient vigor to result in complete separation of all particles finer than the 75- μm (No. 200) sieve from the coarser particles, and to bring the fine material into suspension. The use of a large spoon or other similar tool to stir and agitate the aggregate in the wash water has been found satisfactory. Immediately pour the wash water containing the suspended and dissolved solids over the nested sieves, arranged with the coarser sieve on top. Take care to avoid, as much as feasible, the decantation of coarser particles of the sample.
- Note 6**—There should be enough wetting agent to produce a small amount of suds when the sample is agitated. The quantity will depend on the hardness of the water and the quality of the detergent. Excessive suds may overflow the sieves and carry some material with them.
- 9.3. Add a second charge of water (without wetting agent) to the sample in the container, agitate, and decant as before. Repeat this operation until the wash water is clear.
- 9.4. Complete the test as for Procedure A.

10. CALCULATION

- 10.1. Calculate the amount of material passing a 75- μm (No. 200) sieve by washing as follows:
- $$A = [(B - C) / B] \times 100 \quad (1)$$
- where:
- A = percentage of material finer than a 75- μm (No. 200) sieve by washing;
- B = original dry mass of sample, g; and
- C = dry mass of sample after washing, g.

11. REPORT

- 11.1. Report the percentage of material finer than the 75- μm (No. 200) sieve by washing to the nearest 0.1 percent, except if the result is 10 percent or more, report the percentage to the nearest whole number.

11.2. Include a statement as to which procedure was used.

12. PRECISION AND BIAS

12.1. *Precision*—The estimates of precision of this test method listed in Table 1 are based on results from the AASHTO Materials Reference Laboratory Proficiency Sample Program, with testing conducted by this test method and ASTM C117. The significant differences between the methods at the time the data were acquired is that T 11 required, and ASTM C117 prohibited, the use of a wetting agent. The data are based on the analyses of more than 100 paired test results from 40 to 100 laboratories.

Table 1—Precision

	Standard Deviation (1s), ^a %	Acceptable Range of Two Results (d2s), ^a %
Coarse aggregate: ^b		
Single-operator precision	0.10	0.28
Multilaboratory precision	0.22	0.62
Fine aggregate: ^c		
Single-operator precision	0.15	0.43
Multilaboratory precision	0.29	0.82

^a These numbers represent the (1s) and (d2s) limits as described in ASTM C670.

^b Precision estimates are based on aggregates having a nominal maximum size of 19.0 mm (3/4 in.) with less than 1.5 percent finer than the 75- μ m (No. 200) sieve.

^c Precision estimates are based on fine aggregates having 1.0 to 3.0 percent finer than the 75- μ m (No. 200) sieve.

12.1.1. The precision values for fine aggregate in Table 1 are based on nominal 500-g test samples. Revision of this test method in 1996 permits the fine aggregate test sample size to be 300 g minimum. Analysis of results of testing of 300-g and 500-g test samples from Aggregate Proficiency Test Samples 99 and 100 (Samples 99 and 100 were essentially identical) produced the precision values in Table 2, which indicates only minor differences due to test sample size.

Table 2—Precision Data for 300-g and 500-g Test Samples

Fine Aggregate Proficiency Sample	Sample Size	No. Labs	Avg	Within Laboratory		Between Laboratory	
				1s	d2s	1s	d2s
AASHTO T 11/ASTM C117 (Total material passing the	500 g	270	1.23	0.08	0.24	0.23	0.66
No. 200 sieve by washing, %)	300 g	264	1.20	0.10	0.29	0.24	0.68

Note 7—The values for fine aggregate in Table 1 will be revised to reflect the 300-g test sample size when a sufficient number of Aggregate Proficiency Tests have been conducted using that sample size to provide reliable data.

12.2. *Bias*—Because there is no accepted reference material suitable for determining the bias for the procedure in this test method, no statement on bias is made.

13. KEYWORDS

13.1. Aggregate; size analysis; wash loss; 75- μ m (No. 200) sieve.

¹ Except for Sections 5.1 and 6.2, and Note 4, this test method is identical to ASTM C117-13.

Proposed Standard Method of Test for

**DETERMINING THE RELATIVE
DENSITY (SPECIFIC GRAVITY) AND
ABSORPTION OF LIGHTWEIGHT
AGGREGATE**

AASHTO Designation: TP XX-XX

Proposed test method under review before submitting to AASHTO Subcommittee
on Materials



**American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001**

Proposed test method under review before submitting to AASHTO Subcommittee on Materials – ~~July~~Month 31Day, 2016XX

Proposed Standard Method of Test for

DETERMINING THE TACK COAT RELATIVE DENSITY (SPECIFIC GRAVITY) AND ABSORPTION OF LIGHTWEIGHT AGGREGATE

AASHTO Designation: TP XX-XX



1. SCOPE

- 1.1. This test method covers the determination of the relative density (specific gravity) of lightweight aggregate in the field or laboratory. This test method covers the determination of the tack coat quality as measured by the tensile strength of tack coat materials on the free surface of asphalt concrete in the field or laboratory.
- 1.2. This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all safety concerns/problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENTS

- 2.1. AASHTO Standards:
- M 231, Standard Specification for Weighing Devices Used in the Testing of Materials
 - T 2, Standard Method of Test for Sampling of Aggregates
 - T 84, Standard Method of Test for Specific Gravity and Absorption of Fine Aggregate
 - T 164, Standard Method of Test for Quantitative Extraction of Asphalt Binder from Hot Mix Asphalt (HMA) Standard Method of Test for Specific Gravity and Absorption of Fine Aggregate
 - T 248, Reducing Samples of Aggregate to Testing Size
 - Standard Method of Test for Specific Gravity and Absorption of Fine Aggregate

Formatted: Body Text

3. TERMINOLOGY

- 3.1. Absorption/Spray Application – The increase in the mass of aggregate due to water in the pores of the aggregate material, but not including water adhering to the outside surface of the particles, expressed as a percentage of the dry mass.
- 3.2. Specific gravity – The ratio of mass of a volume of a material at a stated temperature to the mass of the same volume of distilled water at the same temperature. A measure of the tack coat uniformity of coverage of a tack coat application on a pavement surface is referred to as tack coat

quality. ~~suita~~This tack coat quality is ~~bility~~ as described by the tensile strength of the tack coat material.

4. SUMMARY OF METHOD

4.1. A sample of aggregate is immersed in water for 24 ± 4 h to allow filling of the permeable pores essentially fill the pores. Excess water ~~It is then decanted and removed from the water, and the~~ a centrifuge is used to remove water is dried from the surface of the particles. The mass of the sample is measured and recorded. Next using a centrifuge, and the mass determined. Subsequently, the sample (or a portion of it) of aggregate is placed in a graduated container and the volume of the sample is determined by utilizing a pycnometer by the gravimetric method. Finally, the sample is oven-dried and the mass is determined again. Using the mass values thus obtained and formulas in this test method, it is possible to calculate relative density (specific gravity) and absorption of the aggregate are calculated.

5. SIGNIFICANCE AND USE

5.1. Lightweight aggregate is used as an additional source of water in ~~i~~This test method is suitable for field or laboratory tests to determine the quality of tack coat adhesion quality of a tacked surface as measured by the tensile strength. ~~K~~The knowledge of tack coat adhesion quality serves as a tool in characterizing the tack coat material internally-cured concrete mixtures resulting in reduced early-age cracking potential.

5.2. The tensile strength produced using this test method is influenced by the temperature at which the tacked surface ~~i~~was tested and the application rate of the tack coat material.

~~5.3.5.2.~~ The specific gravity and absorption values calculated in this test method are used in the design of internally-cured concrete mixtures tensile strength values measured by this test method, with the equipment and procedures stated herein, do not necessarily agree or correlate directly with other techniques of tack coat adhesion quality measurements. This test method is also suitable for research and development purposes, where direct comparisons between tack coat materials on a pavement surface are to be made within the same test program.

6. APPARATUS

6.1. ~~Centrifuge~~ – Extraction apparatus conforming to AASHTO T 164, method A ~~Louisiana Tack Coat Quality Tester~~ – The device shall be equipped with a closed-loop servo motor actuator for precision control of the rate of displacement during testing. It shall be capable of measuring loads of up to 446 N (100 lbf) with an accuracy of $\pm 1\%$. The displacement of the actuator shall be measured using a position transducer that has a total travel of 100 mm (3.937 in.) The diameter of the loading plate shall be 100 mm (3.937 in.). The device is illustrated in Figure 1.

6.2. ~~Filter ring~~ ~~Computer and Software~~ – The software shall be designed such that it displays the time, normal load, and displacement of the actuator continuously during testing while graphically illustrating the relationship of the normal load and time. It shall allow the user to input the required compressive load, the time to hold the compressive load, and the displacement rate required. The actual holding time of the compressive load shall be displayed during testing as well as the actual displacement rate. In addition, the software shall allow the user to move the actuator manually Felt or paper, to fit the rim of the bowl, conforming to AASHTO T 164.

6.3. ~~Pycnometer~~ ~~Infrared Reflective Heating Source~~ – A two-quart flask as specified in AASHTO T 84. It shall be equipped with a 250-watt, 120-volt bulb. It shall be designed such that it can be positioned six inches from the surface to be tested without making contact made with the tacked

Formatted: Font: Italic

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman

surface. The pycnometer should have a capacity at least 50 percent more than the volume needed to accommodate the test sample.

- 6.4. Oven Thermometer – The drying apparatus capable of drying the test specimen at a temperature shall be suitable to measure the temperature of a tacked surface without directly contacting the test area. It is recommended that an infrared thermometer be utilized $110 \pm 5^{\circ}\text{C}$.
- 6.5. Weight Balances – A scale as specified in AASHTO M 231, class G2. The weights used shall be equal or greater than the expected maximum normal load. Note that the normal load applied by the machine cannot exceed 446 N (100 lbf).
- 6.6. Miscellaneous Temperature Control Devices – Spatulas and brushes, as needed. The device mechanism of the temperature control device shall be to adjust the surface temperature to the required test temperature. It is recommended that a fan be used to cool the tacked surface and a heat gun be used to heat the tacked surface.

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman

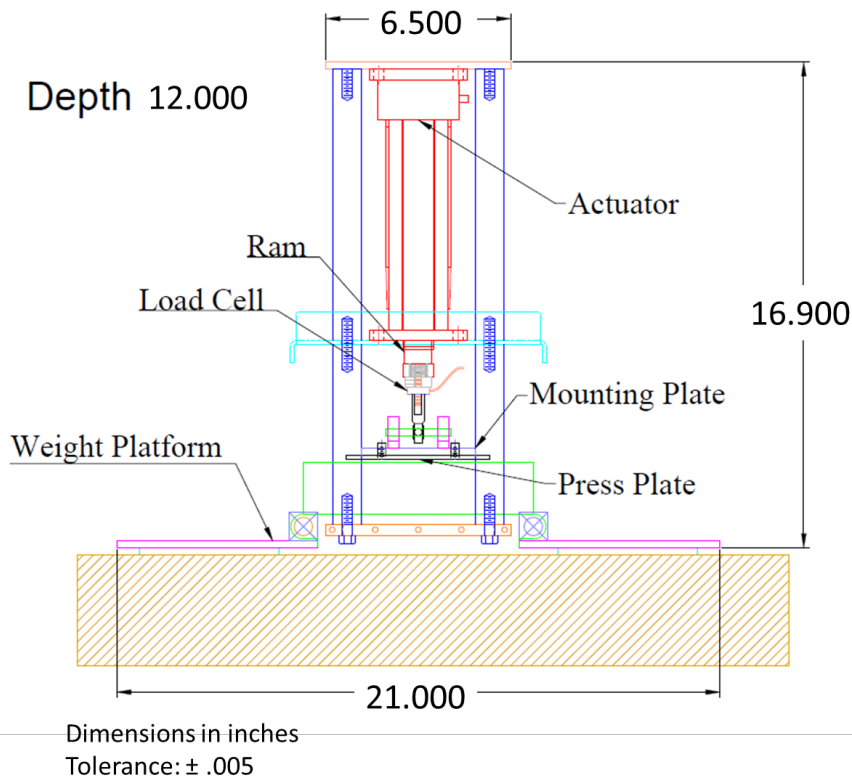
Formatted: Font: (Default) Times New Roman

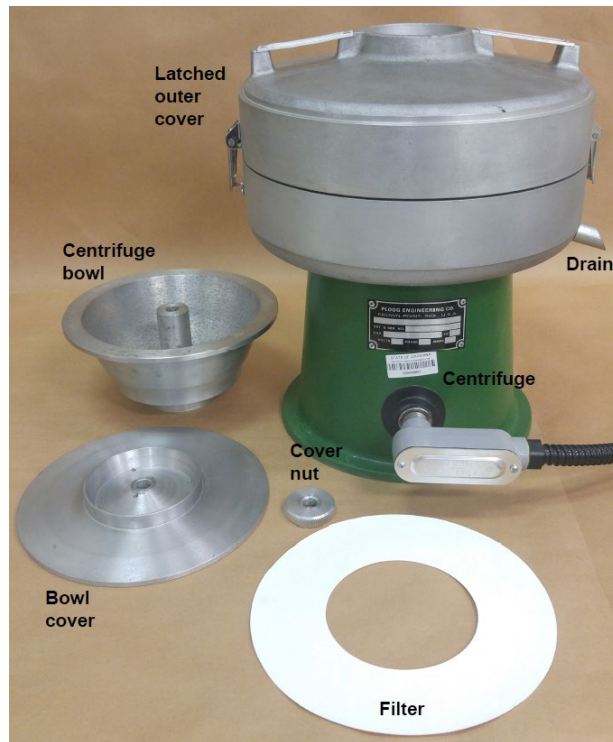
Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman





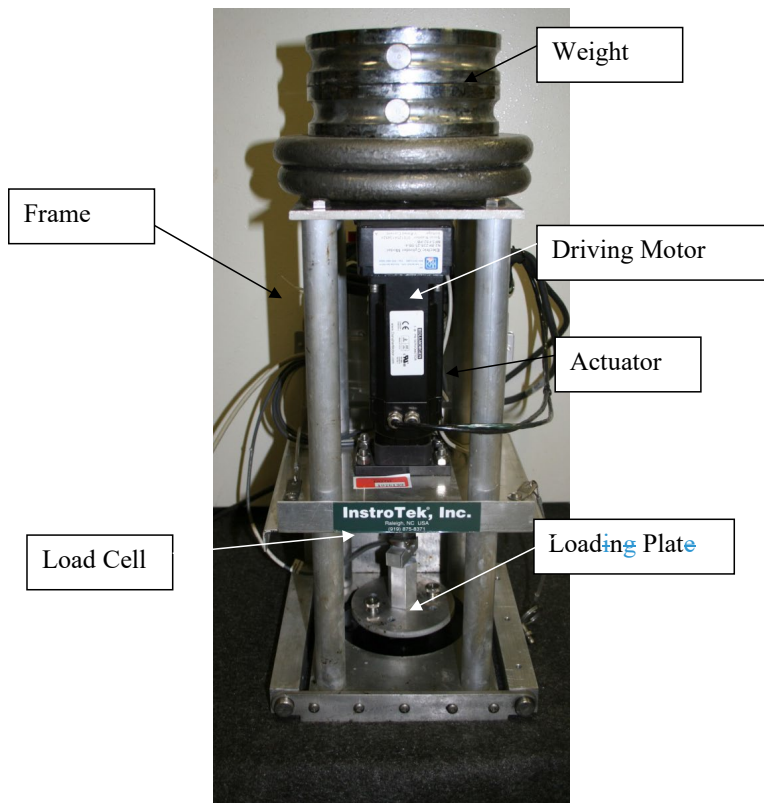


Figure 1. ~~H~~ustration of the LTCQT deviceCentrifuge apparatus.

7. HAZARDS

- 7.1. Standard laboratory safety precautions must be observed when preparing and ~~hand~~testing the ~~test~~asphalt concrete specimens.

8. PREPARATION OF THE TEST SPECIMENS

- 8.1. Obtain approximately 1000 g of the lightweight aggregate using the AASHTO T 248Testing-area shall be cleaned prior to the tack coat application. procedure and oven-dry it at $110 \pm 5^{\circ}\text{C}$ to a constant mass. Constant mass is obtained when the weight of the test specimen does not change by more than 0.1 percent of its original weight after a 15-minute interval. After constant mass is obtained, cool the specimen to room temperature. SubmergeSubmerge the specimen in water for 72 ± 4 hours. For field testing, omit oven drying and soaking.

- 8.1. Place the aggregate sample in the centrifuge bowl.

Formatted: Font: (Default) Times New Roman, Font color: Auto

Commented [SJ1]: Soaking before placing in the centrifuge bowl allows multiple samples to be tested quickly. 72 hour soak is used to be in agreement with ASTM C1761 and ASTM C128. For field testing (as at Ada), the material is already pre-soaked, so this step is eliminated.

- 8.2. Tack coat material shall be applied using the appropriate method. For laboratory sample, apply tack coat at the specified application rate using a paintbrush. In the laboratory, the proper amount of tack coat is determined based on the application rate. The specimen is placed on a laboratory scale and the appropriate amount of tack coat is then applied to the top surface using a one-inch natural bristle brush. Field sections typically use a distributor truck for spray application of tack coat material.
- Submerge the aggregate in the centrifuge bowl with water for 24 ± 4 hours.
- 8.3. Decant excess water with care to avoid the loss of fines. For field testing, a 150-mm (5.906-inch) by 150-mm (5.906-inch) area of emulsified tacked surfaces shall be desiccated prior to testing. It is recommended that this shall be accomplished by placing the Infrared Reflective Heating source six inches above the tacked surface for a minimum of one hour. Note that this time may be extended for bulk application rates greater than 0.05 gal/yd².
- 8.3. 8.4 Measure 600 ± 10 g of lightweight aggregate into the centrifuge bowl. For field testing, record the mass as M_w .
- 8.4. ~~Number of Test Areas~~—Place the filter ring on the bowl, clamp on the cover, and start the centrifuge. A single test shall consist of at least three test areas. Laboratory testing requires three SGC prepared samples. Adjust the rotation speed, if needed, to 2000 ± 20 rpm. Maintain the rotational speed for 3 minutes \pm 15 seconds and then turn the centrifuge off.
- 8.4. After the centrifuge has come to a stop, remove the latched outer cover. Remove the inner cover nut and filter paper. Scrape the sides of the bowl and use a brush to remove aggregate from the filter paper.
- 8.5. The test areas shall be numbered and the locations shall be documented. The test specimen is now in the wetted surface-dry condition.

9. PROCEDURE

- 9.1. Weigh the wetted surface-dry aggregate test sample and record this mass to the nearest 0.1 g (A). Partially fill the pycnometer with water and introduce the weighed pre-wetted aggregate into the pycnometer. Add water to fill to Testing areas (specimen) shall be conditioned to the correct testing temperature using a heat blower or fan the IRH device. It is recommended that the softening point (AASHTO T53) of the tack coat material be used as the testing temperature. e shall be the softening point of the tack coat material. approximately 90 percent of capacity of the pycnometer.
- 9.2. Roll and agitate the pycnometer to remove air bubbles. Device positioning—Place the LTCQT directly above the tacked surface to be tested. Lift up the front end of the device to verify that the loading plate is positioned directly above the tacked surface that will be tested. It takes approximately 15-20 minutes to eliminate air bubbles.
- 9.3. Adjust the water temperature to $23 \pm 1.7^\circ\text{C}$ ($73.4 \pm 3^\circ\text{F}$) and bring the level of the water to the calibration mark of the pycnometer. Determine the mass of the pycnometer, specimen, and water and record it to the nearest 0.1 g (B). The correct weight (40 lbf) shall be placed on top of the LTCQT device.
- 9.4. Decant excess water with care to avoid loss of fines. Transfer the test specimen to an appropriate vessel for oven-drying. Rinse the flask until all material has been transferred. The eThe compressive load (89 N (20 lbf)), time to hold the compressive load (3 minutes), and the displacement rate (0.2 mm/sec (0.008 in./sec)) shall be entered into the computer by the user. The compressive load shall not exceed the weight placed on top of the LTCQT device.

Formatted: Font: (Default) Times New Roman

Formatted: Font color: Auto

Formatted: Font: (Default) Times New Roman, Font color: Auto

Formatted: Normal

Commented [SJ2]: This is used for adjusting the mixing water for correct for surface moisture.

Formatted: Subscript

Commented [SJ3]: Renumber paragraphs as required

Formatted: Font: Italic

Formatted: Font: Italic

Formatted: Font: (Default) Times New Roman

Commented [SJ4]: Although longer times won't change the results, we should include a range.

Formatted: Font color: Black

Formatted: Font: (Default) Times New Roman, Font color: Auto

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman

Commented [S5]: Verify and add

Formatted: Font: (Default) Times New Roman

9.5. Dry the test specimen in an oven at $110 \pm 5^\circ\text{C}$ to a constant mass. Zero the load reading prior to the initiation of the test. Immediately following the initiation of the test, the load shall be offset such that the software displays a load of 0 N (lbf) prior to the contact between the loading plate and the tacked surface. It is also recommended that the plate be positioned as close as possible to the tacked surface prior to testing so as to minimize the change in temperature. Constant mass is obtained when the weight of the test specimen does not change by more than 0.1 percent of its original weight after a 15-minute interval. Cool the specimen to room temperature and record the mass to the nearest 0.1 g (C). The initial position of the loading plate shall be determined to allow sufficient time for the observation of the initial load and application of the offset.

Formatted: Font: (Default) Times New Roman, Font color: Auto

Formatted: Font: (Default) Times New Roman, Font color: Auto

9.6. Fill the empty pycnometer with water to its calibrated mark. The compressive load shall be mechanically applied to the tacked surface for the specified amount of time (3 minutes). Once the allotted time has ended, the loading plate shall automatically be raised move away from the tacked surface at the prescribed displacement rate. The software shall by design record the normal load, vertical displacement, and time throughout the test. Record the ultimate tensile load (P_{ult}) of the tack coat material. A graph of a typical test results is shown in Figure 2. Weigh and record this mass to the nearest 0.1 g (D).

Formatted: Font: (Default) Times New Roman

Commented [S6]: add

Formatted: Font: (Default) Times New Roman

Commented [S7]: Add Figure

Formatted: Font: (Default) Times New Roman

10. CALCULATIONS

10.1. Calculate the wetted surface dry specific gravity of the lightweight aggregate tack coat adhesion quality, TCQ, as follows:

$$G_{WSD} = \frac{A}{A + D - B}$$

where:

G_{WSD} = Wetted surface-dry specific gravity

A = Mass of the wetted surface-dry test specimen, g

B = Mass of the pycnometer containing the specimen and water, g

D = Mass of the pycnometer filled with water, g

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman

Formatted: Font color: Auto

Formatted: Normal

Formatted: Font: Times New Roman, Not Italic

Formatted: Subscript

Formatted: Normal

Formatted: Font color: Auto

Formatted: Normal

Formatted: Indent: Left: 1.13", No bullets or numbering

Formatted: Normal

Formatted: Subscript

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman, Font color: Auto

Formatted: Centered

10.2. Calculate the 24-hour absorption of the lightweight aggregate as follows:

$$A_{2472} = \frac{A - C}{C} \times 100$$

where:

A_{2472} = the 2472-h absorption, expressed as a percentage of the oven-dry mass, percent

10.1. C = Mass of the oven-dry aggregate, g

$$TCQ = \frac{P_{ult}}{\frac{\pi D^2}{4}}$$

where:

TCQ = tack coat quality, Pa (PSIpsi)

P_{ult} = ultimate tensile load, N (lbf)

D = diameter of the loading plate, m (inch)

10.3. For field testing, calculate the surface moisture of the lightweight aggregate as follows:

$$WS = \frac{MW - A}{A} \times 100$$

Where W_s = the surface moisture in the lightweight aggregate, expressed as a percentage of the wetted surface dry mass.

11. REPORT

- 11.1. Maximum size of the lightweight aggregate. Test location.
- 11.2. Note the appearance of the tacked surface before and after testing including any contaminants, milling striations, stripping, tack coat streaks, etc. Source of the lightweight aggregate.
- 11.3. Test results:
- 11.3.1. Test date. Softening point temperature, °C (°F)
- 11.3.2. Wetted specific gravity of the lightweight aggregate, to the nearest 0.001.
- 11.3.1. Loading plate dimensions—including the diameter, and the cross-section area. 2472-hour absorption of the lightweight aggregate, to the nearest 0.1 percent.
- Ultimate tensile load applied, nearest 4.4 N (1 lbf)
- 11.3.2.
- 11.3.3. Tensile strength, nearest 68.9 Pa (0.01 psi/PSI). Pa.
- 11.3.4. Corresponding vertical deformation, nearest 0.025 mm (0.001 inch).
- 11.3.3. Average and standard deviation of tensile strength for the set of tested areas.
- 11.3.5. 11.3.4 For field testing, report the surface moisture of the lightweight aggregate to the nearest 0.1 percent.

12. PRECISION AND BIAS

- 12.1. The precision and bias statements for this method have not been determined.

13. KEYWORDS

lightweight aggregate, internal curing, specific gravity, absorption, centrifuge Tack Coat Adhesion Quality, Tensile Strength, Asphalt Overlay, Tack Coat, Slippage Failure.

13.1.

Commented [SJ8]: You might want to change the symbols and use A for the mass of the soaked aggregate, B for the wetted surface dry aggregate, etc. Maybe then the surface moisture would be S.

Formatted: Font color: Auto

Formatted: Normal, Indent: Left: 0"

Formatted: Subscript

Commented [SJ9]: The surface moisture is calculated this way, because it's used to correct the batch weight of the presoaked aggregate. If we use the oven dry weight, we will over-correct.

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman

Formatted: Tab stops: 1", List tab

Formatted: Font: (Default) Times New Roman, Font color: Auto

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman

Formatted: Indent: Left: 1", No bullets or numbering

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman

Formatted: Tab stops: 1", List tab

Formatted: Body Text, Tab stops: Not at 1"

Formatted: Font: (Default) Times New Roman, Font color: Auto

Commented [SJ10]: ASTM is developing a single-lab, single operator and multiple operator precision statement for the centrifuge method for determining absorption. The ASTM C1761 precision statement on the specific gravity portion of the method is as follows: 10.7 Precision and Bias:

10.7.1 An interlaboratory study of this test method has not been completed. The pooled single operator standard deviations based on one laboratory were found to be 0.3 % for the 72-h absorption and 0.010 for the relative density (OD). NOTE 10—Samples of lightweight fine aggregate from four sources were used in the single-laboratory study. The 72-h absorption ranged from 9 to 28 % and the relative density (OD) ranged from 1.06 to 1.74. The standard deviations did not depend on the mean values and pooled standard deviations were calculated. 10.7.2 The bias of this test method cannot be determined because lightweight aggregate having accepted reference values is not available.

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman

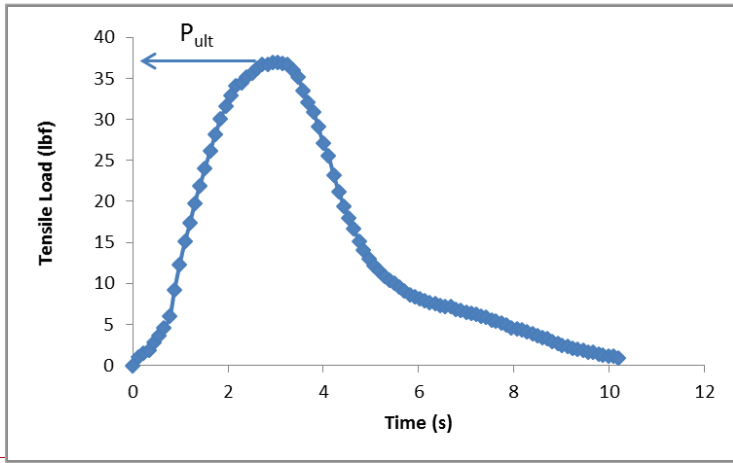


Figure 2. Typical test results

13.1.

Formatted: Heading 2, Left

Formatted: Font: Arial

Formatted: Font: Arial

Formatted: Heading 2

Standard Practice for

**Sample Preparation and Polishing
of Asphalt Mixture Specimens for
Dynamic Friction Testing**

AASHTO Designation: R XX-XX

Technical Section: 2c, Asphalt–Aggregate Mixtures

Release: Group 3 (August)



**American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001**

Standard Practice for

Sample Preparation and Polishing of Asphalt Mixture for Dynamic Friction Testing

AASHTO Designation: R XX-XX



Technical Section: 2c, Asphalt–Aggregate Mixtures

Release: Group 3 (August)

1. SCOPE

- 1.1. This method covers the sample preparation and polishing of asphalt mixtures for Dynamic Friction Testing using a Three-Wheel Polishing Device (TWPD). This standard is to be used with compacted asphalt mixture slab specimens. Other specimen preparation procedures would be needed for assembling a group of gyratory cylinders to be polished using a TWPD. The values stated in SI units are to be regarded as the standard. Other units are presented for informational purposes, but SI units shall only be used when determining results to be used in Equation 1.
- 1.2. *This standard practice may involve hazardous materials, operations, and equipment. 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 DOCUMENT

- 2.1. *AASHTO Standards:*
- M 231, Weighing Devices Used in the Testing of Materials
 - AASHTO R 30, Standard Practice for Mixture Conditioning of Hot Mix Asphalt (HMA)
 - AASHTO R 47, Standard Practice for Reducing Samples of Hot Mix Asphalt (HMA) to Testing Size
 - AASHTO T 168, Standard Method of Test for Sampling Bituminous Paving Mixtures
- 2.2. *ASTM Standard:*
- ASTM E1911, Standard Test Method for Measuring Paved Surface Frictional Properties Using the Dynamic Friction Tester

3. SIGNIFICANCE AND USE

- 3.1. This test method simulates the polishing of asphalt pavement surfaces caused by vehicular traffic.

4. TERMINOLOGY

- 4.1. *initial friction value*—the initial friction measurement on the asphalt mixture test specimens before they are polished in the TWPD

- 4.2. *terminal friction value*—the friction measurement on the asphalt mixture test specimens at the point at which additional cycles of polishing in the TWPDP will have negligible effects on the resulting friction value of the surface

5. APPARATUS

- 5.1. Sample Compaction Device – A machine capable of uniformly compacting an asphalt mixture within a rigid mold to a specified height to achieve a specified density. This may be accomplished using linear kneading compaction, plate compaction, or manual impact compaction.
- 5.2. Specimen Mold – A rigid specimen mold with dimensions that permit the compaction of a 508 x 508 mm (20 x 20 in.) asphalt mixture slab specimen. In some cases, a Dynamic Friction Tester (DFT) will accommodate a smaller sample, in which case, the resulting compacted asphalt mixture slab specimen shall be no less than 400 mm (16 in.) wide.
- 5.3. Non-stick Paper – Paper or other material that does not readily adhere to an asphalt mixture.
- 5.4. Metal Partition – For full scale slab specimens, a metal partition capable of dividing the asphalt mixture into four quadrants.
- 5.5. Transfer Funnel – A metal device with a tapered end capable of transferring an asphalt mixture from pans into the four quadrants created by the splitter.
- 5.6. Thermometers – Armored, glass, or dial type thermometers with metal stems for determining the temperature of aggregates, binder, and asphalt mixtures up to 204°C (400°F) and readable to 2°C (5°F).
- 5.7. Balance – A balance meeting the requirements of AASHTO M 231, Class G 5, for determining the mass of aggregates, binder, and asphalt mixtures.
- 5.8. Oven – An oven thermostatically controlled to $\pm 3^{\circ}\text{C}$ (5°F), for heating aggregates, binder, asphalt mixtures, and equipment as required. The oven shall be capable of maintaining the temperature required for asphalt mixture conditioning in accordance with AASHTO R 30.
- 5.9. Three-Wheel Polishing Device (TWPDP) – A polishing device that has three patterned pneumatic tires and is capable of exerting 0.65 +/- 0.02 Kn (146 +/- 5 lbs) through the tires to the test surfaces. The device's height shall be adjustable to accommodate sample heights of 25 mm (1.0 in.) to 50 mm (2.0 in.).
- 5.9.1. The tire size shall be 2.80/2.50-4 and shall maintain a pressure of 240 ± 34 kPa (35 \pm 5 psi) and a tread depth of no less than 2 mm (0.1 in.). The tire tread shall be free of any visible contamination. When replacement is necessary, all tires shall be replaced at the same time.
- 5.9.2. The polishing machine shall be equipped with a water system to wash off abraded rubber particles. The water will be applied uniformly across the surface of the specimen such that any dislodged material is flushed away.
- 5.9.3. The driving mechanism for the vertical shaft shall be an electric motor geared to rotate the shaft and wheel assembly at a speed of 6.28 radians per second (60 \pm 5 revolutions per minute).
- NOTE 1: The path of polishing should coincide with the direction of friction testing.
- 5.9.4. The machine shall be equipped with an automatic counter that can shut off the machine at a predetermined number of revolutions.

5.9.5. Dynamic Friction Tester (DFT) – A device used to measure pavement surface friction values as is described in ASTM E1911.

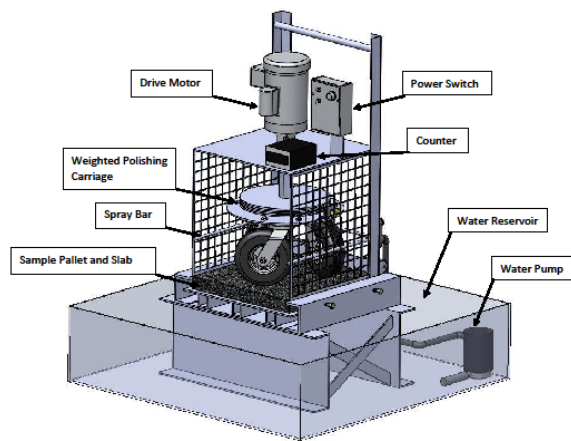


Figure 1. Three-Wheel Polishing Device with Parts Labeled

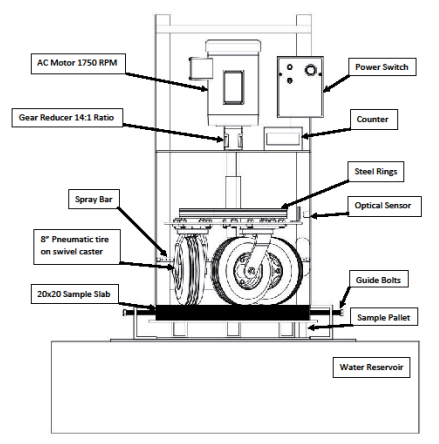


Figure 2. Three-Wheel Polishing Device Front View

Commented [MH1]: More gray-scale contrast between slab and guide bolts
Remove motor details RPM and Gear ratio

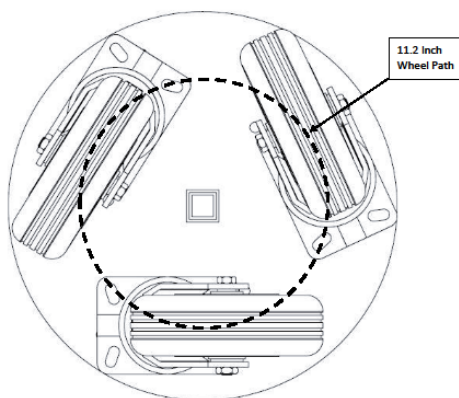


Figure 3. Wheel Path of Three-Wheel Polishing Device

6. PROCEDURE

6.1. Equipment Preparation

- 6.1.1. Adjust the specimen compaction device as needed to achieve desired slab thickness.
- 6.1.2. Cut two pieces of non-stick paper, one for the top and one for the bottom, to fit in mold.
- 6.1.3. Place assembled mold, if required, and other appropriate compaction tools that will be in contact with the sample in an oven set to the desired compaction temperature a minimum of 30 minutes prior to compaction.

NOTE 2: The parts of the specimen compaction device that are placed in the oven will be specific to the compaction device used. For compactors equipped with internal heating, placing the mold components in the oven should not be necessary.

6.2. Material Preparation

- 6.2.1. Determine mass of total asphalt mixture needed to achieve desired height and air voids (see Note 3). Equation 1 shows how to calculate total asphalt mixture mass.

$$m_T = (lwt)(G_{mm} * \rho_w) \left[\frac{(100 - \%V_a)}{100} \right] \quad (\text{Equation 1})$$

where:

- m_T = total mass of asphalt mixture to construct a slab in g;
- l = length of slab, to the nearest 0.1 mm;
- w = width of slab, to the nearest 0.1 mm;
- t = desired thickness of slab, to the nearest 0.1 mm;
- G_{mm} = theoretical maximum specific gravity of the asphalt mixture;
- V_a = desired percent air voids of slab,
- ρ_w = density of water, 0.001 g/mm³.

NOTE 3: Obtain sufficient asphalt mixture density to ensure the surface of the slab does not rut or ravel during polishing. A common target air voids is $7 \pm 1\%$ for dense graded and gap-graded asphalt mixtures. A higher target air voids, such as $15 \pm 2\%$, should be used for open-graded asphalt mixtures.

- 6.2.2. For specimens using an asphalt mixture obtained from the field or asphalt mixture plant, sample according to AASHTO T 168. Reduce the asphalt mixture to batch size using AASHTO R47.
- 6.2.3. Prepare 4 batches of asphalt mixture. Determine the total mass of each batch by dividing m_T by 4.
- 6.2.4. Mix each batch separately and set aside.
- 6.2.5. Place all 4 pans in oven for two hours at the compaction temperature in accordance with AASHTO R 30.
- 6.3. Specimen Preparation Procedure
 - 6.3.1. When the compaction temperature of the asphalt mixture is achieved, assemble the heated components on suitable platform or floor.
 - 6.3.2. Place a piece of pre-cut non-stick paper on top of the base plate.
 - 6.3.3. Place the metal partition on top of the non-stick paper as shown in Figure 4. Pour one of the asphalt mixture batches from one pan into the transfer funnel, then into one quadrant. Pour the next asphalt mixture batch into the transfer funnel and then into the quadrant diagonally across from the first quadrant. Repeat for the other two batches. Carefully remove the metal partition.

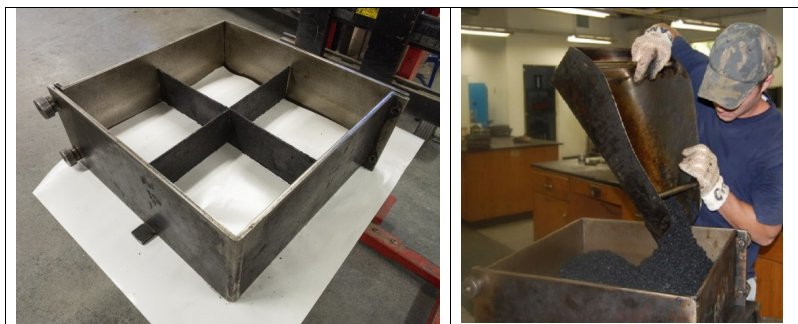


Figure 4. Technician pouring a batch into the partitioned compaction mold.

- 6.3.4. Spade the combined asphalt mixture batches with a large trowel until the asphalt mixture is a relatively uniform depth. Level the asphalt mixture with the trowel, taking care not to segregate the particles. Each asphalt mixture batch should be kept in the vicinity of the quadrant in which it was poured.
- 6.3.5. Place another piece of non-stick paper on top of the leveled asphalt mixture.
- 6.3.6. Compact the asphalt mixture until desired height is achieved.
- 6.3.7. Remove the non-stick paper from the top of the slab.

- 6.3.8. Slide the mold onto a counter and let it cool in front of a fan for a minimum of one hour before removing the mold. Do not handle the slab before it reaches room temperature.
- 6.3.9. Once the slab has cooled to room temperature, depending on the compaction method, demold and flip the slab over and remove the non-stick paper from the bottom.
- 6.3.10. Depending on the compaction method, the bottom of the slab could be the ideal side for most testing.
- 6.3.11. Ensure there is no more than a 1-mm departure in any of the areas to be tested by the DFT that is not related to mixture surface texture.
- 6.3.12. The slab should be stored on a rigid plate such as an approximately 25-mm (1-in.) thick piece of plywood to protect against deformation. Do not stack slabs or place the slab on a non-flat surface.
- 6.4. Sample Polishing Procedure
- 6.4.1. Before starting the polishing procedure of the prepared specimen, check that the condition of the TWPD meets the criteria set in Section 5.9. Gently clean any contamination from the tires, if necessary.
- 6.4.2. Measure the initial friction value by the Dynamic Friction Tester (DFT) according to ASTM E1911. Use a template to guide the location of the DFT, example shown in Figure 5, so the friction measurement path aligns with the TWPD polishing path.

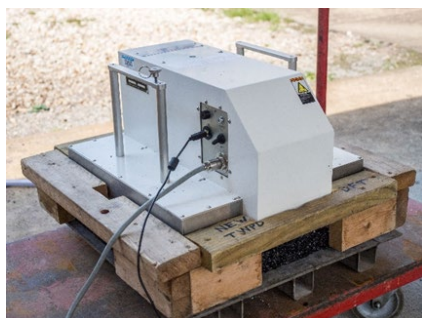


Figure 5. DFT placed into a guide template

- 6.4.3. Remove the slab from the DFT, and slide the specimen under the wheel assembly of the TWPD. Position the specimen so that the slab is against the back and side spacers, as shown in Figure 6.

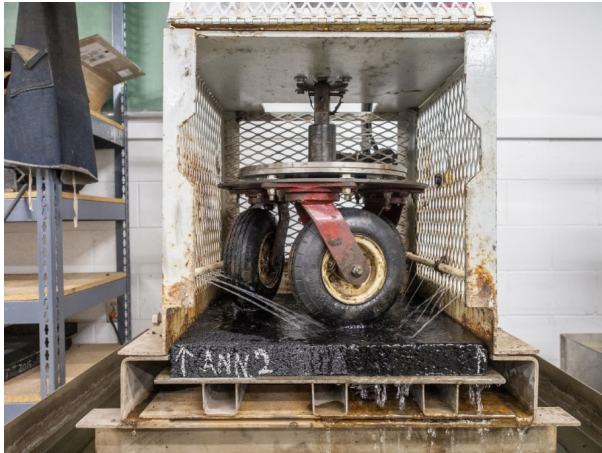


Figure 6. Properly positioned specimen in the TWP.

- 6.4.4. Gently lower the polishing tire carriage onto the specimen.
- 6.4.5. Close the safety door of the polisher.
- 6.4.6. Set the Automatic Counter to the desired number of revolutions established by the agency. Turn on the water flow. Begin polishing. One revolution of the polishing carriage corresponds to one pass made by all three wheels.

NOTE 4: 100,000 revolutions have been found to be sufficient to polish most compacted asphalt mixes to the terminal friction value. Intermittent friction values may be obtained, if desired, to capture the rate of polishing of the asphalt mixture before it reaches its terminal friction value.
- 6.4.7. Once the sample has been polished, turn off the water flow and raise the polishing tire carriage and slide out the test specimen slab.
- 6.5. Measure the friction value by the DFT according to ASTM E1911.

7. KEYWORDS

- 7.1. Friction test; asphalt mixtures; Three-Wheel Polishing Device (TWP); friction value; surface friction; Dynamic Friction Tester (DFT).

Standard Practice for

**Sample Preparation and Polishing
of Unbound Aggregates for
Dynamic Friction Testing**

AASHTO Designation: R xx-xx

Technical Section: 1c, Aggregates

Release: Group

ASTM Designation: N/A



**American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001**

**Sample Preparation and Polishing of Unbound Aggregates for
Dynamic Friction Test AASHTO Designation: RXX-XX**

Technical Section: 1c, Aggregates

Release: Group ASTM Designation: N/A

1. SCOPE

- 1.1. This method covers the sample preparation and polishing of unbound aggregates for Dynamic Friction Testing.
- 1.2. The values stated in SI units are to be regarded as the standard.
- 1.3. *This standard does not purport to address all the safety concerns associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to its use.*
-

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
- M 231, Standard Specification for Weighing Devices Used in the Testing of Materials
 - T 279, Standard Method of Test for Accelerated Polishing of Aggregates Using the British Wheel
 - R 90, Standard Practice for Sampling Aggregate Products
- 2.2. *ASTM Standard:*
- ASTM E1911, Standard Test Method for Measuring Paved Surface Frictional Properties Using the Dynamic Friction Tester
 - ASTM C778, Standard Specification for Standard Sand
-

3. SIGNIFICANCE AND USE

- 3.1. This test method simulates the polishing of vehicular traffic on coarse aggregates used in asphalt or concrete pavements or fine aggregates used for various pavement surface treatments.
-

4. TERMINOLOGY

- 5.1 *initial friction value* - the initial friction measurement on aggregate test specimens before being polished in the Three Wheel Polishing Device.
- 5.2 *terminal friction value*— the friction measurement on the aggregate test specimens at which point additional cycles of polishing in the TWPD will have negligible effects on the resulting friction value of the surface.

5. APPARATUS

- 5.1. Three-Wheel Polishing Device (TWP) – A polishing device that has three patterned pneumatic tires and is capable of exerting 0.65 ± 0.02 kN (146 ± 5 lbs.) through the tires to the test surfaces. The device's height shall be adjustable to accommodate sample heights of 25 mm (1.0 in.) to 50 mm (2.0 in.). (See Figure 1, 2 & 3)
- 5.1.1. The tire size shall be 2.80/2.50-4 and shall maintain a pressure of 240 ± 34 kPa (35 ± 5 psi) and a tread depth of no less than 2 mm (0.1 in.). The tire tread shall be free of any visible contamination. When replacement is necessary, all tires shall be replaced at the same time.
- 5.1.2. The driving mechanism for the vertical shaft shall be an electric motor geared to rotate the shaft and wheel assembly at a speed of 6.28 ± 0.5 radians per second (60 ± 5 revolutions per minute).
- NOTE 1: The path of polishing should coincide with the direction of friction testing
- 5.1.3. The device shall be equipped with an automatic counter that can shut off the machine at a predetermined number of revolutions.

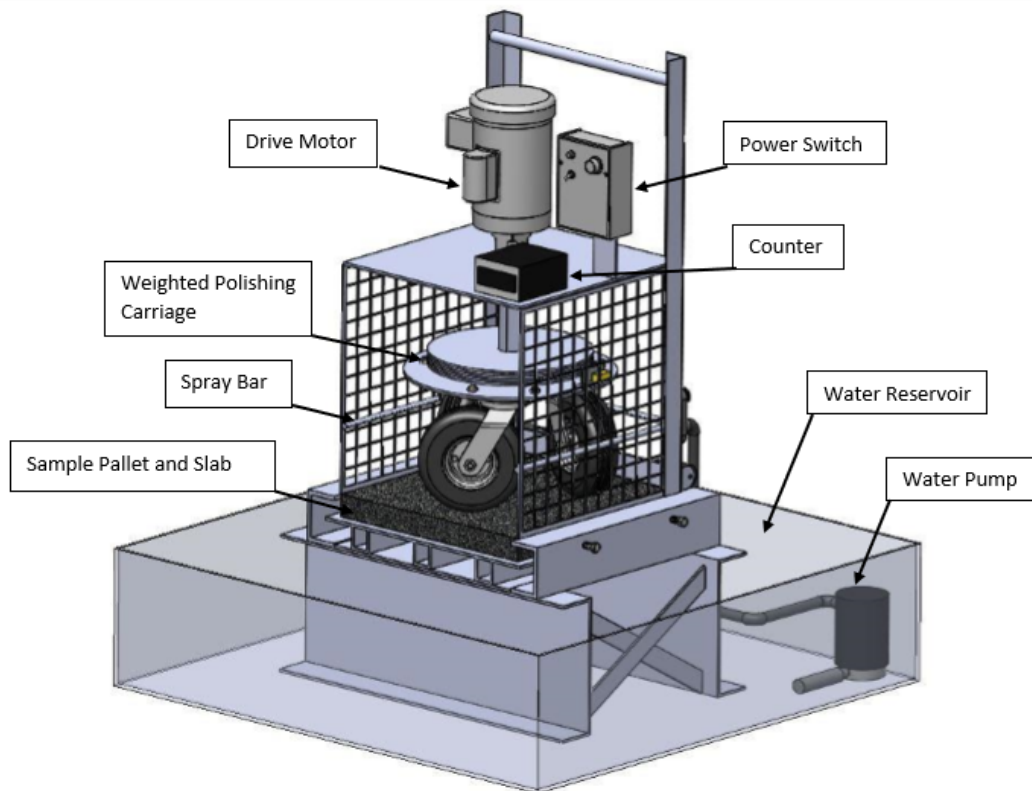


Figure 1. Three Wheel Polishing Device

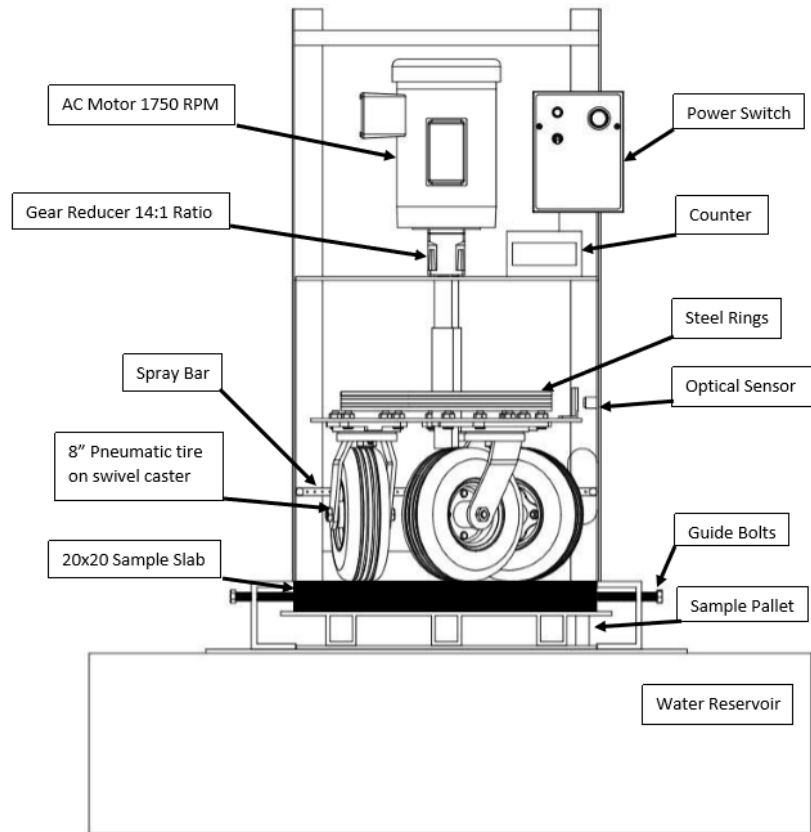


Figure 2. Three Wheel Polishing Device Front View

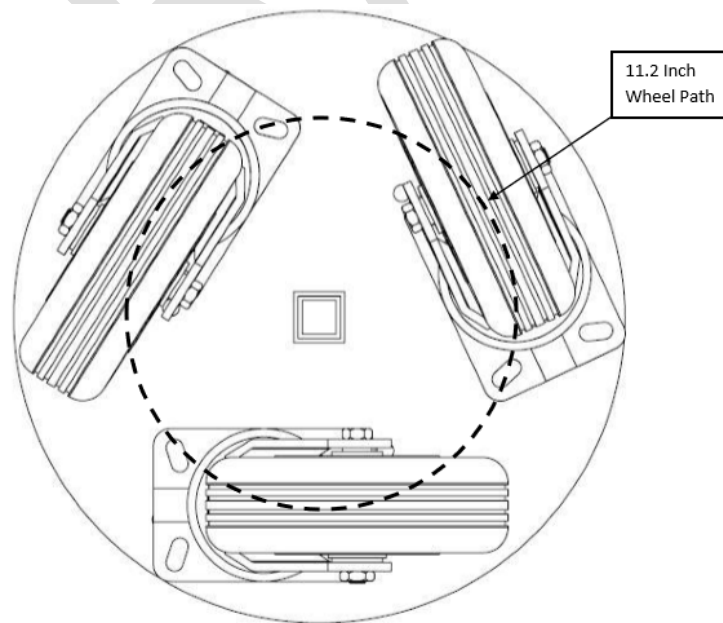


Figure 3. Wheel Path of Three Wheel Polishing Device

- 5.2. *Circular Casting Mold*- The casting mold shall be made with Stainless Steel (or another suitable material) capable of molding a specimen with an outside diameter of 355.6 mm (14"), inside diameter of 209.6 mm (8 1/4") and a height of 25 mm (1"). (See Figure 4.)
- 5.3. *Capping Mold* – a sturdy flat metal plate with dimensions of 400 mm x 400 mm x 20 mm that weighs a minimum of 10 kg (22 lb) to squeeze out excess epoxy. (See Figure 5.)
- 5.4. *Square Sample Holder* – The sample holder shall be made with Stainless Steel (or another suitable material) with dimensions of 508 mm x 508 mm x 50.8 mm (20" x 20" x 2") for holding the prepared sample during polishing and testing. (See Figure 6.) The sample holder may be marked to indicate the sitting position of the DFT.
- 5.5. *Miscellaneous supplies*- including disposable cups, spatula, and stirring rods.
- 5.6. *Source of Heat* – A ventilated oven capable of maintaining the temperature surrounding the sample at $110 \pm 5^{\circ}\text{C}$ ($230 \pm 9^{\circ}\text{F}$).
- 5.7. *Balance* – The balance shall have sufficient capacity and be readable to 0.1 percent of the sample mass and conform to the requirements of AASHTO M 231, class G 2.
- 5.8. *A Ventilated Work Area* – A working space for molding and curing test specimens that is vented to the outside, sufficient to evacuate fumes that can be generated from the materials that are used in preparing the test specimens.

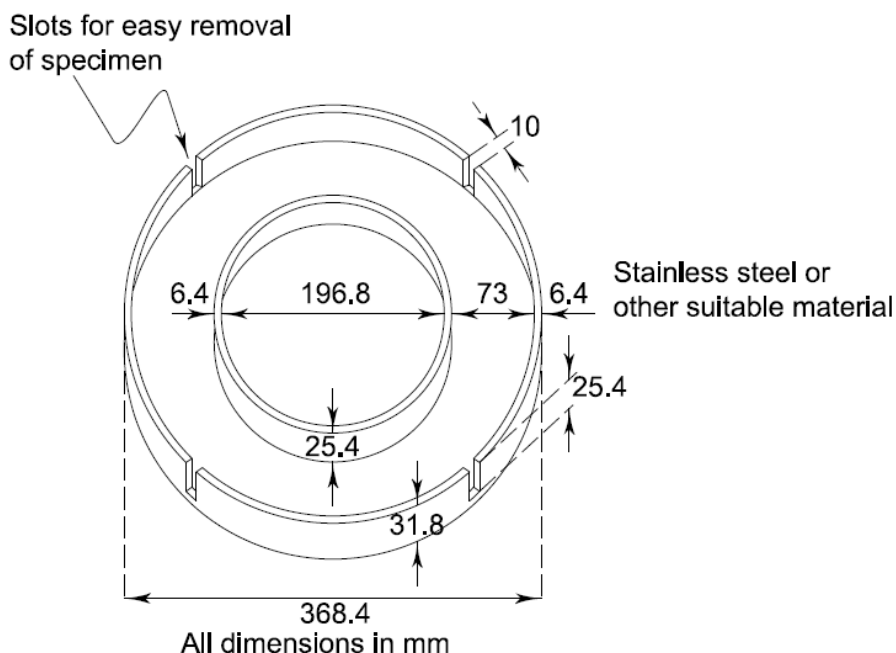


Figure 4 – Circular Casting Mold

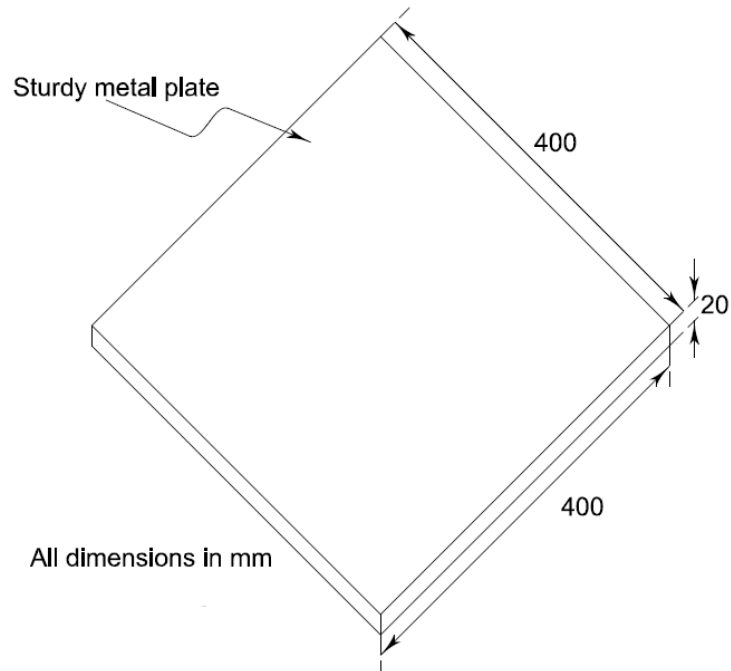


Figure 5 – Capping Mold

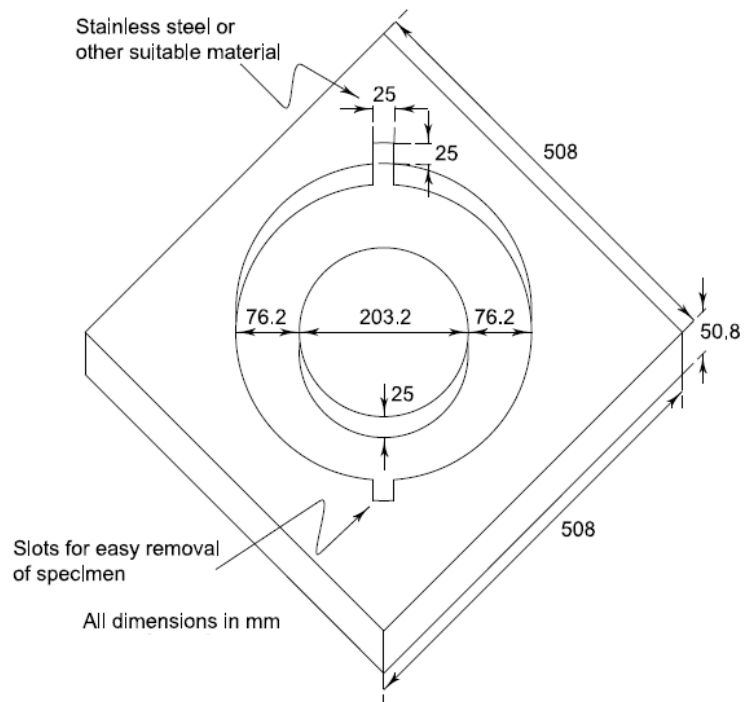


Figure 6 – Square Sample Holder

6. MATERIAL

- 6.1. *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 minutes and a curing time of 3 to 6 hours. This bonding agent shall not be so fluid as to flow through the glass beads. A bonding agent conforming to the requirements of AASHTO T 279 Appendix X1 has been found suitable for this purpose.
- 6.1.1 Extender Pigment – A supply of Wollastonite (or another suitable extender pigment). An extender pigment conforming to the requirements of AASHTO T 279 Appendix X1 has been found suitable for this purpose.
- 6.1.2 Gelling Agent - A supply of amorphous fumed silica conforming to the requirements of AASHTO T 279 Appendix X1 has been found suitable for this purpose.
- 6.1.3 Hardener - Methyl Ethyl Ketone Peroxide.
- 6.2. Mold Release Agent – Paste wax or equivalent
- 6.3. Glass Beads – 425- μm sieve (No. 40) to 250- μm sieve (No. 60) size glass beads for sifting into the interstices of the aggregate prior to placing the bonding material (or a standard sand conforming to the requirements of ASTM C778)
- 6.4. Coarse Aggregate – Approximately 0.014 m³ (1/2 ft³) supply of coarse aggregate to be tested and sampled in accordance with AASHTO R 90. The aggregate shall have met the mix design requirements of surface asphalt or concrete pavement mixtures.
- 6.5. Fine Aggregates - Approximately 0.014 m³ (1/2 ft³) supply of fine aggregate to be tested and sampled in accordance with AASHTO R90. The aggregate shall have met the requirements of the desired pavement surface treatment.

7. SELECTION OF METHOD

- 7.1. Coarse Aggregate -Test samples of unbound coarse aggregates used in asphalt or concrete pavements shall be prepared according to Method A.
- 7.2. Fine Aggregate - Fine Aggregates used for various pavement surface treatments shall be prepared according to Method B.

METHOD A — SAMPLE PREPARATION OF UNBOUND COARSE AGGREGATE

8. PROCEDURE

- 8.1. At least two specimens shall be tested for each coarse aggregate sample.

- 8.2. Sieve enough material to obtain at least 3.5 kg (7 lbs.) of aggregate per specimen passing the 12.5 mm (½ inch) sieve and retained on the 9.5 mm (¾ inch) sieve.
- 8.3. Thoroughly wash the aggregates obtained from Section 8.2 and dry to a constant weight at a temperature of $110 \pm 5^{\circ}\text{C}$ ($230 \pm 9^{\circ}\text{F}$).
- 8.4. Clean the casting mold, cover the inside of the four slots with a duct tape, and coat with a mold release agent.
- 8.5. Place a single layer of dry aggregate by hand as densely as possible with a flat surface down to cover the bottom surface of the mold as depicted in Figure 7.



Figure 7.- Aggregate placed in a Casting Mold

- 8.6. After placing the aggregate, fill the spaces between the aggregate with glass beads or standard sand. Pour the glass beads or standard sand to fill one-fourth to one-half of the aggregate depth to ensure the bonding agent does not seep to the bottom of the mold, thus being exposed on the finished polishing surface.
- 8.7. Prepare the epoxy mix in batches at a properly ventilated area at an ambient temperature of $20 \pm 5^{\circ}\text{C}$ ($68 \pm 9^{\circ}\text{F}$). To prepare one batch of epoxy, thoroughly mix the ingredients listed in Table 1.

Note 2. Refer to the Safety Data Sheet of the ingredients of the mix and use proper Personal Protective Equipment.

Material		Quantity
Extender Pigment	Wallastonite	120 g
Gelling Agent	Amorphous Silica	11 g
Bonding Agent	Polyester resin	296 g
Hardener	Methyl Ethyl Ketone Peroxide	4 g

Table 1 – Epoxy Ingredients

- 8.8. Pour the epoxy onto the placed aggregates at a properly ventilated area; then use a spatula to spread the epoxy.
- 8.9. Repeat the procedures in Section 8.7 and section 8.8 until the casting mold is filled in excess of its rim.
- 8.10. Coat the bottom of the capping mold with release agent and place it on top of the casting mold. Press it down to squeeze out the excess epoxy to form a smooth surface.
- 8.11. Allow the mold to dry at a properly ventilated area for at least 12 hours at an ambient temperature of $20 \pm 5^{\circ}\text{C}$ ($68 \pm 9^{\circ}\text{F}$). Then carefully remove the capping mold and make certain the epoxy has sufficiently hardened before removing the specimen from the casting mold.
- 8.12. Remove the specimen from the casting mold by first inverting the mold and lightly prying the specimen from the mold using the slots provided.
- 8.13. If glass beads/standard sand was used, remove all free and excess glass beads/standard sand from the face of the specimen. The finished specimen should appear like Figure 8.



Figure 8. Finished Specimen

METHOD B— SAMPLE PREPARATION OF FINE AGGREGATE – USED FOR PAVEMENT SURFACE TREATMENTS.

9. PROCEDURE

- 9.1. At least two specimens shall be tested for each fine aggregate sample.
- 9.2. Sieve enough material to obtain at least 1 kg (2.2 lbs.) of aggregate per specimen passing the 4.75 mm (No. 4) sieve and retained on the 1.18 mm (No.16) sieve.
- 9.3. Prepare a hard-surfaced epoxy base on the circular casting mold as shown in Figure 9. Use the same materials and quantities in Section 8.7 (or a suitable material compatible with the bonding agent) when preparing the epoxy base. Before pouring the epoxy, place an insert into the casting mold to offset the depth of the epoxy base by the depth of the fine aggregate layer. Cover the inside of the four slots with a duct tape and coat the casting mold and the insert with release agent.



Figure 9- Epoxy Base for Fine Aggregate Specimen

- 9.4. Allow the mold to cure at a properly ventilated area for at least 12 hours at an ambient temperature of $20 \pm 5^{\circ}\text{C}$ ($68 \pm 9^{\circ}\text{F}$). Then carefully remove the capping mold and make certain the epoxy has sufficiently hardened before removing the specimen from the casting mold.
- 9.5. Remove the specimen from the casting mold by first inverting the mold and lightly prying the specimen from the mold using the slots provided. Remove the insert at the base of the casting mold. Put back the epoxy base into the casting mold upside down and use the bottom side as the base surface for the fine aggregate.
- 9.6. Mix and evenly apply a bonding agent that is compatible with the aggregate layer and the epoxy base as shown in Figure 10. Apply a bonding agent at a thickness that would achieve an approximate 50% embedment depth of the aggregate. Avoid flushing (pooling) of the bonding agent on top of the specimen.
- Note 2. An application rate of 2 L/m^2 (0.04 gal/sq. ft) has been found suitable for High Friction Surface Treatment.



Figure 10- Application of Bonding Agent on the Epoxy Base

- 9.7. Apply generous amount of the fine aggregate to completely cover the bonding agent and leave it to cure as per the manufacturers recommended conditions.
- 9.8. Once cured, remove any loosely bound aggregates by brushing the specimen with stiff bristle brush before putting into the sample holder as shown in Figure 8.



Figure 11- Fine Aggregate Specimen

10. POLISHING PROCEDURE FOR UNBOUND COARSE AGGREGATE OR FINE AGGREGATE- USED IN VARIOUS PAVEMENT SURFACE TREATMENTS

- 10.1. Before starting the polishing procedure of the prepared sample check the condition of the rubber tires. Ensure that all three wheels contain a cold tire pressure of 240 ± 34 kPa (35 ± 5 psi). The ambient temperature should be $20 \pm 5^{\circ}\text{C}$ ($68 \pm 9^{\circ}\text{F}$). The tire tread should be free of any visible contamination
- 10.2. Remove particles from tire tread before running test. Replace cut tires if necessary. No water needs to be introduced during polishing.
- 10.3. Place the prepared coarse aggregate or fine aggregate sample into the sample holder. Drive plastic shims around the sample to ensure a snug fit of the sample in the sample holder. The sample shall not be allowed to move inside the sample holder during polishing. Make sure that the specimen is flush with sample holder.
- 10.4. Measure initial friction value by the Dynamic Friction Tester (DFT) According to ASTM E1911 using the marked position for the DFT. It is critical that the DFT measurement be taken on the same footpath of the polishing device.

- 10.5. Slide the specimen under the wheel assembly of the polishing device using the four side and two back alignment screws against the sample holder to centrally position the specimen on the same foot print where the initial friction value was obtained, as shown in figure 12.
- 10.6. Gently lower the polisher onto the specimen. Ensure that the frame is firmly fixed to the base and the three-wheel carriage is sited on the sample and is floating on the square drive shaft.

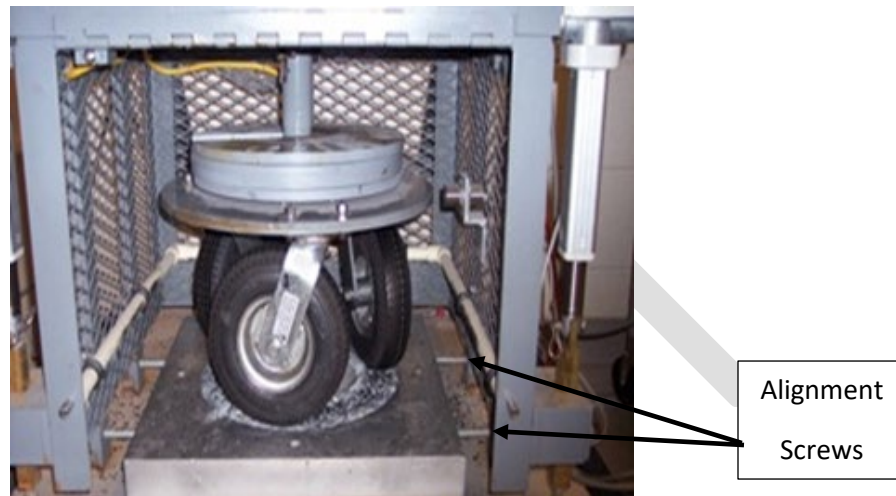


Figure 12 – Circular Track Polishing Machine
(with properly placed specimen.)

- 10.7. Close the safety door of the polishing device.
- 10.8. Set the Automatic Counter for the desired number of revolutions. One revolution of the polishing carriage corresponds to one pass made by all three wheels.
- Note 3. 100,000 revolutions have been found sufficient to polish an unbound coarse aggregate or fine aggregate to its terminal friction value. Intermittent friction values may be obtained, if desired, to capture the rate of polishing of the aggregate before it reaches its terminal friction value.
- 10.9. Once the sample has been polished, raise the polishing device and slide out the sample holder.
- 10.10. Brush off any abraded rubber debris from the sample and measure the polish value by the Dynamic Friction Tester According to ASTM E1911. It is critical that the DFT measurement be taken on the same footpath of the polishing device.

11. KEYWORDS

- 11.1 Friction test; asphalt mixtures; three-wheel polishing device; friction value; surface friction

DRAFT