Aggregate Technician Course
Tennessee Department of Transportation
Volume 19.1
Aggregate Technician Course
Tennessee Department of Transportation
Volume 19.1

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Welcome!

Aggregate Technician Course

Classroom Rules

- Be Respectful
- Facility Information
- Keep It Clean
- Phone Etiquette
Who Are YOU?

- Name
- Company
- Experience

Technician Certification Program

- Asphalt Roadway Inspector
- Asphalt Plant Inspector
- Asphalt Mix Design
- Concrete Field Testing
- Concrete Plant Quality Control
- Concrete Mix Design
- **Aggregate Technician**
- Nuclear Gauge Safety (TDOT Employees Only)
Purpose of Certification

- To ensure proper performance of tests
- To improve reliability of results
- For quality control
- To comply with federal requirements

Course Highlights

- Course schedule
  - Slide presentations
  - Written Exam
  - Performance Exam
- Results
- Certification
- Recertification
  - Every 5 years
Examination

• Written Exam (No Phones Allowed)
  • 50 questions
  • Open-book
  • 2 hours to complete
  • To Pass
    • Must get 75% overall and 70% in each section

• Performance Exam
  • Pass/Fail
  • PPE Required (Close-Toed Protective Shoes, Safety Glasses)

Results

• Available within one week of completion

• Contact the Headquarters Materials & Tests Training Coordinator, Kim Whitby

  • kimberly.whitby@tn.gov
  • 615-350-4158
Resources

- Course materials
  - Course textbook
  - Presentation slides and videos
- TDOT
  - Standard Specifications, January 1, 2015
  - Supplemental Specifications
- Regional Materials & Tests Contacts
  - Region 1: Brad Baskette
  - Region 2: Tony Renfro
  - Region 3: Kevin Isenberg
  - Region 4: Mitch Blankenship

AASHTO/ASTM Resources

- Sampling of Aggregates: R 90 / D75
- Reducing Samples of Aggregate to Testing Size: R 76 / C702
- Total Evaporable Moisture Content of Aggregate by Drying: T 255 / C566
- Materials Finer than #200 Sieve in Mineral Aggregate by Washing: T 11 / C117
- Sieve Analysis of Fine & Coarse Aggregate: T 27 / C136
- Specific Gravity of Coarse Aggregate: T 85 / C127
- Specific Gravity of Fine Aggregate: T 84 / C128
- Soundness of Aggregate: T 104 / C88
- L.A. Abrasion: T 96 / C131
Resources

- Tennessee Department of Transportation
  - https://www.tn.gov/tdot.html
- American Road & Transportation Builders Association
  - https://www.artba.org/
- Tennessee Road Builders Association
  - www.trba.org/
- Tennessee Ready Mixed Concrete Association
  - www.tnconcrete.org/
- American Association of State Highway Transportation Officials
  - https://www.transportation.org
- American Society for Testing and Materials
  - https://www.astm.org/
- American Concrete Institute
  - https://www.concrete.org/
- Construction Materials Engineering Council
  - https://www.cmeg.org/
- Portland Cement Association
  - www.cement.org/

ADA Notice of Requirements

- Can be found at the following website:
  https://www.tn.gov/tdot/government/g/public-accessibility-office/ada.html
- To be in compliance with TDOTs requirements listed on the website above, it is our goal to provide reasonable accommodations to those who identify themselves as having a disability and request such accommodations.
- Please feel free to bring it to any of the course instructors and accommodations will be administered as discretely as possible.
Questions
Quarry Safety and PPE
Aggregate Safety

References
TDOT Lab Guidelines
Mine Safety and Health Administration

Personal Protective Equipment

• Safety Vest
• Safety Glasses
• Hard Hat
• Ear Protection
• Gloves
• Protective Shoes
• Additional safety equipment may be required and should be provided by the facility.
**General Safety**

**Field/Lab**

- Abide by facility requirements
- MSHA at quarries
- OSHA in TDOT Lab
- Must be accompanied by a certified miner

**TDOT Lab Requirements**

- Safety Glasses
- Protective Shoes
- Gloves (as needed)
Site Safety

• Sign in/out when visiting a facility

MSHA Checklist

When entering Query property, travel should be limited to the authorized areas where your services are required.

Quarry company vehicles and equipment always have the Right of Way. CB channel at this operation is

Mobile equipment has blind spots. Do not approach mobile equipment unless authorized, the operator knows you are there and signals that it is okay to approach. Do not park in the blind spots of equipment.

Traffic pattern in the pit is [Place “X” in correct box]: [ ] left hand [ ] right hand [ ] combination of both

Stay at least 200 feet back from equipment on ramps. Equipment in front of you can coast downhill if the engine or drive-line fails. Material can also fall out of loaded trucks in front of you.

Seat belts must be worn at all times.

Post all traffic rules and regulations are to be followed at all times. Speed limit is 15 miles per hour unless otherwise posted.

Do not leave your vehicle unattended. Unattended vehicles must have the controls placed in park and parking brake set. If parked on a grade, the wheels must be chocked or turned into a berm or bank.
Emergency Procedures

To be completed if individual will be working in a particular area

New process

Coordinate with aggregate operation

Daily Workplace Examination

To be completed if individual will be working in a particular area

New process

Coordinate with aggregate operation
Regional Safety Contacts

- **Region 1:** K. Duane Manning  
  p. 865-594-4512  
  duane.manning@tn.gov

- **Region 2:** Christopher Smith, P.E  
  p. 423-634-2455 c. 423-290-7491  
  christopher.smith@tn.gov

- **Region 3:** Webb Rizor  
  p. 615-350-4494  
  webb.rizor@tn.gov

- **Region 4:** John Thomas  
  p. 731-935-0312  
  john.thomas@tn.gov
Sampling of Aggregates

AASHTO R 90

ASTM D75
TDOT Standard Method of Test for Sampling of Aggregates

References
TDOT Standard Specifications
AASHTO R 90
ASTM D75

Apparatus

- Shovel, Scoops
- Brushes
- Sampling Tubes
- Belt Template
- Mechanical Sampling Systems
- Sample Containers
- Tags
Purpose

• Preliminary investigation of the potential source of supply
  • Sample at source
  • Complete quality testing (dependent upon application)
• Control of the product at the source
• Control of the operations at the site of use
  • Project site
  • Asphalt or Concrete Plant
• Acceptance or rejection of the materials
  • TDOT Standard Specifications
## Sizes of Coarse Aggregate Table 903.22-1

<table>
<thead>
<tr>
<th>Size</th>
<th>Nominal Size, Square Openings</th>
<th>4”</th>
<th>3-1/2”</th>
<th>3”</th>
<th>2-1/2”</th>
<th>2”</th>
<th>1-1/2”</th>
<th>1”</th>
<th>3/4”</th>
<th>1/2”</th>
<th>3/8”</th>
<th>No. 4</th>
<th>No. 8</th>
<th>No. 16</th>
<th>No. 50</th>
<th>No. 100</th>
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<td>100</td>
<td>90 - 100</td>
<td>35 - 70</td>
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<td>90 - 100</td>
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<td>25 - 60</td>
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<td>35 - 70</td>
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<td>90 - 100</td>
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<td>30 - 65</td>
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<td>0 - 10</td>
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<td>7</td>
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<td>8</td>
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</tr>
</tbody>
</table>

(1) Screenings

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**TDOT Department of Transportation**

15
Size of Aggregate

- **Nominal maximum size** of aggregate is the smallest sieve opening through which the entire amount of the aggregate is permitted to pass.

<table>
<thead>
<tr>
<th>Size Nominal Size, Square Openings</th>
<th>4&quot;</th>
<th>3-1/2&quot;</th>
<th>3&quot;</th>
<th>2-1/2&quot;</th>
<th>2&quot;</th>
<th>1-1/2&quot;</th>
<th>1&quot;</th>
<th>3/4&quot;</th>
<th>1/2&quot;</th>
<th>3/8&quot;</th>
<th>No. 4</th>
<th>No. 8</th>
<th>No. 16</th>
<th>No. 50</th>
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<tbody>
<tr>
<td>57 1&quot; - No. 4</td>
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</tr>
</tbody>
</table>

- **Maximum size** of aggregate is the smallest sieve opening through which the entire amount of aggregate is required to pass.
## Minimum Field Sample Size

<table>
<thead>
<tr>
<th>Nominal Maximum Aggregate Size</th>
<th>Minimum Field Sample Mass, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>#8 22</td>
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</tr>
<tr>
<td>#4 22</td>
<td></td>
</tr>
<tr>
<td>3/8” 22</td>
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</tr>
<tr>
<td>½” 35</td>
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<tr>
<td>¾” 55</td>
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<tr>
<td>1” 110</td>
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<tr>
<td>1 ½” 165</td>
<td></td>
</tr>
<tr>
<td>2” 220</td>
<td></td>
</tr>
<tr>
<td>2 ½” 275</td>
<td></td>
</tr>
<tr>
<td>3” 330</td>
<td></td>
</tr>
<tr>
<td>3 ½” 385</td>
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</tr>
</tbody>
</table>
Aggregate Production and Use

https://www.youtube.com/watch?v=qWEci7TbjBk&feature=youtu.be
Aggregate Production and Use
Methods of Sampling

- Flowing aggregate stream
- Conveyor belt
- Stockpiles
  - With power equipment
  - Without power equipment
- Roadways
- Transportation units

Flowing Aggregate Stream
(by mechanical means)

- From bins, for example
- Three increments
- Each increment obtained using a suitable sampling device
- Device must be capable of interrupting the entire flow of material as it passes off the belt
Conveyor Belts

- **Three** increments
- Production suspended while sampling
- Lockout-tagout (MSHA required)
- Templates useful for defining sampling area
- All material within sampling area is removed including fines (with a brush)

Stockpiles

- Stockpile must be checked for segregation and noted in log
- Segregation is the separation of varying sizes of aggregate
- Power equipment is recommended
- Portions collected at various locations around the main stockpile
With Power Equipment

• After re-blending, loader enters stockpile with bucket approximately 6” above ground level

• Loader bucket is raised perpendicular to the ground

• Bucket is tilted forward to roll material out into a separate stockpile

With Power Equipment

• The loader is then used to backblade the smaller stockpile ONE time

• Divide the sample pad into 4 quadrants and sample equal amounts

• Avoid sampling within 1 ft. of sample pad edge

• The FOUR increments are then combined to comprise the final field sample
Without Power Equipment

If power equipment is not available:

• The pile is visually divided into three even sections: top third, mid-point, and bottom third of the elevation of the stockpile

• Portions are obtained from each section at least 12” below the surface by removing the outer layer of material

• The three increments are then combined to comprise the final field sample

• Note that although this is a recognized sampling method, many producers may not allow people on stockpiles for safety reasons.

Sampling Tubes

• Fine aggregate only

• Sample shall be taken at a minimum height of 3 ft from the surrounding grade

• At least five tube insertions randomly spaced across face of stockpile

• Note that although this is a recognized sampling method, many producers may not allow people on stockpiles for safety reasons.
Sampling Tubes

- Three increments
- Sample obtained from uncompacted or loosely-compacted base or subgrade material
- Random locations
- Full depth of layer must be sampled
- Avoid contamination from underlying material

Roadways
Transportation Units

- Railroad cars, barges, trucks
- Avoid if at all possible
- Power equipment is recommended
- Various levels and random locations
- Three or more trenches
  - Three increments from each trench

Sample Containers

- Durable
- OSHA requirement \([ \leq 50 \text{ lbs}]\)
- Portion the sample if necessary
- Appropriate container for test to be performed
Tagging a Sample

Project Number: 55001-3231-18
Date Sampled: 11 Mar 02  Submitted: 12 Mar 02
Sampled by: F. Flintstone
Submitted by: F. Flintstone
Producer: Stone Materials, Inc.
Pit Number: 185  Sampled from: Stockpile
County: Davidson  Region: 3
# Submitting a Sample

**STATE OF TENNESSEE**  
**DEPARTMENT OF TRANSPORTATION**  
**DIVISION OF MATERIALS AND TESTS**  
6601 CENTENNIAL BLVD.  
NASHVILLE, TENNESSEE 37243-0360  

**CONTRACTOR MATERIAL CERTIFICATION**  
AND/OR  
**SAMPLING AND TESTING RECORD**

<table>
<thead>
<tr>
<th>Field</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original Sample</td>
<td>☐</td>
</tr>
<tr>
<td>Check Sample</td>
<td>☐</td>
</tr>
<tr>
<td>Project Reference No.</td>
<td></td>
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<tr>
<td>Project No.</td>
<td></td>
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<tr>
<td>Contractor</td>
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<tr>
<td>Date Sampled</td>
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<td>Producer</td>
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<tr>
<td>Region</td>
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<tr>
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</tr>
<tr>
<td>Heat No.</td>
<td>Size</td>
</tr>
<tr>
<td>Date Received at Lab</td>
<td></td>
</tr>
<tr>
<td>Date Reported</td>
<td></td>
</tr>
<tr>
<td>Sampled by</td>
<td>Phone</td>
</tr>
<tr>
<td>Amount Represented</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>Report No.</td>
<td></td>
</tr>
</tbody>
</table>
Questions
Reducing Samples of Aggregate to Testing Size

AASHTO R 76

ASTM C702
**TDOT Standard Method of Test for Reducing Samples of Aggregate to Testing Size**

References
- TDOT Standard Specifications
- AASHTO R 76
- ASTM C702

**Methods of Reduction**

- Method A - Mechanical Splitter
- Method B - Cone and Quarter
- Method C - Miniature Stockpile
To Determine Method

Moisture condition of the aggregate

- Dry
- Moist
- Saturated-Surface-Dry (SSD/Absorption)
- Wet/Free Moisture

To Determine Method

Size of aggregate

- Coarse
  - Retained on #4
- Fine
  - Passing #4
- Combined
#4 Sieve

- The #4 sieve has 4 openings per linear inch
- How many openings per square inch?
### Determine Method

<table>
<thead>
<tr>
<th>Moisture</th>
<th>Aggregate Size</th>
<th>Coarse</th>
<th>Combined</th>
<th>Fine</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSD and drier</td>
<td>A, B</td>
<td>A, B</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Free moisture on surface</td>
<td>A, B</td>
<td>B</td>
<td>B, C</td>
<td></td>
</tr>
</tbody>
</table>

- Method A - Mechanical Splitter
- Method B - Cone and Quarter
- Method C - Miniature Stockpile
Mechanical Splitter / Method A

For Coarse and Combined Aggregate

- Even number of chutes
- Chutes of equal width
- At least 8 chutes
- Individual chutes about 50% larger than largest particles

Mechanical Splitter / Method A

For Fine Aggregate

- Even number of chutes
- Chutes of equal width
- At least 12 chutes
- Individual chutes ½” to ¾” wide
Cone and Quarter / Method B

• Cone the sample on a hard, clean, level surface.
• Turn sample over 3 times and place into a cone.
• Flatten the cone to a uniform thickness.
• Diameter = 4 to 8 times the thickness

Cone and Quarter / Method B

• Divide the flattened cone.
• After dividing, remove two diagonal quarters (including fines).
• Mix and quarter the remaining material until sample is adequately reduced.
Cone and Quarter / Method B
Fine Aggregate

Method B Alternative

Mix by rolling on canvas.
Flatten aggregate pile to a diameter 4 to 8 times the thickness.
Method B Alternative

Divide the aggregate into four separate quarters using a shovel or stick.

Remove two diagonally opposite quarters including fines.

Miniature Stockpile / Method C

• Place sample on hard, clean, level surface
• Mix thoroughly by turning over three times
• Form a cone with the last turning
• Flatten, if desired, to a uniform thickness
• Select at least five increments at random locations using a shovel, scoop, or spoon
Miniature Stockpile / Method C
Total Evaporable Moisture Content of Aggregate by Drying

AASHTO T 255
ASTM C566
TDOT Standard Method of Test for Total Evaporable Moisture Content of Aggregate by Drying

References
TDOT Standard Specifications
AASHTO T 255
ASTM C566

Apparatus
- Balance
- Heat Source
- Sample Container
- Stirring Spoon
- Brush
- Gloves
Sample Size

TABLE 1 Sample Size for Aggregate

<table>
<thead>
<tr>
<th>Nominal Maximum Size of Aggregate, mm (in.)</th>
<th>Mass of Normal Weight Aggregate Sample, min. kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.75 (0.187) (No. 4)</td>
<td>0.5</td>
</tr>
<tr>
<td>9.5 (%6)</td>
<td>1.5</td>
</tr>
<tr>
<td>12.5 (%6)</td>
<td>2</td>
</tr>
<tr>
<td>19.0 (%6)</td>
<td>3</td>
</tr>
<tr>
<td>25.0 (1)</td>
<td>4</td>
</tr>
<tr>
<td>37.5 (1½)</td>
<td>6</td>
</tr>
<tr>
<td>50 (2)</td>
<td>8</td>
</tr>
<tr>
<td>63 (2½)</td>
<td>10</td>
</tr>
<tr>
<td>75 (3)</td>
<td>13</td>
</tr>
<tr>
<td>90 (3½)</td>
<td>16</td>
</tr>
<tr>
<td>100 (4)</td>
<td>25</td>
</tr>
<tr>
<td>150 (6)</td>
<td>50</td>
</tr>
</tbody>
</table>

^ Based on sieves meeting Specification E11.

^ Determine the minimum sample mass for lightweight aggregate by multiplying the value listed by the dry-loose unit mass of the aggregate in kg/m³ (determined using Test Method C29/C29M) and dividing by 1600.

Samples
Determine Sample Mass

- Weigh the sample to the nearest 0.1g

6285.6 g

Dry the Sample

- Dry the aggregate to a constant mass (does not vary more than 0.1%) in an oven at 230 ± 9°F
- Allow the material to cool
Reweigh the Sample

- Weigh the sample to the nearest 0.1g

Calculations

\[ P_{\text{Moisture,Total}} = \frac{M_{\text{Original}} - M_{\text{Dry}}}{M_{\text{Dry}}} \times 100 \]

\[ P = \frac{W - D}{D} \times 100 \]
Problem

Given:
• Weight of the original sample \( (W) = 1092.4 \text{ g} \)
• Weight of sample after drying \( (D) = 1080.5 \text{ g} \)

Determine:
Total percent \( (P) \) moisture content of the aggregate

Solution

\[
P = \frac{W - D}{D} \times 100
\]
### Practice

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Original Weight</th>
<th>Dry Weight</th>
<th>$\frac{W - D}{D} \times 100$</th>
<th>Moisture Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>588.3</td>
<td>570.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1556.8</td>
<td>1540.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1225.0</td>
<td>1220.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1665.2</td>
<td>1650.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Determine the percent moisture content in the wet condition:**

**Determine the percent moisture of the aggregate at SSD (Absorption):**

**DRY** 900g  **MOIST** 930g  **SSD** 955g  **WET** 975g
• Determine the percent of free moisture on the sample:

• Determine the amount of water the aggregate has in the wet condition:
5

Materials Finer Than #200 Sieve

In Mineral Aggregates by Washing

AASHTO T 11

ASTM C117
TDOT Standard Method of Test for Materials Finer Than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing

References
TDOT Standard Specifications
AASHTO T 11
ASTM C117

Apparatus

- Balance
- Sieves (#16 & #200)
- Container
- Oven
- Wetting Agent
- Mechanical Washer (optional)
# Sample Size

<table>
<thead>
<tr>
<th>Nominal Maximum Size&lt;sup&gt;A&lt;/sup&gt;</th>
<th>Minimum Mass, g</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.75 mm (No. 4) or smaller</td>
<td>300</td>
</tr>
<tr>
<td>9.5 mm (3/8”)</td>
<td>1000</td>
</tr>
<tr>
<td>12.5 mm to 19.0 mm (½” to ¾”)</td>
<td>2500</td>
</tr>
<tr>
<td>25 mm (1”) or larger</td>
<td>5000</td>
</tr>
</tbody>
</table>

<sup>A</sup> Based on sieve sizes meeting Specification E11.
Dry the Sample

- Dry the aggregate to a constant mass (does not vary more than 0.1%) in an oven at 230 ± 9°F
- Allow the material to cool

Determine the Sample Mass

- Weigh the sample to the nearest 0.1g
Two Procedures

Procedure A - Washing with plain water
- Dust of Fracture

Procedure B - Washing using a wetting agent
- Clay Particles

Procedure
- Place the sample in the container
- Add water to cover the sample
- Add wetting agent if performing Procedure B
Procedure

• Agitate the sample
• Use a spoon to stir, if desired
• Ensure complete separation of particles

Procedure

Pour the wash water with suspended solids over the nested sieves
Procedure

- Repeat the washing with plain water
- Repeat until wash water is clear
- Use wetting agent first wash only

Alternate Procedure

- Mechanical washing is allowable as long as the results are consistent with hand washing
- Some samples may degrade in mechanical washers
Procedure

- Flush material retained on sieves back into container
- Do not splash as this may lose material

Dry the Sample

- Dry the aggregate to a constant mass (does not vary more than 0.1%) in an oven at 230 ± 9°F
- Allow the material to cool
Determine the Sample Mass

Weigh the sample to the nearest 0.1g

Calculations

\[
P_{\leq \#200} = \frac{M_{\text{Dry, Before}} - M_{\text{Dry, After}}}{M_{\text{Dry, Before}}} \times 100
\]
Results

• If the percentage of material finer than #200 is less than 10%, then report the results to the nearest 0.1.

• If the percentage of material finer than #200 is greater than 10%, then report the results to the nearest whole number.

Problem

Given:

• Original mass of the sample = 595.6 g
• Mass of the sample after washing = 579.3 g

Determine:

• The percent (P) of material finer than the #200 sieve in the sample.
Solution

\[ P_{\leq \#200} = \frac{M_{\text{Dry, Before}} - M_{\text{Dry, After}}}{M_{\text{Dry, Before}}} \times 100 \]

\[ P_{\leq \#200} = \]

Practice

Given:

• Original mass of the sample = 6895.5 g
• Mass of the sample after washing = 6045.0 g

Determine:

• The percent (P) of material finer than the No. 200 sieve in the sample
Solution

\[ P \leq \#200 = \frac{M_{Dry, Before} - M_{Dry, After}}{M_{Dry, Before}} \times 100 \]
Sieve Analysis of Fine & Coarse Aggregates

AASHTO T 27

ASTM C136
TDOT Standard Method of Test for
Sieve Analysis of Fine and
Coarse Aggregates

References
TDOT Standard Specifications
AASHTO T 27
ASTM C136

Apparatus

• Balance
• Oven
• Sieves
• Mechanical Shaker
Aggregate Gradation

Well-Graded

Gap-Graded

Uniformly-Graded
7.3 *Fine Aggregate*—The size of the test sample, after drying, shall be 300 g minimum.

7.4 *Coarse Aggregate*—The size of the test sample of coarse aggregate shall conform with the following:

<table>
<thead>
<tr>
<th>Nominal Maximum Size, Square Openings, mm (in.)</th>
<th>Test Sample Size, min, kg (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5 (3/8)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>12.5 (1/2)</td>
<td>2 (4)</td>
</tr>
<tr>
<td>19.0 (3/4)</td>
<td>5 (11)</td>
</tr>
<tr>
<td>25.0 (1)</td>
<td>10 (22)</td>
</tr>
<tr>
<td>37.5 (1 1/2)</td>
<td>15 (33)</td>
</tr>
<tr>
<td>50 (2)</td>
<td>20 (44)</td>
</tr>
<tr>
<td>63 (2 1/2)</td>
<td>35 (77)</td>
</tr>
<tr>
<td>75 (3)</td>
<td>60 (130)</td>
</tr>
<tr>
<td>90 (3 1/2)</td>
<td>100 (220)</td>
</tr>
</tbody>
</table>
Dry the Sample

• Dry the aggregate to a constant mass (does not vary more than 0.1%) in an oven at 230 ± 9°F
• Allow the material to cool

Determine the Sample Mass

Weigh the sample to the nearest 0.1 of a unit of the original sample mass
Sieves

Loose Mesh

Clogged

Hole/Tear

Options for Overloading

• Use larger sieve
• Portion the sample
• Place another sieve in the nest

Overloaded Sieve

12” Round

18” x 26” Tray
# Maximum Loading of Sieves

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

<table>
<thead>
<tr>
<th>Sieve Opening Size</th>
<th>Nominal Dimensions of Sieve&lt;sup&gt;a&lt;/sup&gt;</th>
<th>203.2-mm, dia&lt;sup&gt;b&lt;/sup&gt;</th>
<th>254-mm, dia&lt;sup&gt;b&lt;/sup&gt;</th>
<th>304.8-mm, dia&lt;sup&gt;b&lt;/sup&gt;</th>
<th>350 by 350, mm</th>
<th>372 by 580, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sieving Area, m²</td>
<td>0.0285</td>
<td>0.0457</td>
<td>0.0670</td>
<td>0.1225</td>
<td>0.2158</td>
</tr>
<tr>
<td>125 mm (5 in.)</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td>67.4</td>
<td></td>
</tr>
<tr>
<td>100 mm (4 in.)</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td>30.6</td>
<td>53.9</td>
<td></td>
</tr>
<tr>
<td>90 mm (3 1/2 in.)</td>
<td>c</td>
<td>c</td>
<td>15.1</td>
<td>27.6</td>
<td>48.5</td>
<td></td>
</tr>
<tr>
<td>75 mm (3 in.)</td>
<td>c</td>
<td>8.6</td>
<td>12.6</td>
<td>23.0</td>
<td>40.5</td>
<td></td>
</tr>
<tr>
<td>63 mm (2 1/2 in.)</td>
<td>c</td>
<td>7.2</td>
<td>10.6</td>
<td>19.3</td>
<td>34.0</td>
<td></td>
</tr>
<tr>
<td>50 mm (2 in.)</td>
<td>3.6</td>
<td>5.7</td>
<td>8.4</td>
<td>15.3</td>
<td>27.0</td>
<td></td>
</tr>
<tr>
<td>37.5 mm (1 1/2 in.)</td>
<td>2.7</td>
<td>4.3</td>
<td>6.3</td>
<td>11.5</td>
<td>20.2</td>
<td></td>
</tr>
<tr>
<td>25.0 mm (1 in.)</td>
<td>1.8</td>
<td>2.9</td>
<td>4.2</td>
<td>7.7</td>
<td>13.5</td>
<td></td>
</tr>
<tr>
<td>19.0 mm (3/4 in.)</td>
<td>1.4</td>
<td>2.2</td>
<td>3.2</td>
<td>5.8</td>
<td>10.2</td>
<td></td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
<td>0.89</td>
<td>1.4</td>
<td>2.1</td>
<td>3.8</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>9.5 mm (5/8 in.)</td>
<td>0.67</td>
<td>1.1</td>
<td>1.6</td>
<td>2.9</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>0.33</td>
<td>0.54</td>
<td>0.80</td>
<td>1.5</td>
<td>2.6</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> 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).

<sup>b</sup> 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.).

<sup>c</sup> Sieves indicated have less than five full openings and should not be used for sieve testing.
Mechanical Shaker

- Shake thoroughly
- Agitating for more than 10 minutes may degrade the sample

Weighing

Weigh the sample to the nearest 0.1 of a unit of the original sample mass
AASHTO Loss

\[
\text{AASHTO Loss} = \frac{\text{Original Sample Wt.} - \text{Total Cumulative Wt.}}{\text{Original Sample Wt.}} \times 100
\]

AASHTO Loss must be \( \leq 0.3\% \)

Calculations

\[
\text{Cumulative } \% \text{ Retained} = \frac{\text{Cumulative Wt. Retained}}{\text{Original Sample Wt.}} \times 100
\]

Cumulative % Passing = 100 – Cumulative % Retained
Sample Problem #1

<table>
<thead>
<tr>
<th>Natural Sand for Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original Sample Weight (g)</td>
</tr>
<tr>
<td>Sieve Size</td>
</tr>
<tr>
<td>No. 4</td>
</tr>
<tr>
<td>No. 8</td>
</tr>
<tr>
<td>No. 16</td>
</tr>
<tr>
<td>No. 30</td>
</tr>
<tr>
<td>No. 50</td>
</tr>
<tr>
<td>No. 100</td>
</tr>
<tr>
<td>No. 200</td>
</tr>
<tr>
<td>Pan</td>
</tr>
</tbody>
</table>

Sample Problem #1

\[ \text{AASHTO Loss} = \frac{\text{Original Sample Wt.} - \text{Total Cumulative Wt.}}{\text{Original Sample Wt.}} \times 100 \]

AASHTO Loss =
## Sample Problem #1

**Original Sample Weight**: 507.8 g

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Cumulative Wt Retained (g)</th>
<th>Cumulative % Retained</th>
<th>Cumulative % Passing</th>
<th>Specification 903.01</th>
<th>Meets? Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4</td>
<td>0.0</td>
<td></td>
<td></td>
<td>95 - 100</td>
<td>Yes</td>
</tr>
<tr>
<td>No. 8</td>
<td>51.0</td>
<td></td>
<td></td>
<td>-</td>
<td>No</td>
</tr>
<tr>
<td>No. 16</td>
<td>149.0</td>
<td></td>
<td></td>
<td>50 - 90</td>
<td>Yes</td>
</tr>
<tr>
<td>No. 30</td>
<td>255.0</td>
<td></td>
<td></td>
<td>-</td>
<td>No</td>
</tr>
<tr>
<td>No. 50</td>
<td>372.0</td>
<td></td>
<td></td>
<td>5 - 35</td>
<td>Yes</td>
</tr>
<tr>
<td>No. 100</td>
<td>467.0</td>
<td></td>
<td></td>
<td>0 - 20</td>
<td>Yes</td>
</tr>
<tr>
<td>No. 200</td>
<td>496.0</td>
<td></td>
<td></td>
<td>0 - 3</td>
<td>Yes</td>
</tr>
<tr>
<td>Pan</td>
<td>507.0</td>
<td></td>
<td></td>
<td>-</td>
<td>No</td>
</tr>
</tbody>
</table>
Fineness Modulus

- Numerical value to indicate fineness of aggregate
- Aggregate with same fineness modulus will require the same quantity of water to produce a mix of the same consistency and strength
- Higher fineness modulus means material is more coarse
- Cumulative percent retained on No. 100, No. 50, No. 30, No. 16, No. 8, No. 4, 3/8 inch, 3/4 inch, 1 1/2 inch and 3 inch sieves (Divide by 100)
- For concrete sand, 2.3 - 3.1
# FM Sample #1

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Cumulative Percent Retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 in</td>
<td></td>
</tr>
<tr>
<td>1 1/2 in</td>
<td></td>
</tr>
<tr>
<td>3/4 in</td>
<td></td>
</tr>
<tr>
<td>3/8 in</td>
<td></td>
</tr>
<tr>
<td>No. 4</td>
<td></td>
</tr>
<tr>
<td>No. 8</td>
<td></td>
</tr>
<tr>
<td>No. 16</td>
<td></td>
</tr>
<tr>
<td>No. 30</td>
<td></td>
</tr>
<tr>
<td>No. 50</td>
<td></td>
</tr>
<tr>
<td>No. 100</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>FM</td>
<td></td>
</tr>
</tbody>
</table>
Sample Problem #2

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Cumulative Weight Retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2 in</td>
<td>0.0</td>
</tr>
<tr>
<td>1 in</td>
<td>0.0</td>
</tr>
<tr>
<td>3/4 in</td>
<td>0.6</td>
</tr>
<tr>
<td>1/2 in</td>
<td>8.8</td>
</tr>
<tr>
<td>3/8 in</td>
<td>16.5</td>
</tr>
<tr>
<td>No. 4</td>
<td>24.3</td>
</tr>
<tr>
<td>No. 8</td>
<td>24.6</td>
</tr>
<tr>
<td>Pan</td>
<td>25.4</td>
</tr>
</tbody>
</table>

AASHTO Loss = \( \frac{\text{Original Sample Wt.} - \text{Total Cumulative Wt.}}{\text{Original Sample Wt.}} \times 100 \)
## Sample Problem # 2

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Cumulative Wt Retained (lb)</th>
<th>Cumulative % Retained</th>
<th>Cumulative % Passing</th>
<th>Specification 903.22</th>
<th>Meets? Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ½ in</td>
<td>0.0</td>
<td></td>
<td>100</td>
<td>100</td>
<td>Yes</td>
</tr>
<tr>
<td>1 in</td>
<td>0.0</td>
<td></td>
<td>95 - 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>¾ in</td>
<td>0.6</td>
<td></td>
<td>-</td>
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<td>½ in</td>
<td>8.8</td>
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<tr>
<td>3/8 in</td>
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<td></td>
<td>-</td>
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<tr>
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Original Sample Weight 25.6 lb
## FM Sample #2

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<tr>
<td>1 1/2 in</td>
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<tr>
<td>3/4 in</td>
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<td>3/8 in</td>
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<tr>
<td>No. 4</td>
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<td>No. 8</td>
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<td>No. 16</td>
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<td>No. 30</td>
<td></td>
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<tr>
<td>No. 50</td>
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<td>No. 100</td>
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<tr>
<td><strong>Total</strong></td>
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<tr>
<td><strong>FM</strong></td>
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</tbody>
</table>
Questions
7

Specific Gravity

AASHTO T 84 & 85
ASTM C128 & 127
Specific Gravity

- Ratio of aggregate weight to the weight of an equal volume of water
- Dimensionless number (no units attached)

Specific Gravity = 2.70 means that the rock weighs 2.70 times an equal volume of water

Water

100 lb

Stone

270 lb
Uses of Specific Gravity

- Weight-Volume Conversions
- Identifying Deleterious Materials (e.g. shale or chert)
- Mining Operations / Planning
- Void Calculations
- Float / Separation Systems

Rock and Water

- Considerations
  - Rock has weight
  - Rock takes up space (volume)
  - Absorbed Water has weight
  - Absorbed Water takes up space (volume)
Specific Gravity

\[ \text{Specific Gravity} = \frac{\text{Weight}}{\text{Volume} \times (\text{Unit Weight of Water})} \]

Unit Weight of Water = 62.4 lb/ft³ =

Water (1 ft³) → 62.4 lb

Recording Specific Gravity

- Report specific gravity results to the nearest 0.001
- Specific gravity for concrete aggregate may be reported to the nearest 0.01
Types of Specific Gravity

• Apparent
• Bulk
• Bulk Saturated Surface Dry (SSD)
• All three types of specific gravity can be calculated using one test

Types of Specific Gravity

• Apparent
  • Not generally seen in concrete or asphalt mix designs
  • Used for in situ conversions from surveyed volumes to calculate tons
• Bulk
  • Used in some asphalt mix designs (i.e. Superpave)
• Bulk Saturated Surface Dry (SSD)
  • Used in concrete mix designs to account for absorbed water
**Apparent Specific Gravity**

- Considerations
  - Mass of Oven Dry Rock
  - Volume of Solid Rock Only

\[
G_{sa} = \frac{\text{Mass of Oven Dry Aggregate}}{(\text{Volume of Oven Dry Aggregate}) \times (\text{Unit Weight of Water})}
\]

**Bulk Specific Gravity**

- Considerations
  - Mass of Oven Dry Rock
  - Volume of Solid Rock
  - Volume of External Voids

\[
G_{sb} = \frac{\text{Mass of Oven Dry Aggregate}}{(\text{Volume of Aggregate} + \text{Volume of Voids}) \times (\text{Unit Weight of Water})}
\]
SSD Specific Gravity

- Considerations
  - Mass of Oven Dry Rock
  - Mass of Absorbed Water
  - Volume of Solid Rock
  - Volume of External Voids

Specific Gravity Relationships

\[ G_{SSD} = \frac{\text{Mass of Oven Dry Aggregate} + \text{Mass of Absorbed Water}}{\left(\text{Volume of Aggregate} + \text{Volume of Voids}\right) \times \text{Unit Weight of Water}} \]

It is Always True that

Apparent > SSD > Bulk

Unless

Absorption = 0
Specific Gravity Relationships

Apparent = SSD = Bulk

Only When
Absorption = 0

Questions
Sodium Sulfate Soundness

AASHTO T 104
ASTM C88
Sodium Sulfate Soundness

References
TDOT Standard Specifications
AASHTO T 104
ASTM C88

• Test that estimates aggregate’s “soundness” by saturating in sodium sulfate solution and drying (5 cycles)
• The aggregate is measured before and after to see how much it is broken down (Loss)
• Simulates weathering under exposed applications such as asphalt, concrete, or base
• TDOT does not evaluate Reclaimed Concrete Aggregate (RCA) for soundness
Soundness

Before

After
# Sodium Sulfate Soundness

(AASHTO T 104 / ASTM C88)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
<th>Max Loss, %</th>
</tr>
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<tbody>
<tr>
<td><strong>Asphalt Aggregates</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>903.11</td>
<td>Surface (Coarse)</td>
<td>9.0</td>
</tr>
<tr>
<td>903.06</td>
<td>Base &amp; Leveling (Coarse)</td>
<td>9.0</td>
</tr>
<tr>
<td>903.11</td>
<td>Surface (Fine)</td>
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</tr>
<tr>
<td>903.06</td>
<td>Base &amp; Leveling (Fine)</td>
<td>12.0</td>
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<tr>
<td><strong>Concrete Aggregates</strong></td>
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<td></td>
</tr>
<tr>
<td>903.03</td>
<td>Coarse</td>
<td>9.0</td>
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<tr>
<td><strong>Base Aggregates</strong></td>
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<td>--</td>
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</tr>
</tbody>
</table>

*Materials referring to ASTM D692 adhere to this quality unless specified differently*
Questions
L.A. Abrasion
(Wear)

AASHTO T 96
ASTM C131
L.A. Abrasion
(Wear)

References
TDOT Standard Specifications
AASHTO T 96
ASTM C131

What is L.A. Abrasion?

• Wear is the measure of a coarse aggregate’s resistance to degradation after undergoing a combination of abrasion, grinding, and impact.

• This test is widely used to indicate relative quality among aggregate sources.
Process

- Sample is separated into specific sizes and weighed
- Sample is placed into a drum with steel balls and rotated
- After rotating, the sample is removed, separated back into specific sizes, and weighed
- The difference between the first and the final weights is reported as the abrasion (loss).
Los Angeles Abrasion
(AASHTO T 96 / ASTM C131)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
<th>Max Loss, %</th>
</tr>
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<tbody>
<tr>
<td>Asphalt Aggregates</td>
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<tr>
<td>903.11</td>
<td>Surface</td>
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<tr>
<td>903.06</td>
<td>Base &amp; Leveling</td>
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<tr>
<td>Concrete Aggregates</td>
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<tr>
<td>903.03</td>
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<td>903.01</td>
<td>(Fine)*</td>
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<td>ASTM D692**</td>
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</table>

* Applies to source material for manufactured fine aggregate (Limestone or Dolomite)

** ASTM D692 applies to coarse fractions (per ASTM D448) unless specified otherwise. Crushed Blast Furnace Slag not to be tested.
Questions
10

TDOT Surface Aggregates
TDOT Surface Aggregates

References
TDOT Standard Specifications

Why?
We will look at...

- What happens between the tire and the road
- What influences skid resistance
- What our TN natural resources have to offer
- TDOT surface aggregate program
- TDOT friction testing program

Surface Texture Ranges

From: "Guide for Pavement Friction", Hall et. al.
Micro- & Macro-Texture

- Key is to optimize micro- and macro-texture, and to select materials that do not polish under traffic.

Sedimentary, Igneous, and Metamorphic Rocks

*From: Santa Fe College.edu*
TDOT Surface Aggregates Program

TDOT Spec Book 903.24

<table>
<thead>
<tr>
<th>Type</th>
<th>Applications</th>
<th>2-year / Min Traffic Test Section</th>
<th>Min Silica Dioxide SiO₂ (%)</th>
<th>Max Calcium Carbonate CaCO₃ (%)</th>
<th>Min Acid Insols (%)</th>
<th>Min 9-hr BPN</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>All Pavements</td>
<td>No</td>
<td>40%</td>
<td>32%</td>
<td>50%</td>
<td>30</td>
</tr>
<tr>
<td>II</td>
<td>All Pavements</td>
<td>Yes</td>
<td>30%</td>
<td>N/A</td>
<td>35%</td>
<td>30</td>
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<tr>
<td>III</td>
<td>Non-Interstate &lt; 15,000 ADT</td>
<td>Yes</td>
<td>20%</td>
<td>N/A</td>
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<tr>
<td>IV</td>
<td>2-lane &lt; 5,000 ADT</td>
<td>Yes</td>
<td>10%</td>
<td>N/A</td>
<td>N/A</td>
<td>22</td>
</tr>
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</table>

Chemistry Component
Chemistry

- **Silica Dioxide** is a very hard mineral that resists polishing under traffic. TDOT requires min amount of silica.

- **Calcium Carbonate** is the primary mineral in limestone. Limestones tend to polish under traffic. Max amount specified for Type I applications.

Acid Insoluble Test

What remains is the residue... Silica, Alumina, Iron
## TDOT Surface Aggregates Program

TDOT Spec Book 903.24

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<tr>
<th>Type</th>
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### Polishing Component

**British Wheel & Pendulum**

- Simulates traffic
- Measures polishing characteristics
TDOT Regions
Different Regions Offer Different Rock Types
# Approved Surface Aggregate Sources

## Region 1 - Surface Aggregates

<table>
<thead>
<tr>
<th>Producer</th>
<th>Location</th>
<th>Type</th>
<th>Material</th>
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</thead>
<tbody>
<tr>
<td>Blue Water Industries (Elizabethton)</td>
<td>Elizabethton, TN</td>
<td>1</td>
<td>Quartz</td>
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<td>Harrison Construction (APAC)</td>
<td>Waynesville, NC</td>
<td>1</td>
<td>Granite</td>
</tr>
<tr>
<td>Hedrick Enterprises (Grove stone)</td>
<td>Black Mountain, NC</td>
<td>1</td>
<td>Granite</td>
</tr>
<tr>
<td>Hedrick Enterprises (North Buncombe)</td>
<td>Asheville, NC</td>
<td>1</td>
<td>Granite</td>
</tr>
<tr>
<td>Horsehead</td>
<td>Rockwood, TN</td>
<td>1</td>
<td>Slag</td>
</tr>
<tr>
<td>Maynead</td>
<td>Mt. City, TN</td>
<td>1</td>
<td>Granite</td>
</tr>
<tr>
<td>Newport Sand &amp; Gravel</td>
<td>Newport, TN</td>
<td>1</td>
<td>Pea Gravel &amp; Sand</td>
</tr>
<tr>
<td>Rogers Group</td>
<td>Caryville, TN</td>
<td>4</td>
<td>Limestone</td>
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<tr>
<td>Tube City IMS</td>
<td>Knoxville, TN</td>
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<td>Slag</td>
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<tr>
<td>Vulcan Materials</td>
<td>Enka, NC</td>
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<td>Granite</td>
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<tr>
<td>Vulcan Materials (Greystone)</td>
<td>Greenville, TN</td>
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<td>Pea Gravel &amp; Sand</td>
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## Region 2 - Surface Aggregates

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<td>Harrison Construction (APAC)</td>
<td>Murphy, NC</td>
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<td>Martin Marietta</td>
<td>Dallas, GA</td>
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</tr>
<tr>
<td>Midlands Aggregates</td>
<td>Dallas, GA</td>
<td>1</td>
<td>Granite</td>
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<tr>
<td>Rogers Group</td>
<td>Allons, TN</td>
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<td>Sandstone</td>
</tr>
<tr>
<td>Rogers Group</td>
<td>Englewood, TN</td>
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<td>Limestone</td>
</tr>
<tr>
<td>Rogers Group</td>
<td>McMinnville, TN</td>
<td>2</td>
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</tr>
<tr>
<td>Vulcan Materials</td>
<td>Blairsville, GA</td>
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<tr>
<td>Vulcan Materials</td>
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<tr>
<td>Vulcan Materials</td>
<td>Elizay, GA</td>
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<td>Granite</td>
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</table>

## Region 3 - Surface Aggregates

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<th>Producer</th>
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<th>Type</th>
<th>Material</th>
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</thead>
<tbody>
<tr>
<td>Rogers Group</td>
<td>Cross Plains, TN</td>
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<tr>
<td>Rogers Group</td>
<td>Gordonsville, TN</td>
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<tr>
<td>Rogers Group</td>
<td>Hickman Co. (Bon Aqua), TN</td>
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<tr>
<td>Rogers Group</td>
<td>Lawrenceburg, TN</td>
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<tr>
<td>Rogers Group - TN River Sand &amp; Gravel</td>
<td>Linden, TN</td>
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<td>Gravel</td>
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<tr>
<td>Vulcan Materials</td>
<td>Clarksville, TN</td>
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<td>Limestone</td>
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<tr>
<td>Vulcan Materials</td>
<td>Dickson, TN</td>
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<td>Limestone</td>
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<td>Vulcan Materials</td>
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<td>Vulcan Materials</td>
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## Region 4 - Surface Aggregates

<table>
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<td>Ford Construction</td>
<td>Troy, TN</td>
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<td>International Mill Service (Delta Contract)</td>
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<td>J.R. Hayes Construction</td>
<td>Buchanan, TN</td>
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<td>Gravel</td>
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<tr>
<td>Memphis Stone &amp; Gravel</td>
<td>Arlington, TN</td>
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<td>Gravel</td>
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<td>Gravel</td>
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<td>Phoenix Services</td>
<td>Hickman, AR</td>
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<td>Slag</td>
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<tr>
<td>Shilo Sand &amp; Gravel</td>
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<td>Gravel</td>
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<td>Collierville, TN</td>
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<td>Millington, TN</td>
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<tr>
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<td>Stantonville, TN</td>
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</table>
## TDOT Surface Aggregates Program

TDOT Spec Book 903.24

<table>
<thead>
<tr>
<th>Type</th>
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<th>Min 9-hr BPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>All Pavements</td>
<td>No</td>
<td>40%</td>
<td>32%</td>
<td>50%</td>
<td>30</td>
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<tr>
<td>II</td>
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<td>Yes</td>
<td>30%</td>
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<td>35%</td>
<td>30</td>
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<td>Yes</td>
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<td>N/A</td>
<td>25%</td>
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<td>10%</td>
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<td>N/A</td>
<td>22</td>
</tr>
</tbody>
</table>

**Approval Component**

**TDOT Friction Testing Program**

- Evaluate aggregate & track performance over time
- Research new material & products such as high friction surfaces
- Able to identify low friction routes through TDOT's Friction Program
Review

• Micro- and Macro-texture
• Geology across the state
• Physical and Chemical Properties
• Approved Surface Aggregates
• TDOT Roadway Testing Program
11

Base Stone
Base Stone

References
TDOT Standard Specifications
**Purpose of Base Stone**

- Protect the subgrade
- A load-bearing layer to help transition the load from the surface to the subgrade
- Protect the pavement system from water intrusion and deformation

**Density**

- Density of an Aggregate is Defined as Weight per Unit Volume
  - Pounds per Cubic Foot = \( pcf = \frac{lb}{ft^3} \)

---

Weight, lb = 142.0
Importance of Density

- Strength and stiffness are derived from stone-to-stone contact in an aggregate support layer.
- Dry density is a measure of the amount of solid particles (weight) in a unit volume.
- Higher density indicates more stone-to-stone contact.
- More stone-to-stone contact means greater stiffness and better support.

Moisture – Density Relationship

- Sample and test to determine standard proctor density and optimum moisture content.
- TDOT uses Standard Proctor method.
What Influences Density?

- Gradation
- Moisture
- Compactive Effort
- Particle Shape and Others...
Gradation Influence

• Too Fine
  • Coarse particles float in fines

• Too Coarse
  • Excessive voids & lower internal friction

• Just Right
  • Well-proportioned size distribution
Gradation Influence

Table 903.05-2: Grading Table for Type A and Type B Aggregate for Mineral Aggregate Base and Surface Courses

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Total Percent by Weight, Passing Sieves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grading A</td>
</tr>
<tr>
<td>2-1/2 inch</td>
<td>100</td>
</tr>
<tr>
<td>2 inch</td>
<td>95-100</td>
</tr>
<tr>
<td>1-1/2 inch</td>
<td>--</td>
</tr>
<tr>
<td>1 inch</td>
<td>--</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>--</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>35-65</td>
</tr>
<tr>
<td>No. 4</td>
<td>--</td>
</tr>
<tr>
<td>No. 16</td>
<td>--</td>
</tr>
<tr>
<td>No. 100</td>
<td>0-10</td>
</tr>
</tbody>
</table>

(1) For gravel and chert bases containing clay, the range is 20-43.
(2) For gravel and chert bases containing clay, the range is 7-18.
Moisture Influences

• Too Wet
  • Base is “soupy” & water pushes particles apart

• Too Dry
  • No lubrication to enhance compaction

• Just Right
  • Particles move easier and voids replaced with solid particles

Compactive Effort

• Too Little
  • Particles aren't tightly packed

• Too Much
  • Breakdown particles
  • Generate fines
  • Coarse float in fines matrix

  GOOD
  COMPACTION
  LEADS TO
  GOOD
  PERFORMANCE
Others...

• Particle Shape
• Plasticity
• Construction Foundation

Base Stone Process

• Produce a well-graded material to meet specifications
• Send it through a pugmill to add water
• Place it on the roadway
• Grade to proper elevation
• Compact with roller(s)
Base Stone Process

Well-Graded Base Stone

Add Water, Mix, and Load Truck

Placing

Grading

Compacting
Questions
12

SOP 2-1

Aggregate Approval Process
SOP 2-1
Aggregate Approval Process

Purpose

• Process for necessary approval
• Testing material qualities
• Communication between TDOT and Producers
• Surface aggregates
All Aggregates

• All sources must go through the following process to have their product approved for TDOT work
  • Submit Quality Control Plan (QCP) to HQ M&T
  • Submit Independent test results to HQ M&T
  • Verification sample taken by regional staff
  • Consistency sample taken by regional staff

• Any producer not on the Producer List will have to go through this process

Quality Control Plan

• Generic QC Plan on TDOT Webpage
• Contact Information of Key Personnel
• Location of Site and Office
• Stockpile Management
• Operation and Handling Procedures
• QC Failure Response
Tennessee Department of Transportation
Headquarters Materials and Tests Division

Region 3

Nashville, TN

Quality Control Plan
2018

07/05/2018
Quality Control Plan

Physical Location of the Source: Division of Materials and Tests

6601 Centennial BLVD
Nashville, TN 37243

Mailing Address: Department of Transportation
Division of Materials and Tests
6601 Centennial BLVD
Nashville, TN 37243

Phone Number: (615) 350-4152
Fax Number: (615) 350-4128

Contact Person & Title: Bob Smith, Transportation Project Specialist
Phone Number: (615) 350-4152
Fax Number: (615) 350-4128
Email: bob.smith@tn.gov

List of personnel responsible for production and quality control at the site and include information on how to contact each person.

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bob Smith</td>
<td>TPS</td>
<td>(615) 350-4128</td>
<td><a href="mailto:bob.smith@tn.gov">bob.smith@tn.gov</a></td>
</tr>
<tr>
<td>David Jones</td>
<td>GTA</td>
<td>(615) 350-4100</td>
<td><a href="mailto:david.jones@tn.gov">david.jones@tn.gov</a></td>
</tr>
</tbody>
</table>
Quality Control Plan

Include a description of the property site and reference to the nearest identifiable points such as highways and towns.

The Materials and Tests Division is located in Building A on the First floor at 6601 Centennial Blvd. The location of the site is about 1.5 miles off of I-40 at exit 204A. If you are on Briley Parkway you will take exit 26B to Centennial Blvd.

Map of the Location
Labeling of Stockpiles

- How are stockpiles labeled to eliminate confusion between the operators, trucks, and customers?
- What steps are taken to make sure there is no confusion between surface aggregates and standard aggregates in the same quarry?
- The sign must be legible from the cab of a truck fifty feet from the identified pile.
Control of Stockpiles

- How are the stockpiles constructed?
- How far apart are the stockpiles separated?
- How often is the aggregate sampled and tested?
- How is contamination prevented during the process of developing a stockpile?
Control of Production

• State the process of how the material is developed from mining to final product.
• Show a figure of the crushing and screening process.
• The different sizes of processed aggregate such as #57s and #4s should be listed.
• The type of aggregate produced such as limestone, granite, gravel, etc. should be listed.
• Formation types should be identified.
• How is the prevention of segregation, degradation, and contamination controlled during the production process?
Loading and Shipping

• Develop a loading and shipping control plan which includes a description of the methods by which the products are to be loaded and shipped.

• How is the prevention of segregation, degradation, and contamination controlled during the loading and shipping process?

• What are the steps taken to ensure that all shipping units are clean?

Dealing with Quality Control Failures

• How does the producer plan to initiate an immediate investigation?

• How will the producer implement corrective action to remedy the cause of the problem?

• How are the operators trained to identify a problem?
Independent Lab Tests

• All aggregates must present the following quality results from within the last 6 months:
  • Gradation
  • Sodium Sulfate Soundness
  • LA Abrasion
  • Specific Gravities
  • Absorption

• Other state DOT labs acceptable as independent labs

Verification Sample

• Regional staff takes sample for TDOT verification testing
• Quality results are verified
• Failure of any test requires a referee sample
Consistency Sample

• Confirms results after verification or referee testing
• Proves that the quality results are consistent
• Failure may require referee

Source Approval

• A producer will be added to the Producer List once the preceding steps are completed and requirements are met
• After added to the Producer List, the source may used on TDOT projects or products
• Producers must follow Quality Monitoring procedures to remain on the Producer List
Quality Monitoring

• “An aggregate’s approval is based on continuous satisfactory field performance as well as periodic laboratory evaluation...”

• Samples will be taken every six months but no closer than 90 days apart

• If a quality sample fails, a referee sample will be tested and then confirmed by consistency

Failure & Removal

• Any failed test will result in a referee sample.

• A failed referee will result in removal from the Producer List.
Surface Aggregate Approval

- Aggregate to be used in roadway surface courses (Asphalt & Concrete) must meet additional requirements to ensure enough friction is provided
- Lab tests and field performance determine type and approval
- Crushed Granite, Gravel, Gneiss, Quartzite, Sandstone, and Slag will automatically test as Type I

Surface Aggregates
Chemical Analysis

- Silica Dioxide Content (ASTM C25)
- Calcium Carbonate Content (ASTM C25)
- Acid Insoluble Residue (ASTM D3042)
- British Pendulum Number (AASHTO T 278/279)
Surface Aggregates
Test Strip

- All strips have a minimum test time of 2 years
- Must be ~0.5mi in both directions without signals or stop signs (≥40mph)
- Each type requires a certain amount of traffic to simulate polishing and may need to operate longer to achieve minimum traffic
- The producer is responsible for finding and coordinating a test strip with the contractor and providing appropriate calculations for ADT

Surface Aggregates
Field Performance

- Strip will be periodically tested for frictional value throughout 2+ year operation
- After test period, frictional value must exceed 40 to qualify
Surface Aggregates
Quality Monitoring

- Take samples twice a year, no closer than 90 days apart, for complete chemical and physical testing

- Crushed aggregates not composed of limestone may exclude British Pendulum Test

Questions ??
Appendix
Appendix

References
SOP 1-1
SOP 2-1
Generic Aggregate QC Plan

SOP 1-1

• Acceptance table for aggregate used in various types of construction
• Provides information on the following:
  • Test(s) to be performed
  • Who samples
  • How often to test
  • Location/Time of sampling
SOP 2-1

- Approval Procedures
- Quality Monitoring Process
- Facility Removal
- QC Plan
- Surface Aggregate Requirements
- Quality Requirements

Generic Aggregate QC Plan

- QC Plan layout
- Contact information
- Location map
- Minimum topics to cover

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Useful Links

• SOPs

• Generic QC Plan
  • https://www.tn.gov/tdot/materials-and-tests/field-operations.html
<table>
<thead>
<tr>
<th>Type of Construction</th>
<th>Material</th>
<th>Test</th>
<th>Sampled By</th>
<th>Frequency</th>
<th>Location or Time of Sampling</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AGGREGATE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggregate for Underdrains</td>
<td>Aggregate</td>
<td>Gradation</td>
<td>M&amp;T</td>
<td>Per month</td>
<td>Project site or plant stockpile</td>
<td></td>
</tr>
<tr>
<td>Base Courses (Aggregate- Cement OR Aggregate-Lime- Fly Ash)</td>
<td>Aggregate</td>
<td>Gradation</td>
<td>Project Inspector</td>
<td>Every 2,500 tons</td>
<td>Plant stockpile</td>
<td>First sample should be taken at beginning of day.</td>
</tr>
<tr>
<td></td>
<td>Moisture</td>
<td></td>
<td></td>
<td>Every 2,500 tons or two per day</td>
<td>At time of weighing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aggregate-Cement Mixture</td>
<td>Density, Moisture</td>
<td></td>
<td>Five tests per 10,000 square-yard lot</td>
<td>Immediately following compaction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aggregate-Lime-Fly Ash Mixture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Granular Backfill</td>
<td>Aggregate for Bridges, Box Culverts, &amp; other major structures</td>
<td>Gradation, Moisture</td>
<td>Project Inspector</td>
<td>Per day</td>
<td>Plant or roadway</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Density, Moisture</td>
<td></td>
<td></td>
<td>Three tests per layer</td>
<td>Immediately following compaction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aggregate for Pipe Culverts</td>
<td>Gradation, Moisture</td>
<td></td>
<td>Per day</td>
<td>Plant or roadway</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Density, Moisture</td>
<td></td>
<td></td>
<td>Per layer every 50 feet</td>
<td>Immediately following compaction</td>
<td></td>
</tr>
<tr>
<td>Mineral Aggregate Base</td>
<td>Mineral Aggregate</td>
<td>Proctor, Specific Gravity, Optimum Moisture</td>
<td>M&amp;T</td>
<td>Per year or as material changes</td>
<td>At source</td>
<td>Quality report required for each project.</td>
</tr>
<tr>
<td></td>
<td>Gradation, Moisture</td>
<td>Project Inspector</td>
<td>At beginning of project and every 2500 tons thereafter (Minimum of 1 per week)</td>
<td>Plant or roadway</td>
<td>First sample should be taken at beginning of day.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Density, Moisture</td>
<td></td>
<td>Five tests per 10,000 square-yard lot</td>
<td>Immediately following compaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Quantities</td>
<td>Gradation</td>
<td></td>
<td></td>
<td>Per week</td>
<td>Plant or roadway</td>
<td>Not to exceed 500 tons per project.</td>
</tr>
</tbody>
</table>
Tennessee Department of Transportation  
Division of Materials and Tests  

Procedures for Aggregate Approval and Quality Monitoring  
(SOP 2-1)

**Purpose:** The purpose of this document is to establish a formal process for evaluating, testing, and approving aggregate sources and their products for use in general Tennessee Department of Transportation (TDOT) construction and bituminous or concrete surface mixtures.

**Background:** Aggregates must exhibit certain physical and chemical properties that reflect their ultimate quality and durability. The TDOT Standard Specifications for Road and Bridge Construction dated January 1, 2015, have several aggregate properties specified, including abrasion resistance, freeze-thaw durability, gradation, particle shape, deleterious materials, and others. Aggregates used for bituminous or concrete riding surfaces must demonstrate additional properties that would indicate the aggregates ability to satisfactorily provide a polish-resistant pavement. These properties may include silica dioxide content, insoluble residue content, calcium carbonate content, and British Pendulum Numbers.

1. **Approval Process**

All aggregate sources shall submit the following required documents to Headquarters Materials & Tests (HQMT) and complete the following procedures to have their products be considered for use in TDOT projects. Additional tests may be required for materials with certain uses (e.g. surface aggregates). These procedures are required for any source which is not currently on the approved list. See Qualified Product List (QPL) 35 for lightweight aggregate approval procedures.

1.1 **Submittal Letter**

The Producer shall submit in writing their request to be considered for their aggregate products to be approved for use on TDOT projects and products. This letter shall include all the aggregate products (type, sizes, uses, etc.) the Producer is requesting to be considered and shall be submitted to HQMT at the following email:  
TDOT.AggregateMTR@tn.gov

1.2 **Quality Control Plan (QCP)**

The Producer shall prepare a written QCP that is specific to the site requesting approval. Appendix A details the minimum information required in the QCP. A *generic QCP* has also been prepared which includes the minimum information required.
1.3 Independent Lab Test Results

1.3.1 The Producer shall submit test results (see Appendix C) from an AASHTO Re:Source accredited independent laboratory or other State DOT laboratory. The tests shall be performed on material produced within the previous 6 months. The tests shall include, at minimum, the following:

- Sieve Analysis (Gradation)
  - ASTM C136/AASHTO T27
- Specific Gravities (Bulk, SSD, and Apparent) and Absorption
  - ASTM C127 & C128/AASHTO T84 & T85
- Sodium Sulfate Soundness
  - ASTM C88/AASHTO T104
- L.A. Abrasion
  - ASTM C131/AASHTO T96

1.3.2 Aggregates for use in riding surfaces (Surface Aggregates) must meet additional requirements:

- Silica Dioxide Content
  - ASTM C25
- Calcium Carbonate Content
  - ASTM C25
- Acid Insoluble Residue
  - ASTM D3042
- Accelerated British Pendulum Numbers (BPN)
  - ASTM D3319/AASHTO T279

1.4 Verification

Upon receipt of a complete QCP and satisfactory independent test data, HQMT will notify Regional Materials & Tests personnel. Regional Materials & Tests will then acquire a sample and submit it to the HQMT lab for complete verification testing.

1.5 Consistency

Upon verification of the test results, Regional Materials & Tests personnel will take another sample and submit it to the HQMT lab for consistency testing. Two consecutive samples shall meet the applicable requirements to show consistency of the aggregate.

1.6 Referee Sample

If a sample fails to meet the requirements of any of the approval criteria, then a “referee” sample of the same material shall be obtained for testing. If the “referee” sample fails to meet any of the approval criteria, then the Department will not reconsider the material for approval for 6 months.
1.7 Laboratory

Aggregate facilities must provide a Type A laboratory as specified in Section 106.06 of the Standard Specifications.

1.8 Surface Aggregate (Polish Resistant) Test Strip Requirements

In addition to the verification of the aggregate properties detailed in 1.3.1 and 1.3.2, a test section will be required to verify the field performance of the aggregate, with the exception of Type I material detailed in Appendix B. The Producer must submit the requested location of the test strip no less than ten (10) days prior to construction of the test strip. HQMT must give approval of the test strip location prior to any construction. During construction of the test strip, Regional Materials & Tests personnel or designee shall take a sample of the surface aggregate at the asphalt plant and submit it to the HQMT laboratory for chemical test verification.

1.9 Approval

Once the above process is complete and all requirements are met, the Producer Form shall be completed and submitted to HQMT. The Producer will be notified by HQMT once they have been made approved and added to the Producer List.

1.10 Stockyards and other non-producing suppliers

Stockyards supplying material to TDOT projects must also be approved on the Producer list. If the source material (quarry, dredge, pit, etc.) being supplied by the stockyard is not currently approved on the Producer list, then the stockyard must submit for approval as detailed in the approval process listed above. If the source material is currently approved on the Producer List, then the stockyard may submit for approval based on other acceptance testing such as gradation to indicate proper storage and handling procedures.

2. Quality Monitoring Process

An aggregate’s approval status is contingent on satisfactory field performance and periodic laboratory evaluation. In addition to the quality monitoring outlined below, an aggregate’s approval status may also be rescinded if there is any concern for safety that may be related to the approved material.

2.1 Quality Testing Program

2.1.1 Coarse aggregate and manufactured sand sources will be continuously sampled and tested for quality by TDOT. Semiannually, a sample of the approved material shall be obtained by Regional Materials and Tests personnel and submitted to the HQMT laboratory for a verification of the applicable aggregate properties. The semiannual tests will represent January--June and July--December. No two verification samples shall be taken within 90 days of each other. If at any time TDOT feels the necessity to pull additional samples for testing (e.g. change in ledge, pit, etc.), such sample will represent the most recent semiannual test. Aggregate that does not meet TDOT specifications will not be accepted for use on projects or in products for TDOT.
2.1.2 Natural Sand (dredged, pit) will be sampled and tested for quality by TDOT at a minimum of once per year.

2.1.3 Surface Aggregates (Non-polishing) will be continuously sampled and tested for quality by TDOT. Semiannually, a sample of any approved limestone material shall be obtained by Regional Materials and Tests personnel and submitted to the HQMT laboratory for a verification of both the applicable physical and chemical aggregate properties. The semiannual tests will represent January--June and July--December. No two verification samples shall be taken within 90 days of each other. All other crushed aggregate types will only require a physical verification testing at the same frequency.

2.1.4 If there is any change to the Producer’s QCP (changes in procedures, key personnel, etc.), then an updated QCP shall be submitted to HQMT.

2.2 Quality Failure

2.2.1 If a sample fails to meet any of the approval criteria, then a “referee” sample of the same material shall be obtained for testing. When two consecutive samples fail quality testing, the aggregate source’s approval shall be immediately rescinded and the use of the failing material and products utilizing the failing material shall cease.

2.2.2 Regional Materials and Tests shall notify the Producer of the failing test results as soon as possible; at which time a representative from the Producer, Regional Materials and Tests, and HQMT will hold a conference to identify the location/distribution of the failing material and to develop a plan for both the utilization of any existing material and the acceptance of newly produced material.

3. Facility Removal

3.1 If a facility is removed from the Producers List, TDOT shall notify the Producer in writing within seven days. This notification shall direct the Producer that they shall not supply any material to a TDOT project. Upon such notice, the Producer shall immediately cease production, shipment, and placement of such material that is to be supplied to TDOT projects and products. After such notice is issued, the Producer reserves the right to request meeting with HQMT to discuss the cease of material(s) for TDOT projects.

3.2 Installed material may be left in place at TDOT’s discretion.

3.3 Producers shall provide TDOT with a list of material and quantities supplied to TDOT projects, including contract numbers, and TDOT approved asphalt and concrete plants from the date of the last passing inspection.

3.4 Materials on the Producer’s yard produced from the date of the last passing test until the date of the failing test may not be acceptable for use on TDOT projects. All cost incurred will be the responsibility of the Producer.
3.5 Time of Facility Removal

3.5.1 The producer will be removed from the Producer List for a suitable time period in which new material can be produced and can be demonstrated to consistently meet the appropriate approval criteria.

3.5.2 Once consistent, quality material is able to be produced, the Producer must submit a letter to HQMT stating the appropriate material(s) that will be provided to TDOT projects. This letter shall be accompanied with acceptable tests listed in Section 1.3 of this SOP completed by an AASHTO Re:Source accredited independent laboratory dated between the date removed and the date to be reactivated.

3.5.3 The Producer must provide a revised Quality Control Plan addressing the corrective actions taken to resolve any issues of non-compliance.

3.5.4 Upon receipt of the above requirements, Regional Materials & Tests will sample and test the new material for verification and consistency in accordance with Section 1.4 and 1.5.

3.5.5 Once the above process is complete and all requirements are met, the Producer will be reactivated on the Producer List and will be notified by HQMT of their updated status.
Appendix A: Quality Control Plan

A. Minimum Requirements

A.1. The plan must indicate in detail how the Producer proposes to control the equipment, materials, and production methods to insure that the specified products are obtained. The plan must list the personnel responsible for production and quality control at the site and include information on how to contact each person (phone, email, etc.).

A.2. The following specific information must also be included in the plan

A.2.1. Identification of the physical location of the source, to include a description of the property site and reference to the nearest identifiable points such as highways and towns. The physical address and map shall be included.

A.2.2. A description of the signs used to identify each stockpile as intended for TDOT usage. Stockpile signs must be legible from the cab of a truck fifty feet from the identified pile. A photo of the signage shall be submitted with the plan.

A.2.3. A loading and shipping control plan which includes a description of the methods by which the products are to be loaded and shipped for use by TDOT, including safeguards against loading improper aggregate, contamination, degradation, and segregation of the aggregate. The plan must also include methods of insuring that all products are accurately identified and that all shipping units are clean. A diagram of the process, from mining/dredging through the loading and transporting offsite, shall be included.

A.2.4. A plan for dealing with quality control sample failures. This plan must include how the Producer plans to initiate an immediate investigation and how the Producer will implement corrective action to remedy the cause of the problem. The plan shall state how loading operators are trained to identify problems.
Appendix B: Surface Aggregate (Non-Polishing) Requirements

B.1. Chemical Testing Requirements and Specifications

B.1.1. Based on the chemical and physical properties, the Producer must identify the TYPE of aggregate for which he requests approval. Initial approval of coarse aggregates such as crushed granite, crushed gravel, crushed gneiss, crushed quartzite, crushed sandstone, or crushed slag shall be tested for both physical and chemical properties. Physical testing results are required to meet the current TDOT specifications while the chemical testing is required to verify the composition of the material. Other crushed aggregate (limestone for example) may be used provided it meets the chemical, physical and performance characteristics shown below.

B.1.2. Current TYPE requirements and limitations are listed in Table 903.24-1 for other material (limestone for example).

Table 903.24-1. Quality Requirements for Type I, II, III, and IV Aggregate

<table>
<thead>
<tr>
<th>Traffic use</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silica Dioxide (ASTM C-25)</td>
<td>All roads</td>
<td>40% min.</td>
<td>30% min.</td>
<td>20% min.</td>
</tr>
<tr>
<td>Acid Insoluble Residue (ASTM D 3042)</td>
<td>All roads</td>
<td>50% min.</td>
<td>35% min.</td>
<td>25% min.</td>
</tr>
<tr>
<td>British Pendulum Number (AASHTO T-278, T-279)</td>
<td>All roads</td>
<td>30 min.</td>
<td>30 min.</td>
<td>25 min.</td>
</tr>
<tr>
<td>Calcium Carbonate</td>
<td>All roads</td>
<td>32 % max.</td>
<td>20,000 ADT min. for 2 years, OR 7.3 million vehicle passes per test lane for min. 2 years (4-lane rural interstate, max. ADT 35,000 allowable)</td>
<td>20,000 ADT min. for 2 years, OR 7.3 million vehicle passes per test lane for min. 2 years (non-interstate)</td>
</tr>
<tr>
<td>Test Section for Approval</td>
<td>All roads</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B.2. Field Performance (Test Strip)

B.2.1. Other material (limestone for example) which has been laboratory tested and conforms to the chemical and physical properties of Table 903.24-1 (above) and Subsection 903.24 of the Standard and any Supplemental Specifications must then demonstrate satisfactory test strip performance. Material meeting TYPE I requirements are exempt from providing a test section for approval, but must maintain a satisfactory field performance to remain an approved source.
B.2.2. The aggregate Producer, with TDOT assistance, will be responsible for identifying existing or proposed asphalt paving construction project for a test strip location. The test strip shall be within the traffic range identified in Table 903.24-1 (above) for the TYPE of aggregate which approval is being requested. Traffic ranges shown are for two lane roadways. Since it may be difficult to identify two lane roads with ADT volumes shown, the outside lanes of rural 4-lane roadways will be considered, provided the minimum number of vehicle passes are obtained in that lane. The test section shall have a minimum speed limit of 40 mph, be 0.5-0.6 mile in length in each direction and the entire test section shall be free of controlled intersections (traffic signals or stop signs). The number of vehicle passes will be calculated by assuming the outside lane will receive 30% of the ADT. The Producer shall provide project documentation such as the title sheet which will include the project description, location, and the Average Daily Traffic (ADT). Also, the Producer shall submit the calculations of traffic requirements for specified type of surface aggregate requested.

B.2.3. The aggregate Producer will be responsible for coordinating the test section with the prime contractor. No additional payment will be made for the test section or other costs associated with the test section. Coordination will include the submittal of a bituminous mixture design by a TDOT certified asphalt mix design technician, and appropriate contract Supplemental Agreements or change orders.

B.2.4. Once the bituminous mixture design is approved the test strip may be constructed in accordance with TDOT Standard Specifications and Contract requirements. The Contractor will be required to place, at the Producer’s expense, a blue sign at the beginning and end of each test strip. The signs shall read: “Begin Test Strip” and “End Test Strip”.

B.2.5. After the test strip is completed, TDOT will conduct periodic friction tests to determine the actual in place performance. If the test section demonstrates a frictional value greater than 40* after a minimum two year test period, that source material will be considered acceptable. When the total number of vehicle passes must be met, a test strip may need to be in place for more than 2 years.

* Tested in accordance with AASHTO T-242, a test will be performed each 0.1 mile (minimum 5 per direction) with no individual test below 40.

B.2.6. EXAMPLE:

Type III aggregate is to be tested on a 4 lane rural roadway with an ADT of 18,000.

7.3 Million Vehicle passes are required. (from TABLE 1)
- 18,000 ADT x 0.30 for outside lane = 5400 ADT in the outside lane
- 7,300,000 vehicle passes ÷ 5400 vehicles per day = 1352 days = 3.70 years = ~ 3 years and 8 months
## Appendix C: Aggregate Specification Table

### Selected Quality Requirements for Aggregates

<table>
<thead>
<tr>
<th>Concrete Aggregates</th>
<th>Soundness</th>
<th>Abrasion</th>
<th>Absorption</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Classes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coarse</td>
<td>≤9%</td>
<td>≤40%</td>
<td>≤5%</td>
<td>AASHTO M80</td>
</tr>
<tr>
<td>Fine</td>
<td>≤10%</td>
<td>≤40%³</td>
<td>--</td>
<td>AASHTO M6</td>
</tr>
<tr>
<td>Mortar Sand</td>
<td>≤10%</td>
<td>--</td>
<td>--</td>
<td>AASHTO M45</td>
</tr>
<tr>
<td>Aggregate-Cement Base Course</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Lightweight</td>
<td>≤9%</td>
<td>≤40%</td>
<td>≤10%</td>
<td>AASHTO M195</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Asphalt Aggregates</th>
<th>Soundness</th>
<th>Abrasion</th>
<th>Absorption</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Mix Base &amp; Leveling</td>
<td></td>
<td></td>
<td></td>
<td>ASTM D692³</td>
</tr>
<tr>
<td>Coarse</td>
<td>≤9%</td>
<td>≤50%</td>
<td>≤5%</td>
<td></td>
</tr>
<tr>
<td>Fine</td>
<td>≤12%</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Asphaltic Concrete Surface</td>
<td></td>
<td></td>
<td></td>
<td>ASTM D692³</td>
</tr>
<tr>
<td>Coarse</td>
<td>≤9%</td>
<td>≤40%</td>
<td>≤5%</td>
<td></td>
</tr>
<tr>
<td>Fine</td>
<td>≤12%</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Pavement Preservation Treatments</td>
<td>≤9%</td>
<td>≤40%</td>
<td>--</td>
<td>ASTM D692³</td>
</tr>
<tr>
<td>Slurry Seal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Micro-Surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bituminous Seal Coat</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double Bituminous Surface Treatment</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mineral Filler</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>AASHTO M17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unbound Aggregates</th>
<th>Soundness</th>
<th>Abrasion</th>
<th>Absorption</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral Aggregate Base &amp; Surface</td>
<td>(varies)</td>
<td>≤50%</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Type A</td>
<td>≤15%</td>
<td></td>
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<tr>
<td>Type B</td>
<td>≤20%</td>
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</tr>
<tr>
<td>Recycled Concrete Aggregate RCA</td>
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<td>≤50%</td>
<td>--</td>
<td>ASTM D692³</td>
</tr>
<tr>
<td>Aggregate for Underdrains</td>
<td>≤9%</td>
<td>≤50%</td>
<td>--</td>
<td></td>
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</tbody>
</table>

1. Sodium Sulfate
2. Combined absorption for coarse (#4+) material in a given mix.
3. Applies to manufactured fine aggregate from Limestone or Dolomite.
4. Material must be listed on QPL 35.
5. ASTM D692 applies to coarse fractions (per ASTM D448) unless specified otherwise.
Quality Control Plan

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Quality Control Plan

Physical Location of the Source: Division of Materials and Tests

6601 Centennial BLVD
Nashville, TN 37243

Mailing Address: Department of Transportation
Division of Materials and Tests
6601 Centennial BLVD
Nashville, TN 37243

Phone Number: (615) 350-4152
Fax Number: (615) 350-4128

Contact Person & Title: Bob Smith, GTA
Phone Number: (615) 350-4152
Fax Number: (615) 350-4128
Email: bob.smith@tn.gov

List of personnel responsible for production and quality control at the site and include information on how to contact each person.

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Phone</th>
<th>Email</th>
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</tbody>
</table>
Quality Control Plan

Include a description of the property site and reference to the nearest identifiable points such as highways and towns.

The Materials and Tests Division is located in Building A on the first floor at 6601 Centennial Blvd. The location of the site is about 1.5 miles off of I-40 at exit 204A. If you are on Briley Parkway you will take exit 26B to Centennial Blvd.

Map of the Location
Quality Control Plan

The following topics should be covered and at a minimum include the details shown below.

**Labeling of Stockpiles**

- How are stockpiles labeled to eliminate confusion between the operators, trucks, and customers?
- What steps are taken to make sure there are no confusion between surface aggregates and standard aggregates in the same quarry?
- The sign must be legible from the cab of a truck fifty feet from the identified pile.
- Example of one of the stockpiles with the correct labeling should be shown below.

**Control of Stockpiles**

- How are the stockpiles constructed?
- How far apart are the stockpiles separated?
- How often is the aggregate sampled and tested?
- How is contamination prevented during the process of developing a stockpile?

**Control of Production**

- State the process of how the material is developed from mining to final product.
- Show a figure of the crushing and screening process.
- The different sizes of processed aggregate such as 57’s and number 4’s should be listed.
- The type of aggregate produced such as limestone, granite, gravel and etc. should be listed.
- Formation types should be identified.
- How is the prevention against segregation, degradation, and contamination controlled during the production process?

**Loading and Shipping**

- Develop a loading and shipping control plan which includes a description of the methods by which the products are to be loaded and shipped.
- How is the prevention against segregation, degradation, and contamination controlled during the loading and shipping process?
- What are the steps taken to insure that all shipping units are clean?

**Dealing with Quality Control Failures**

- How the producer plans to initiate an immediate investigation?
- How the producer will implement corrective action to remedy the cause of the problem?
- How are the operators trained to identify a problem?