Los Angeles Abrasion

Hardness

- Hardness is the aggregate’s resistance to abrasion (wear)
- Hardness is an important property for aggregates in pavement surfaces
- Tested by LA Abrasion or Micro Deval
Los Angeles Abrasion

• Measure of resistance of coarse aggregate to degradation (breakdown) by
  – impact
  – abrasion
  – grinding

Note: LA Abrasion test is not just a measure of abrasion!

Los Angeles Abrasion

• Coarse Aggregate < 1 1/2 in.
  – Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
  – AASHTO T96
  – ASTM C131

• Coarse Aggregate > 3/4 in.
  – Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
  – ASTM C535
Significance

• Indicates relative quality of aggregate sources having similar mineral compositions
  – Example: compare different sources of granite
• Cannot necessarily compare distinctly different sources
  – Example: granite vs. marine limestone
• ‘Hard’ rock = Lower percentage loss
• ‘Soft’ rock = Higher percentage loss

Los Angeles Abrasion
Local Variability in Granite

• 16% (Martin Marietta – Augusta, GA)
• 25% (Martin Marietta – Cayce, SC)
• 38% (Hanson – Demorest, GA)
• 43% (Hanson – Jefferson, SC)
• 43% (Vulcan – Anderson, SC)
• 53% (Vulcan – Lyman, SC)

Values from SCDOT January 2013 QPL
Required Apparatus

- Los Angeles Machine
- Standard Sieves
- Scales
- Drying Oven
- Steel Charge
- #12 Sieve

Los Angeles Machine
Los Angeles Machine
Drum

- Hollow steel cylinder, closed at both ends
- Inside diameter of 28 ± 0.2 in.
- Rotates on horizontal axis
  - slope tolerance of 1 in 100
- Dust-tight cover for opening

Los Angeles Machine
Shelf

- Removable, steel shelf
- Extends full length of cylinder
- Dimensions of Shelf = 3-½” wide x 1” thick x 20” length (each ± 0.1”)  
- Mounted to be firm and rigid
Charge

- Steel spheres
- 6 to 12 spheres
  - Average 1-27/32 in. diameter
  - Weigh 390 to 445 g (slightly less than 1 lb.)

<table>
<thead>
<tr>
<th>Sample Grading*</th>
<th>No. of Spheres</th>
<th>Total Mass of Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12</td>
<td>5000 g ± 25 g</td>
</tr>
<tr>
<td>B</td>
<td>11</td>
<td>4584 g ± 25 g</td>
</tr>
<tr>
<td>C</td>
<td>8</td>
<td>3330 g ± 20 g</td>
</tr>
<tr>
<td>D</td>
<td>6</td>
<td>2500 g ± 15 g</td>
</tr>
</tbody>
</table>

* A is coarsest grading, D is finest grading
Type B Grading

• Total Sample: 5,000 ± 10 g (about 11 lbs)
• ½ in. Stone (passing ¾ in. sieve)
  – 2,500 ± 10 g
• ⅜ in. Stone (passing ½ in. sieve)
  – 2,500 ± 10 g

Test Procedure

Sample

• Wash and oven-dry 5,000 g of aggregate sample
  – Dry to constant mass at 230 ºF (+/- 9) (110 ºC (+/- 5))
• Separate sample into individual size fractions by sieving
• Recombine the sieved material to the required grading
  – Record total mass to nearest 1 g
Test Procedure

• Rotate the drum for 500 revolutions at a constant speed of 30 to 33 rpm
  – approximately 15 minutes
  – shelf picks up charge + sample at bottom of drum
  – charge + sample dropped as drum rotates “crushing”
  – charge + sample roll at bottom “grinding”

Test Procedure

• Remove the sample from the machine
• Sieve dry over a No. 12 sieve
• Material passing = degraded
• Material retained = intact
• Wash and oven-dry material retained (if required)
• Weigh to nearest 1 g
Los Angeles Abrasion Hardness

- Mass (weight) placed in abrasion machine
- Mass (weight) of intact particles left after test
- Percent Loss
  \[
  \text{Percent Loss} = \frac{\text{Initial Mass} - \text{Final Intact Mass}}{\text{Initial Mass}} \times 100\%
  \]

Example

- Mass placed in abrasion machine 5008 g
- Mass of intact particles left after test 3891 g

(1 pound = 454 grams)

\[
\text{% loss} = \frac{(5008 \text{ g} - 3891 \text{ g})}{5008 \text{ g}} \times 100 = 22.3\%
\]

- Report results as 22% (nearest whole number)
SCDOT QC Test Frequency
Type B

<table>
<thead>
<tr>
<th>Materials</th>
<th>Value Range</th>
<th>Minimum Testing Frequency</th>
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</thead>
<tbody>
<tr>
<td>Stone (non-slag)</td>
<td>55.0 &amp; above</td>
<td>1 daily</td>
</tr>
<tr>
<td></td>
<td>50.0 – 54.9</td>
<td>1 weekly</td>
</tr>
<tr>
<td></td>
<td>40.0 – 49.5</td>
<td>1 monthly</td>
</tr>
<tr>
<td></td>
<td>Less than 40.0</td>
<td>1 every 6 months</td>
</tr>
<tr>
<td>Slag</td>
<td>35.0 &amp; above</td>
<td>1 weekly</td>
</tr>
<tr>
<td></td>
<td>Less than 35.0</td>
<td>1 every 6 months</td>
</tr>
</tbody>
</table>

SCDOT Specifications
Type B

<table>
<thead>
<tr>
<th>Material Use</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slag for Concrete</td>
<td>40 Max</td>
</tr>
<tr>
<td>Slag for Asphalt Concrete</td>
<td>45 Max</td>
</tr>
<tr>
<td>Interstate/Primary Surface Courses</td>
<td>55 Max</td>
</tr>
<tr>
<td>Secondary Surface Courses</td>
<td>60 Max</td>
</tr>
<tr>
<td>Interstate/Primary Intermediate Courses</td>
<td>55 Max</td>
</tr>
<tr>
<td>Secondary Intermediate Courses</td>
<td>60 Max</td>
</tr>
<tr>
<td>HMA Base Courses</td>
<td>60 Max</td>
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<tr>
<td>Asphalt Double Treatment</td>
<td>60 Max</td>
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<tr>
<td>Concrete</td>
<td>60 Max</td>
</tr>
<tr>
<td>Marine Limestone Base</td>
<td>65 Max</td>
</tr>
<tr>
<td>Soil-Aggregate Sub-base</td>
<td>65 Max</td>
</tr>
</tbody>
</table>
Common Errors

- Sample not representative
- Incorrect number of spheres
- Total charge mass outside tolerances
- Not setting (or resetting) counter
- Drum not rotated at constant speed
  - slip and backlash
- Not removing all material from drum
- Sample not dried to constant mass
- Improper seal between hatch and drum