

Section 4: Hardness, Soundness and Strength

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 (LA) Abrasion

- Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in Los Angeles Machine
- AASHTO T96 / ASTM C131
- Aggregate rotated in drum with standard steel balls
 - grinds and impacts particles into smaller sizes



Los Angeles Abrasion Machine

Los Angeles Abrasion

- Hardness
 - Expressed as percentage of particles degraded
 - Example:

Mass placed in abrasion machine	5,000 g
Mass of intact particles left after test	3,891 g

(1 pound = 454 grams)

- $\% \text{ loss} = \frac{(5,000 \text{ g} - 3,891 \text{ g})}{5,000 \text{ g}} \times 100\% = 22\%$

Los Angeles Abrasion

- 'Hard' rock » Lower percentage
- 'Soft' rock » Higher percentage
- Example
 - What if mass of intact particles is decreased to 3,100 g?

- $\% \text{ loss} = \frac{(5,000 \text{ g} - 3,100 \text{ g})}{5,000 \text{ g}} \times 100\% = 38\%$

Los Angeles Abrasion Common Values

- Basalt » 14%
- Limestone » 30% (Martin Marietta – Kings Mountain, NC)
- Granite » 40% (Hanson - Jefferson, SC)
- Marine Limestone » 53% (Grand Strand Aggregates – Goretown, SC)

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

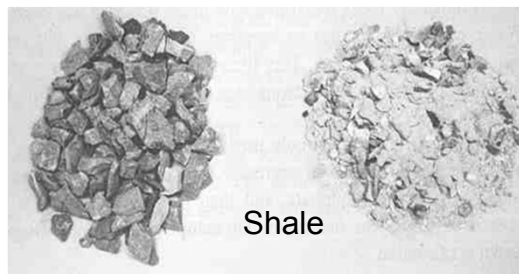
Micro Deval

AASHTO T327/ASTM D6928

- Micro Deval is a measure of abrasion resistance and durability of mineral aggregates resulting from a combination of actions including abrasion and grinding with steel balls in the presence of water.
- SCDOT requires Micro Deval testing in OGFC applications only, whenever the LA of a material falls between 42% and 52%.

Soundness Test

- Provides a measure of the aggregates durability when exposed to the elements
 - measures resistance to rapid weathering
 - important in frost-susceptible regions
- Sulfate Soundness Test
 - AASHTO T104/ASTM C88



Soundness Test

- Rapid weathering is simulated by wetting and drying
 - Aggregate immersed in chemical solution (magnesium or sodium sulfate) for 16-18 hours,
 - Then oven dried at 230 °F to a constant mass, and
 - Then cooled to room temperature
 - Percentage lost calculated after 5 cycles of soaking and drying

Original mass of sample = 2,175 g

Mass of particles after test = 1,847 g

$$\% \text{ loss} = \frac{(2,175 \text{ g} - 1,847 \text{ g})}{2,175 \text{ g}} \times 100\% = 15.1\%$$

Soundness Test

- 'Sound' rock = Lower percentage loss
 - Sedimentary rock typically has higher percentage loss (Limestone)
 - Recycled PCC typically has very high percentage loss
 - Granite typically has a low percentage loss

Particle Strength

- Determines the compressive load aggregate particles can carry before breaking.
- Aggregate strength is typically greater than the strength of asphalt or concrete mixtures.

