Basic Aggregate Properties

Section 1: Introduction

Aggregate Types

- Aggregates are divided into 3 categories based on particle size:
  - Coarse Aggregate
    - Gravel or crushed stone
    - Particle sizes larger than No. 4 sieve (4.75mm)
  - Fine Aggregate
    - Sand or washed screenings
    - Particle sizes between No. 4 and No. 200 sieve (4.75mm-75µm)
  - Fines
    - Silt or clay
    - Particle sizes smaller than No. 200 sieve (75µm)

Coarse Aggregate

- Coarse Aggregate can come from several sources.
- Each of these sources can produce satisfactory aggregates depending on the intended use.
- Each parent material has advantages and disadvantages associated with it.

Coarse Aggregate

- Natural gravel
- Crushed stone
- Lightweight aggregate
- Recycled and waste products
  - slag
  - rubble
  - mine waste
  - asphalt and concrete pavement

Important Properties of Aggregate

- All of these properties can have an affect on how the aggregate performs the tasks that are expected of it.
  - Shape
  - Surface texture
  - Gradation
  - Specific gravity
  - Absorption
  - Hardness
  - Soundness
  - Strength
  - Deleterious materials

The ideal aggregate is…

- Strong and hard to resist loads applied
- Chemically inert so it is not broken down by reactions with substances it comes in contact with
- Has a stable volume so that it does not shrink or swell
- Bonds tightly with asphalt and portland cement paste

The ideal aggregate…

- Contains no impurities or weak particles
- Would be the perfect size and gradation for the application intended
- Would be locally available and economical

Aggregate in Practice

- There is a wide range in strength and hardness even among aggregates produced from the same type of parent material.
- Particles have pores that affect their absorption properties and how well they bond with asphalt and Portland cement.
- Chemical reactions such as alkali-silica reactivity can be problems for Portland cement concrete mixes with certain aggregates
- Bonding properties vary

Aggregate in Practice

- Impurities and weak particles are sometimes present and can result from improper handling. These can have a negative impact on the performance of asphalt and concrete mixes.
- Fines content may be higher than desired or dust may be present that must be removed before the aggregate can be used
- Must control grading using crushing, screening and washing processes to achieve the desired particle size distribution
- May have long haul distance in some areas since good quality aggregates are not locally available
- …..

Aggregate in Practice

- Crushed stone is a natural material …

… Quality Control is important!

Rock Types

- Rocks are classified based on the way they were created.
- There are three ways in which rocks are formed, and therefore three classifications of rock.
  - Igneous rock
  - Sedimentary rock
  - Metamorphic rock

Igneous Rock

- Formed by the crystallization of molten magma as it cools.
- The rate of cooling determines the size of the crystals that are formed.
  - If the magma cools very slowly, large crystals are formed resulting in a coarse grained rock such as granite.
  - If the magma cools very quickly, the grains are very fine.
  - Obsidian is a rock that forms so quickly that crystals are not formed (results in a glassy appearance).
- If the magma cools under the earth's surface, the rock is called intrusive
  - Granite is one type
- If the rock cools on the earth's surface, the rock is called extrusive
  - Basalt is one type

Sedimentary Rock

- Formed by consolidation of soil deposits that are exposed to pressure and /or cementation
  - Sand » Sandstone
  - Silt » Siltstone
  - Clay » Claystone or Shale
  - Calcium (lime) deposits » Limestone
- Sedimentary rocks are often found interbedded with each other as different materials were laid down in layers as sediment types changed during runoff events.
- Limestones are formed:
  - Either as a result of consolidation and cementation of the shells of marine animals or plants
  - Or from the consolidation of fine carbonate mud precipitated from marine waters

Metamorphic Rock

- Formed by the rearranging of the crystal structure of either sedimentary or igneous rocks under extreme heat and/or pressure in the solid state (i.e., the parent rock is not melted)
  - Granite (igneous rock) » Gneiss
  - Sandstone (sedimentary rock) » Quartzite
  - Limestone (sedimentary rock) » Marble

South Carolina Geology

- Blue Ridge (Uplands)
  - Mountain region with many rock outcrops.
- Piedmont
  - Rolling terrain with silt and clay like soils overlying shallow bedrock.
  - Many quarries located in the Piedmont region.
- Coastal Plain (Lowlands)
  - Mostly flat terrain with sandy soils.
  - Bedrock is deep beneath the surface.
  - Few quarries due to depth at which rock is located.
  - Most shallow deposits consist of marine limestone.
- Fall Zone
  - Transition between Piedmont and Coastal Plains
  - Columbia lies in the Fall Zone

South Carolina Geology

- Uplands – Blue Ridge and Piedmont Provinces
  - igneous (granite, basalt)
  - metamorphic (gneiss, schist, quartzite)
- Lowlands – Coastal Plain Province
  - sedimentary (limestone)
  - sands and gravel