Lecture 2: AGGREGATES & Sand

Definition
Types
Classification
Sources
Uses
Properties
Tests and specifications

Defn. of Aggregate: Aggregate is an aggregation of non-metallic minerals obtained in particulate form and can be processed and used for civil and highway engineering constructions

Classification of Aggregates:

- Aggregates based on source
    - Natural: crushed stones, crushed boulders, gravels, shingles, sands, etc
    - Artificial: crushed brick, clay +pfa, synthetic etc.

Natural aggregates are the main source of construction aggregates. They are obtained from stones and stones are obtained from rocks. Rocks are parts of solid earth crust.
Stones are classified as,

1. Geological 2. Engineering 3.Structural 4. Based on Hardness 5. Practical

(Question 1: How do you get building stones? What are the classifications of stones?)
(Question #2: What is the classification of stones? Give examples for each classification.)

1. Geological classification

- Igneous: granite, trap, basalt
- Sedimentary: sandstone, limestone, shale
- Metamorphic: marble, quartzite, slate

2. Engineering/Chemical classification

- Silicious: granite, sandstone, quartzite
- Argillaceous: laterite, porphyry, slate
- Calcareous: limestone, dolomite, marble

3. Structural classification

- Stratified: sandstone, slate
- Unstratified: igneous rock, granite, basalt

4. Classification based on Hardness

- Soft: talk, gypsum, sandstone
- Medium: limestone, dolomite
- Hard: basalt, quartzite, gravel
- Very hard: granite, trap, taconite

5. Practical classification based on physical characteristics

- Granite and other igneous rocks
- Slate and schist
- Sandstone
- Limestone

- Aggregates based on size
    - Coarse aggregate, CA – passing max size and retained on 4.75 mm sieve
    - Fine aggregate, FA – passing 4.75 mm sieve and retained on 0.15/.075 mm sieve
    - Silt and clay or dust or fines or filler – passing .075 mm sieve
- Aggregates based on weight (sp.gr.)
    - Normal weight: bulk unit weight, 1520-1680 kg/m^3 (95-105 pcf), so that normal wt. concrete (NWC) has a unit wt. 150 lb/cft (2400 kg/m^3)
    - Light weight: bulk unit wt. less than 1120 kg/m^3
    - Heavy weight: bulk unit wt. more than 130pcf (2080 kg/m^3)
- Aggregates based on shape
    - Rounded
    - Angular
    - Irregular
    - Elongate
    - Flaky

Aggregates work in a mass, so their size distribution, shape and texture are important characteristics along with their strength (individual or in mass).

The density, voids, compactability, shear strength etc. largely depends on the above characteristics

Properties/Characteristics of Aggregates

- Strength
    - Hardness
    - Toughness
    - Stiffness (especially in the product like concrete)
- Shape and texture
- Specific gravity – ASTM C 127
    - Apparent specific gravity
    - Bulk specific gravity (ssd basis)
    - Bulk specific gravity (o-d basis)
- Porosity
- Moisture content
- Bulking [shown under sand]

Uses of Aggregates

- Bound condition
    - Cement concrete
    - Asphaltic concrete
- Unbound condition
    - Road base, subbases, unbound aggregate roads
- As filter material

Testing of aggregates:

- Grading, Fineness Modulus
- Strength tests
- Durability tests
- Other tests

Strength tests of aggregates:

- ASTM tests (sheet given for concrete aggs.) - L. A. Abrasion test
- BS tests for strength and crushing characteristics

¤ AIV test

¤ ACV test

¤ 10% Fines Value test

¤ AAV test

Absorption test: absorption capacity, effective absorption, surface moisture, air dry, oven dry, SSD (saturated surface dry),

Durability tests

- Soundness by sodium sulphate
- Soundness by magnesium sulfate
- Wet and dry test
- Freeze and thaw test

Other tests of aggregates - As per sheets given

Specification of aggregates - As per sheets given

SAND:

Sand is a loose, fragmented, naturally occurring material consisting of very small particles of decomposed rocks, corals, or shells. It is basically aggregate and called fine aggregate for building and road construction. Based on size, and is divided into,

- Very fine sand [1/16 – 1/8 mm]
- Fine sand [1/8 – ¼ mm]
- Medium sand [¼ - ½ mm]
- Coarse sand [½ - 1 mm]
- Very coarse sand [1 – 2 mm]

Sources of sand: based on the source, sand may be divided into,

- River sand: obtained from river bed and banks or by river dredging, round and polished, contains earthy impurities, gravels etc., white in color, globular and smaller in size, some of them are of best quality and least expensive and suitable for plastering work.
- Pit sand: obtained by pit dredging in the flood plain and lake sides, sharp, angular, homogeneous, soft, porous and free from salt, yellowish or light brown in color, most suitable sand for mortar.

- Sea sand: obtained from sea shore and sea beaches, fine, sound and polished, low quality and contains sea salt and causes efflorescence and dampness, should not be used in mortars, plasters, should be washed before use if the salt content is less than 0.5%.

Functions of sand:

- well graded sand increases density in an aggregate mass
- subdivides the paste of binding material into thin film
- offers requisite surface area
- acts as medium between stones and cementing material
- prevents shrinkage of cementing material

Properties of good sand: good sand for most civil engineering works should be,

¤ sharp, ¤ angular ¤ hard grains
¤ strong ¤ durable ¤ pure silica (SiO_2)

¤ Sand should be free from - coatings of foreign matter
- clay, silt, and
- organic matter

Uses of sand: sand as an engineering material has versatile use in,

- sand is often one of the principal component of concrete
- sand is used in foundry for sand casting
- graded sand is used as an abrasive in sandblasting
- sand is used as filter media
- sand in one of the principal constituent of clay bricks, glass manufacturing etc.
- sand is used in landscaping, construction of golf courses, sea beaches etc.
- sandbags are used for protection against flood, gun fire
- sand is used in railroads to improve the traction of wheels on the rails
- sand is used in the plastering work and in mortar
- sand is used in improved subgrade, subbase and base courses of pavements
- sand is used as a bedding course and cheap filler material for brick and block pavement
- sand is sometimes used for lining of aquariums

Tests of sand:

- Sieve analysis and gradation/Fineness Modulus (FM) of sand
- Shear strength of sand
- Percentage of silt and clay
- Presence of salt
- Presence of organic impurities

Moisture content and bulking of sand:

Water film around sand particles create a barrier thus increasing the inter-particle distance and the volume increases over the real volume at zero moisture content. This is bulking of sand. At certain moisture level the barrier breaks and volume decreases. So when sand is completely under water the volume is same as dry volume. Coarse graded sand has around 18% bulking at 5% m/c while fine grained sand has 37% bulking at 7% m/c

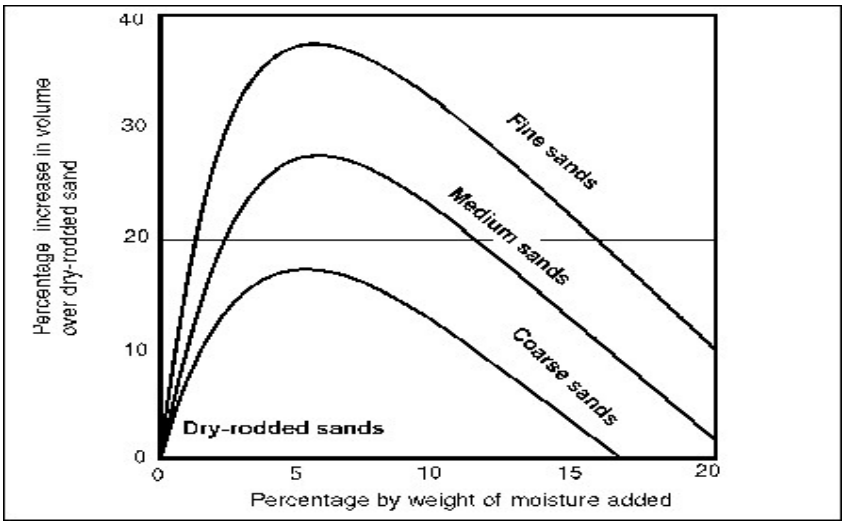


Figure 1. Variation in fine-aggregate bulking with moisture and aggregate grading

Specification of sand:

Depends on the type of use and project.

Question: What is the classification of sand based on size?

Question: Briefly state the sources of sand

Question: What are the functions, properties and uses of sand?

Question: Why is sand necessary for any aggregate construction?

Question: Briefly state the bulking of sand

Question: What are the tests of sand?

Question: What is aggregate grading? Why is grading important for any aggregate onstruction?