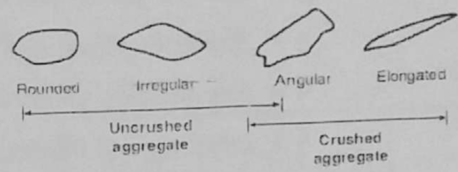
AGGREGATES

Aggregates are the inert materials mixed with binding material like cement, lime or mud in the preparation of mortar or concrete.

NECESSITY OF AGGREGATES



1. To avoid cracking, shrinkage and to improve workability.
2. To reduce the cost factor, being cheaper than the cement.
3. To reduce heat of hydration.

CLASSIFICATION OF AGGREGATES

Depending upon the size of particles and type of use the aggregates are classified as:

1. **Coarse aggregates** which retain on ASTM sieve No. 4, or having a size greater than 4.75mm.
2. **Fine aggregates** which pass through ASTM sieve No.4, or having a size less than 4.75mm but not less than 0.07mm.
3. Aggregates between 0.06mm and 0.002mm is classified as silt and particles smaller are called clay.

TYPES OF COARSE AGGREGATES

- Gravels: Smooth surface natural stones. Source is the rivers in hilly areas. Available in various sizes and shapes.
- Bricks Ballasts/ Bats:
- Crushed stone obtained by crushing the boulders:
  - a) Margalla Crush
  - b) Sargodha Crush
  - c) Sakhi Sarwar Crush
  - d) Dina Crush
  - e) Others

Coarse aggregates may be in various grading as per requirement of the construction work.

AGGREGATES MAY BE: Gradings:

- Well Graded Aggregates: Having all required sizes of particles in required proportions
- Gap Graded Aggregates: Having some sizes missed from the sample.
- Uniformly Graded Aggregates: Having same sizes of all particles.
- Poorly Graded Aggregates: Having disturbed proportions of some sizes in a sample.

Various Lab. Tests on Coarse Aggregate:

1 • Gradation test (Sieve Analysis)
2 • Specific gravity and water absorption test.
3 • Shape test (Flakiness and Elongation)
4 • Los Angeles Abrasion value test (Hardness)
5 • Crushing and Impact value tests
6 • Others Porosity test (to check pores)

TYPES OF FINE AGGREGATES

1. Surkhi → Powder obtained from grinding bricks Used for binding purposes (Pointing
2. Sand
3. Others

SAND

It consists of small grains of Silica and is formed by the disintegration of rocks cause weathering.

TYPES OF SAND

1. **Local pit sand:** Found as deposit in soil and has to be excavated out. Grains of it generally sharp and angular. If free from organic matter and clay , it is extremely goo use in mortar and concrete.
2. **Sea Sand:** Thorough washing is required before use to remove the salts.
3. **River Sand:** It is obtained from the banks and beds of rivers. It may be fine or coarse.

- River Ravi Sand:
  F.M < 1.0, very fine sand containing higher %age of silt. Harmful for structural concrete mortars due to excessive silt.
- Chenab Sand: F.M >1.0. Good for mortars.
- Sakhi Sarwar Sand: F.M >2.0. Good for Concrete
- Lawerencepur Sand: F.M > 2.0. Coarse sand. Good for concrete works.
- Others

VARIOUS LAB. TESTS ON SAND

Fineness Modulus, Silt test, Specific Gravity, Water absorption, Bulk density etc. Alkali React

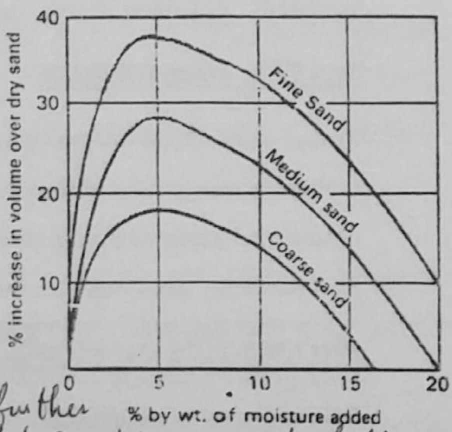
QUALITIES OF GOOD SAND

1. Good sand should have coarse and angular grains of pure Silica.
2. Good sand should be free from silt, clay or any such salts that may attack the reinforce
3. Good sand should not contain any organic matter or any hygroscopic matter.

FUNCTION OF SAND IN MORTAR

1. It is used as an adulterant to increase the volume of mortar, making it economical.
2. It reduces shrinkage and cracking of mortar on setting.
3. It helps pure lime to set because it allows the penetration of air which provides Carbon Dioxide required for carbonization and setting of lime.

BULKING OF SAND



It is the phenomenon by which volume of sand fluctuates with the variation in its moisture contents. Surface moisture holds the particles apart causing an increase in volume over the same amount of sands in surface dry conditions. The amount of bulking will depend on the fineness of sand and bulking effect increases with the increase in moisture contents upto certain limits. Finer sands experience more bulking effects as high as upto 33%, against a moisture content upto 8%. With further increase in moisture content will dec. the bulking effect reaching zero at fully saturated condition.

IMPURITIES IN SAND

- Impurities are always undesirable in sands. They reduce the strength of concrete and mortar. Since it is impossible to have sand without impurities. Therefore maximum 6% impurities are permissible.
- Clay, silt, salts, mica and organic matter are sources of weakness in any sand.
- Impurities in sand may also give the dull appearance.
- Clay and silt will prevent the bonding between aggregate particles and cement by making a thin layer around the aggregate particles which reduce the strength.

SALT CONTAMINATION

Sand taken from the seashores or from some rivers or canals may contain salts. The simplest solution is to wash the sand in fresh water but special care is required where large quantities of salt are present.

An allowable limit for salts present in sand and coarse aggregate of the concrete mix is about 0.05% by weight.

If salt is not removed, it will absorb moisture from the air and cause efflorescence (white spots). A slight corrosion of steel reinforcement may also result. Salts will also retard the setting and hardening of mortar + concrete.

BULK DENSITY

Generally the bulk density is the direct measure of strength. Greater bulk density has positive effect and vice versa. Sands of greater bulk density need less amount of cementing materials and it leads to economical side. Since Lawrancepur sand has greater bulk density so it should be preferred for concrete mixes.

SPECIFIC GRAVITY

Specific gravity of a material gives the relative crushing strength, specific gravity can also be helpful to explore the relative porosity of the material. It may also be used to calculate the quantity of materials. It is used in mix design calculations.

WATER ABSORPTION

Water absorption property of material would have negative effect on the strength of concrete. Concrete mix made with materials with greater water absorption capacity will need relatively greater amount of water to complete hydration reaction.

Lawrancepur sand has less water absorption capacity than other sands.

PROPERTIES OF STONE AGGREGATES

Sand, gravel and crushed stone fall into this category and make up a large percentage of the aggregates used in concrete. Since they generally constitute from 60 to 80 percent of the volume of concrete, their characteristics influence the properties of concrete. They should therefore meet certain requirements if the concrete is to be strong, durable, and economical.

They must be of the proper shape, either rounded or approximately cubical in shape, clean, hard, strong, and well graded. They must possess chemical stability and in many cases exhibit abrasion resistance and resistance to freezing and thawing.

1. SHAPE AND SURFACE TEXTURE

The particle shape and the surface texture of aggregates influence the properties of fresh concrete more than those of hardened concrete. Sharp, angular, and rough aggregate particles require more paste to make good concrete than do rounded ones. Flat, Slivery pieces make concrete more difficult to finish and should be limited to not more than 15 percent of the total. This requirement is particularly important for crushed fine aggregate, since materials made in this way contains more flat and elongated particles.

2. CLEANLINESS OF AGGREGATES

Particles should be free from coatings of clay or other fine material and from organic impurities which may affect the setting of the cement paste. In the case of coarse aggregates, visual inspection will often disclose the presence of such deleterious materials, but where doubt exists, the aggregates should be tested. However, it is not so easy to inspect fine aggregate in the same way, and standard tests may be carried out to determine the amount of silt and organic materials present in the aggregates.

3. AGGREGATE GRADING

Grading, or particle size distribution, is an important feature of aggregates and is determined by a sieve analysis, as specified by ASTM C136. The sieves used included the following sizes: Nos. 4, 8, 16, 30, 50, and 100 for fine aggregate and 6 in, 3 in, 1½ in, ¾ in, 3/8 in, and No. 4 for coarse aggregate.

Limits are usually specified for the percentage of material passing each sieve, Grading limits and maximum size of aggregates are important because they affect relative aggregate proportions, cement and water requirements, workability, economy, porosity, shrinkage, and durability of concrete. In general, aggregates which conform to the grading limits produce the most satisfactory results.

4. MOISTURE CONTENT OF AGGREGATES

Two types of moisture are recognized in aggregates: absorbed moisture and surface moisture. Absorbed moisture is that which is taken in by the voids in aggregate particles and may not be apparent on the surface, while surface moisture is that which clings to the surface of the particle.

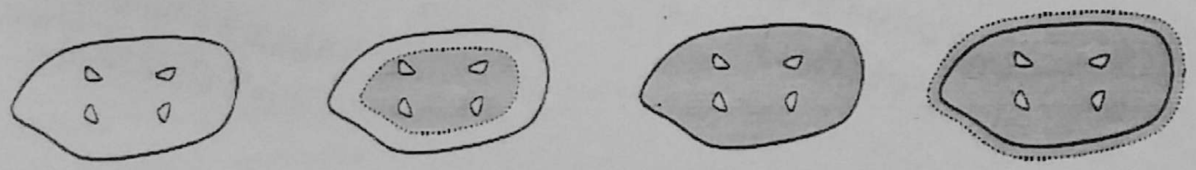
The absorbed and surface moisture of aggregates need to be determined in order to control the net water content of a concrete mix and to make adjustments in batch weights of the materials. The moisture conditions of aggregates are designated as follows:

Oven-Dry: In this condition they are fully absorbent.

Air-Dry: Particles are dry at the surface but contain some interior moisture. They are therefore somewhat absorbent.

Saturated Surface-Dry: In this condition there is no water on the surface, but the particle contains all the interior moisture it will hold. It will neither absorb moisture from nor contribute moisture to the mix.

Damp or Wet: The particles contain an excess of moisture on the surface and will contribute moisture to mix.



1. Completely dry, all pores empty

2. Air dry, partially saturated, pores partially filled

3. Fully saturated surface dry, all pores full but no excess water

4. Wet, excess water

5. SPECIFIC GRAVITY

The specific gravity of an aggregate is another characteristic of the material which needs to be determined. It is not a measure of aggregate quality but is used in making calculations related to mix design. The specific gravity of most normal weight aggregates will range from 2.4 to 2.9. Test methods for determining specific gravity of both coarse and fine aggregates are described in ASTM C127 and C128.

6. HARDNESS OF AGGREGATES

The hardness of aggregates is expressed in terms of their resistance to abrasion. The characteristic is important if the aggregate is used in concrete intended for such purposes as heavy-duty floors. A common method of making this test is described in ASTM C131 or C535 and consists of placing a specified quantity of the aggregate to be tested in revolving steel drum.

7. STRENGTH OF AGGREGATES

One measure of the strength of an aggregate is its resistance to freeze-thaw. This resistance is an important characteristic in concrete which is exposed to severe weather. The freeze-thaw resistance of an aggregate is related to its porosity, absorption, and pore structure. If a particle of the aggregate absorbs so much water that there is not enough pore space available, it will not accommodate the expansion which takes place when the water freezes and the particle will fail. Freeze-thaw tests on aggregates are commonly carried out on specimens of concrete made with the aggregate.

8. CHEMICAL STABILITY OF AGGREGATES

Aggregates need to be chemically stable so that they will neither react chemically with cement nor be affected chemically by outside influences. In some cases aggregates with certain chemical constituents react with alkalis in cement. This reaction may cause abnormal expansion and resultant cracking of concrete. There are three tests used for testing aggregates for reactivity to alkali: ASTM C227, ASTM C289, and ASTM C586.