B. Architecture

Building Material – III (AR6304)

Requirements of Ingredients for Mortar/Concrete

Lecture - 2

Sand:

We deal with sand first. Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. So silt and sand is two different things and gravel is nothing but the small broken part of stone. Sand can also refer to a textural class of soil or soil type that is a soil containing more than 85% sand-sized particles by mass. The composition of sand varies depending on the local rock sources and conditions but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica (silica dioxide or SiO_2) usually in the form of quartz.

Sand which is greater than 0.07mm is used as a fine aggregate in mortar and concrete. It is a granular form of silica. Sand used for mix design is known as standard sand. In India Ennore Sand is considered as standard sand. The standard sand should be obtained from Ennore Tamilnadu. It should be quartz, light grey or whitish variety and should be free from silt. It should pass (100%) through 2mm IS sieve and should be retained (100%) on 90 micron IS sieve with the following distribution.

• Sand – Sources:

Sources of sand can be of two forms that is Natural and Artificial. The most common sources of natural sand can be classified into River

sources and Non river sources. Sand can be found in various modes and it can be found in various places and it can be found in different times. River sources of sand are that run in channel and off channel. In channel sources are that run in stream and off channel sources include floodplain sand, terrace sand and paleo sand. Floodplain sand is nothing but water washes over and over and leaves a layer of sand or silica.

Non-River sources are mostly just land and off shore sources and are contributed from dunes, pits and beaches. Lakes, lagoon and backwater sands are also an important source. Reservoir sand is also an important source. Artificial sources include methods by which sand can be manufactured. It can be made from primary aggregates or secondary aggregates. Sand from primary aggregates is simply manufactures sand and one from secondary is recycled sand. Here you need a primary aggregate for a secondary aggregate sand can be obtain by crushing the basic form of raw material or it can be used by the secondary material that can be used by recycled material.

• Sand – Classification:

Sand may be classified on the basis of sources, mineralogical composition, size of the particles and particle size distribution. Depending upon the source sand may be classed as natural sand resulting from natural disintegration of rocks or deposited by streams. Crushed stone sand produced by crushing hard stones and crushed gravel sands are produced by crushing natural gravel. Based on mineralogical composition sand is divided into quartz, feldspar and carbonaceous varieties. Depending upon its size sand is classified as coarse sand which is fineness modulus usually refers to (F.M) and medium sand and then fine sand.

• Sand – Test:

Sand is takes as for the varieties and each is tested for impurities because sand is having the characteristics of distributing various materials.

- Organic impurities test – this test is conducted at the field for every 20 cum or part thereof.
- Silt content test – this is also a field test and to be conducted for every 20 cum.
- Particles size distribution – this test can be conducted at site or in laboratory for every 40 cu.m of sand.
- Bulking of sand – this test is conducted at site for every 20 cu.m of sand. Based on bulking of sand, suitable water cement ratio is calculated for concrete at site.

• Sand – Test: Bulking of sand :

The increase in moisture of sand increases the volume of sand. The reason is that moisture causes film of water around sand particles which results in the increase of volume of sand. For moisture content percentage of 5 to 8 there will be an increase in volume up to 20 to 40 percent depending upon sand. If the sand is finer there will be more increase in volume. This is known as bulking of sand. When the moisture content of sand is increased by adding more water the sand particles pack near each other and the amount of bulking of sand is decreased. Thus it helps in determining the actual volume of sand, the dry sand and the sand completely filled with water will have the exact volume.

• Sand – Impurities:

The impurities such as clay, dust and organic materials are harmful for mortar and concrete and in any case should not exceed 4% of this clay is most harmful since it coats individual sand particles and prevents their bonding with cement consequently diminishing the strength of mortar which is further reduced by the enhanced water requirement of mortar. The clay and dust impurities can be removed by careful washing. Addition of finely ground clay to clean coarse sand may improve its grading and reduce voids. Hence a lean mortar deficient in fines may be improved both in density and workability by addition of small percentages of such clays. The organic matters, shell and vegetables injure the hardening properties of the cement reducing the

strength and durability. When we talk about the quality of Sand like any other material there are certain features that determine the quality of sand. Good quality sand should not possess more than 4% of silt content. It should have natural and crushed stone sand. It must be free from organic matter and other dirt particles.

Coarse Aggregate:

• Coarse Aggregate - Sources

It is the aggregate most of which is retained on 4.75 mm IS sieve and contains only so much finer material as is permitted by specification. Accordingly coarse aggregate may be described as follows.

- Uncrushed Gravel or Stone – it results from natural disintegration of rock.
- Crushed Gravel or Stone – it result from crushing of gravel or hard stone.
- Partially crushed Gravel or stone – it is a product of the blending of the above two aggregate.

• Coarse Aggregate – Classification:

Nearly all natural aggregate originate from bed rocks. There are three kinds of rocks such as igneous rocks, Sedimentary rocks and metamorphic rocks. Thus the many property of the coarse aggregate are dependent on the characteristics of the parent rock itself.

They can be classified into two main groups.

i. Single size aggregates
ii. Graded aggregate

Single sized aggregates have components which 80-100% of them pass through their specific sieve almost while graded aggregate may have more than one single size aggregates.

• Coarse Aggregate – Properties:

Size of Gravel

The size of Gravel affects the strength and workability. The use of largest maximum size can be used in practical conditions and they help in reducing the cement content, reducing in water requirement and also reducing in dry shrinkage. The maximum size of aggregate should not be greater than one fourth the size of structural member nor should it be less than 5 mm which is minimum cover of reinforcement.

Shape of Gravel:

It is the vital property affecting workability of fresh concrete and also its strength and durability. The parent rock is the cause of the shapes of the aggregates and also their formation over period of time.

According to shape the aggregates is classified as,

- Rounded aggregates
- Irregular or partly rounded aggregate
- Angular aggregate
- Flaky aggregate
- Elongated aggregate
- Flaky and elongated aggregate

Gradation of gravel:

Particles size distribution of the various aggregates is called as gradation. The sieve analysis is conducted to determine the gradations. Grading pattern is arrived by sieving sample through successful sieves. The aggregated retained on each sieve is thus graded. Gradation is an important factor affecting workability. Proper gradation ensures that a sample contains all necessary aggregates to maintain concrete quality. So gradation is an important factor affecting the workability. Workability we talk about set, handle, and harden a particular concrete.

- Coarse Aggregate – Sampling:

Sampling of the aggregates can happen in following points.

- Bins
- Discharge bins
- Belt sampling
- Direct stockpile sampling
- Direct sampling from truck, rail or barges.

Some of the test that can be done for coarse aggregates are sieve test, gravity and absorption test etc.

Water:

• Water resources

Water resources are sources of water that are useful or potentially useful. Potable water or drinking water is considered suitable for concrete making and about 97% of the water on the Earth is salt water and only three percent is fresh water.

Sources of water includes,

In form of river, lake or fresh water wetland surface water is naturally replenished by precipitation and naturally lost through discharge to the oceans, evaporation, transpiration, and groundwater recharge. The other sources are groundwater, under river flow and frozen sources.

- Water - Requirement:

Water serves the following purpose:

i. To wet the surface of aggregates to develop adhesion because the cement pastes adheres quickly and satisfactory to the wet surface of the aggregates than to a dry surface.

ii. To prepare a plastic mixture of the various ingredients and to impart workability to concrete to facilitate placing in the desired position.

iii. Water is also needed for the hydration of the cementing materials to set and harden during the period of curing.

- Water – Quality and test:

The quantity of water in the mixer plays a vital role on the strength of the concrete. Some water which have adverse effect on hardened concrete. Sometimes may not be harmless or even beneficial during mixing. Clear distinction should be made between the effect on hardened concrete and the quality of mixing water. The common specifications regarding quality of mixing water is water should be fit for drinking. Such water should have inorganic solid less than 1000 ppm. This contents lead to a solid quantity 0.05% of mass of cement when w/c ratio is provided 0.5 resulting small effect on strength. But some water which is not potable may be used in making concrete with any significant effect. Dark color or bad smell water may be used if they do not possess deleterious substances. pH of water to even 9 is allowed if it does not taste brackish.

In coastal areas where local water is saline and no alternate sources, the chloride concentration up to 1000 ppm is even allowed for drinking. But this excessive amount of alkali carbonates and bicarbonates in some natural mineral water may cause alkali-silica reaction. It is recommended that the water is tested through a certified lab. Water should meet standards as below

- Limit of Acidity – To neutralize 200 ml sample of water, use phenolphthalein as an indicator. It does not require more that 2 ml 0.1 normal NAOH.
- Limit of Alkalinity – To neutralize 200 ml sample of water use methyl oil as an indicator it does not require more than 10 ml 0.1 normal HCL.
- Limit of Solids - Organic 200 Mg per liter, Inorganic 3000 Mg per liter, Sulfate 400 Mg per liter, Chloride 500 Mg per liter for RCC work and 2000 Mg per liter for Concrete not containing steel. Suspended matter 2000 Mg per liter.