COMPONENTS AND PROPERITIES OF CONCRETE

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Concrete is made up of two components, aggregates and paste. Aggregates are generally classified into two groups, fine and coarse, and occupy about 60 to 80 percent of the volume of concrete. The paste is composed of cement, water, and entrained air and ordinarily constitutes 20 to 40 percent of the total volume. In properly made concrete, the aggregate should consist of particles having adequate strength and weather resistance and should not contain materials having injurious effects. A well graded aggregate with low void content is desired for efficient use of paste. Each aggregate particle is completely coated with paste, and the space between the aggregate particles is completely called with paste. The quality of the concrete is greatly dependent upon the quality of paste, which in turn, is dependent upon the ratio of water to cement content used, and the extent of curing. The cement and water combine chemically in a reaction, called hydration, which takes place very rapidly at first and then more and more slowly for a long period of time in favorable moisture conditions. More water is used in mixing concrete than is required for complete hydration of the cement. This is required to make the concrete plastic and more workable; however, as the paste is thinned with water, its quality is lowered, it has less strength, and it is less resistant to weather. For quality concrete, a proper proportion of water to cement is essential.

Desirable Properties of Concrete Durability:

Ability of hardened concrete to resist deterioration caused by weathering, chemicals, and abrasion Workability: Ease of placing, handling, and finishing

Weather Resistance: Resistance to deterioration caused by freezing and thawing, wetting and drying, and heating and cooling

Erosion Resistance: Resistance to deterioration caused by water flow, traffic, and wind blasting Chemical Resistance: Resistance to deterioration caused by de-icing salts, salt water, sulfate salts

Water Tightness: Resistance to water infiltration

Strength and Economy

Ingredients in Concrete. Hydraulic Cement .Portland Cements and Blended Cements are hydraulic, since they set and harden to form a stone-like mass by reacting with water. The term Hydraulic Cement is all inclusive and is the newer term to be used for both Portland Cement and Blended Cement. The invention of Portland Cement is credited to Joseph Aspdin, an English mason, in 1824. He named his product Portland Cement, because it produced a concrete which resembled a natural limestone quarried on the Isle of Portland. The raw materials used in the manufacturing of cement consist of combinations of limestone, marl or oyster shells, shale, clay and iron ore. The raw materials must contain appropriate proportions of lime, silica, alumina, and iron components. Selected raw materials are pulverized and proportioned in such a way that the resulting mixture has the desired chemical composition. This is done in a dry process by grinding and blending dry materials, or in a wet process by utilizing a wet slurry. In the manufacturing process, analyses of the materials are made frequently to ensure a uniform high quality Portland Cement. After blending, the prepared mix is fed into the upper end of a kiln while burning fuel, producing temperatures of 2600 °F to 3000 °F (1425 °C to 1650 °C), is forced into the lower end of the kiln. During the process, several reactions occur which result in the formation of Portland Cement clinker. The clinker is cooled and then pulverized. During this operation gypsum is added as needed to control the setting time of the cement. The pulverized finished product is Portland Cement. It is ground so fine that nearly all of it passes a sieve having 40,000 openings per sq. inch (1.6 openings per mm2) .

Properties of Hydraulic Cement.

Fineness: Fineness of cement affects heat released and the rate of hydration. Greater cement fineness increases the rate at which cement hydrates and thus accelerates strength development.

Setting Time: Initial set of cement paste must not occur too early; Final set must not occur too late. The setting times indicate that the paste is or is not undergoing normal hydration reactions. Setting time is also affected by cement fineness, water-cement ratio, admixtures and Gypsum. Setting times of concrete do not correlate directly with setting times of pastes because of water loss to air or substrate and because of temperature differences in the field as contrasted with the controlled temperature in the testing lab.

False Set: False set is evidenced by a significant loss of plasticity without the evolution of much heat shortly after mixing. Further mixing without the addition of water or mixing for a longer time than usual can restore plasticity.

Heat of Hydration: Heat of hydration is the heat generated when cement and water react. The amount of heat generated is dependent chiefly upon the chemical composition of the cement. The water-cement ratio, fineness of the cement, and temperature of curing also are factors.

Special Gravity: Special gravity of Portland cement is generally about 3.15. The special gravity of a cement is not an indication of the cements quality; its principal use is in mixture proportioning calculations.

Aggregates for Concrete. Aggregates must conform to certain requirements and should consist of clean, hard, strong, and durable particles free of chemicals, coatings of clay, or other fine materials that may affect the hydration and bond of the cement paste. The characteristics of the aggregates influence the properties of the concrete. Weak, friable, or laminated aggregate particles are undesirable. Aggregates containing natural shale or shale like particles, soft and porous particles, and certain types of chart should be especially avoided since they have poor resistance to weathering.

High Range Water Reducers. High range water reducing and retarding admixtures are water reducers which permit large reductions in the water cement ratio, or provide large increases in the consistency. This can be accomplished with relatively small dosages of the admixture. It is possible to make no-slump concrete and produce a workable concrete. It is also possible to take a normal special cation concrete and increase the consistency to the flowable range of greater than 8 inches (200 mm) of a slump. Because the slump cone is limited in its ability to measure high slumps, the maximum slump should be about 7 inches (175 mm). These admixtures have a very limited time duration before the benefits of increased consistency have been lost, which can create finishing problems. Caution should be exercised in the use of these admixtures and the selection of applications where they will provide a bene! t. Trial batching is recommended prior to use.

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