Concrete Technology

Unit -1

Concrete-siginificance-constituents

Module -1

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History and siginificance of concrete

- History of cementing materials is very old.
- Some kind of cementing materials were used by Egyptians, Romans and Indians in their ancient constructions.
- Early Egyptians mostly used cementing materials, obtained by burning gypsum.Mortar when analyzed from the Great Pyramid showed that it contained 81.5 per cent calcium,sulphate and only 9.5 percent carbonate.
- The early Greeks and Romans used cementing materials obtained by burning lime stones.
- The remarkable hardness of the mortar used in early Roman brickworks, some of which still
- exist, is presenting sufficient evidence of the perfection of cementing material had in ancient
- times.
- The Greeks and Romans later came to know that certain volcanic ash and tuff, when mixed with lime and sand yielded mortar possessing superior strength and better durability in fresh or saltwater.
- Roman builders used volcanic tuff found near Pozzuoli village near Mount Vesuvius in
- Italy. This volcanic stuff or ash mostly siliceous in nature thus acquired the name Pozzolana.
- Later on, the name Pozzolana was applied to any other material, natural or artificial, having
- nearly the same composition as that of volcanic tuff or ash found at Pozzuoli

- In India, powered brick named surkhi has been used in mortar. The Indian practice of through mixing and long continued ramming of lime mortar with or without the addition of Surkhi yielded strong and impervious mortar which confirmed the secret of superiority of Roman mortar.
- Analyzing some of the structures, it is found that Romans added blood and milk to their mortar and concrete to achieve better workability. Hemoglobin is a powerful air-entraining agent and plasticizer, which is another reason for the durability of Roman structures.
- The cementing material made by Romans using lime and natural or artificial Pozzolana retained its position as the chief building material for all work, particularly, for hydraulic construction.
- An investigation carried out by John Smeaton (1756), based on the state of art available in those days to find out the best material to withstand the severe action of sea water, is the most important advance in the knowledge of cements, the forerunner to the discoveries and manufacture of all modern cements.
- He concluded that **lime-stones which contained considerable proportion of clayey matter yielded better lime possessing superior hydraulic** properties.
- In 1976, hydraulic cement was made by calcining nodules of argillaceous lime-stones. In about1800 the product thus obtained was called Roman cement. This type of cement was in use tillabout 1850 after which this was outdated by portland cement

Early history of modern cement:

- L.J. Vicat investigated to prepare an artificial hydraulic lime by calcining an intimate mixture of limestone and clay. This process may be regarded as the leading knowledge to the manufacture of Portland cement. James Frost also patented a cement of this kind in 1811 and established a factory in London district.
- Joseph Aspdin took the patent of portland cement on 21st October 1824 even though similar procedure had been adopted by other investigators. The fancy name of portland was given owing to the resemblance of this hardened cement to the natural stone occurring at Portland in England.
- In his process Aspdin mixed and ground hard lime stones and finely divided clay into the form of slurry and calcined it in a furnace similar to a lime kiln till the CO_2 was expelled.
- The mixture so calcined was then ground to a fine powder. Perhaps, a temperature lower than the clinkering temperature was used by Aspdin.
- Later in 1845 Isaac Charles Johnson burnt a mixture of clay and chalk till the clinkering stage to make better cement and established factories in
- 1851.

Concrete

- Concrete is the most widely used man-made construction material in the world, and is second only to water as the most utilized substance on the planet.
- It is obtained by mixing cementing materials, water and aggregates and sometimes admixtures in required proportions.
- The mixture when placed in forms and allowed to cure ,hardens into rock like mass known as concrete. The hardening is caused by chemical reaction between water and cement and it continues for long time, and consequently the concrete grows stronger with age.
- So basic components of modern concrete :cement, water, fine aggregate, coarse aggregate, mineral additives and admixtures

Concrete - composite construction material

Cement + Coarse Aggregate + Fine Aggregate +

Water + Chemical Admixtures

- The strength ,durability and other characterstics of concrete depend upon the properties of its ingredients, on the proportions of mix ,the method of compaction and other controls during placing, compaction and curing.
- The popularity of the concrete is due to the fact that from the common ingredients, it is possible to tailor the properties of concrete to meet the demands of any particular situation.


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Advantages of concrete

- 1. Availability of concrete ingredients easily.
- 2. Easy handling and moulding of concrete into any shape.
- 3. Easy transportation from the place of mixing to place of casting before initial set takes place.
- 4. Ability to pump/spray to fill into cracks and lining of tunnels.
- 5. When reinforced, all types of the structures are made possible from an ordinary lintel to massive fly overs
- 6. Monolithic character gives better appearance and much rigidity to the structure.
- 7. The property of concrete to possess high compressive strength makes a concrete structure more economical than that of steel structure

Dis-advantages of concrete

- 1. Large amount of CO2 gas will be emitted.
- 2. Due to low tensile strength, concrete is required to be reinforced to avoid cracks.
- 3. In long structures expansion joints are required to be provided if there is large temperature variance in the area.
- 4. Construction joints are provided to avoid cracks due to drying shrinkage and moisture expansion.
- 5. Soluble salts in concrete cause efflorescence if moisture reacts with them.
- 6. Concrete made with ordinary Portland cement, gets integrated in the presence of alkalies, sulfates etc.
- 7. Sustained loads develop creep in structures.

Role of concrete in sustainable infrastructure development:

- In the context of human activity, sustainability has been described as activity or development
- that meets the needs of the present, without compromising the ability of future generations to meet their own needs.
- To assess the sustainability of any system, a balanced consideration of environmental, economic and social aspects is required.
- **Environmental aspects**:
- Concrete projects have superior environmental performance because concrete is durable for nearly 100 years. Due to cement production, large amount of CO2 will be emitted which should be controlled. Due to excess mining of limestone, large amount of byproducts will be generated. Large amount of byproducts like cement kiln dust will be generated in the manufacture of cement. Alternative materials which are non-exhaustible are to be used in the manufacture of cement.

- **Economic aspects:**
- Cement is a reasonably cheap material and is most important material required for the infrastructure to be developed in the entire world.
- Concrete is a reasonable durable material and is resistant to corrosion, attack of chemicals, impact etc.
- Investigations are to be done to make the concrete more durable and increases life span of structures built with it.
- **Social aspects:**
- The construction industry is a vital part of our economy and concrete is an essential part of the construction industry. Construction provides a secure livelihood for hundreds of thousands, and concrete is an integral part of that security. Concrete can be formed in an endless array of shapes to create structures, which are aesthetically and socially pleasing in architecture, civil engineering and landscape architecture. Concrete is used to create buildings that provide safe shelter for human habitation. Without concrete there is no built environment.

Concrete constituent materials:

- Cement manufacturing:

- The process of manufacture of cement consists of grinding the raw materials, mixing them intimately in certain proportions, depending upon their purity and composition, and burning them in a kiln at a temperature of about 1300 to 1500°C.
- At this temperature, the material sinters and partially fuses to form nodular shaped clinker.
- The clinker is cooled and ground to fine powder with addition of about 3 to 5% of gypsum. The product formed by using this procedure is Portland cement
- There are two processes known as —wet and —dry processes in the manufacture of cement depending upon whether the mixing and grinding of raw materials is done in wet or dry conditions.
- Semi-dry process is also there where the raw materials are ground dry and then mixed with about 10-14 per cent of water and further burnt to clinkering temperature

- Wet process remained popular for many years because of accurate mixing of raw materials. Later, due to development of modern techniques, dry process gained importance.
- In dry process, powdered materials are mixed using compressed air. The dry process requires much less fuel as the materials are already in a dry state, whereas in the wet process the slurry contains about 35 to 50 per cent water. Hence drying slurry requires much fuel
- Let us see how wet process is taking place?

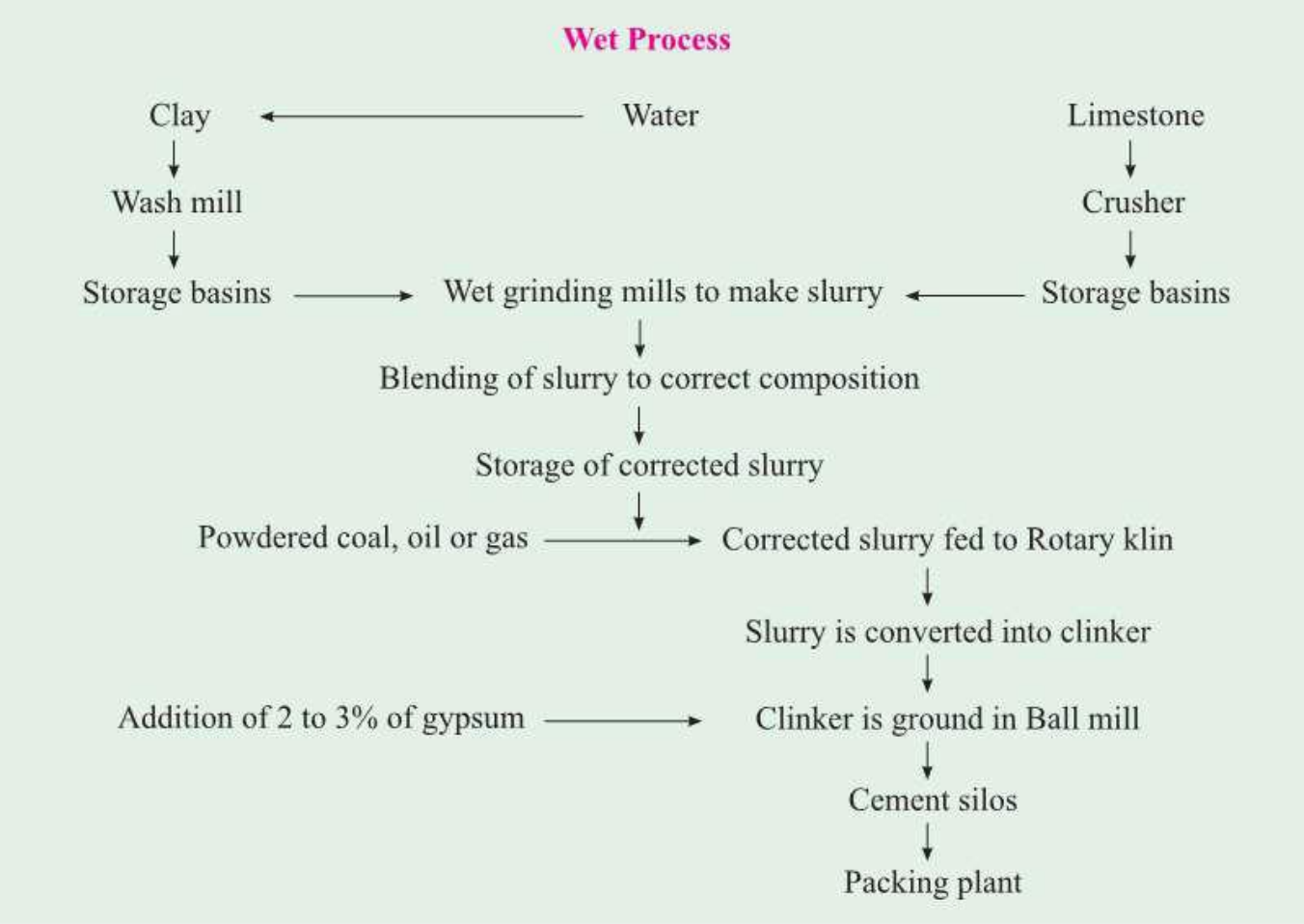
- In the wet process, the limestone brought from the quarries is first crushed to smaller fragments. Then it is taken to a ball or tube mill where it is mixed with clay or shale as the case may be and ground to a fine consistency of slurry with the addition of water
- The slurry is a liquid of creamy consistency with water content of about 35 to 50 per cent, wherein particles crushed to the fineness of Indian Standard Sieve number 9, are held in suspension.
- The slurry is pumped to slurry tanks or basins where slurry tank or basin is kept in an agitated condition by means of rotating arms with chains or blowing compressed air from the bottom to prevent settling of limestone and clay particles.
- The composition of the slurry is tested to give the required chemical composition and corrected periodically in the tube mill and also in the slurry tank by blending slurry from different storage tanks.
- Finally, the corrected slurry is stored in the final storage tanks and kept in a homogeneous condition by the agitation of slurry.

- The corrected slurry is sprayed on to the upper end of a rotary kiln. The rotary kiln is an important component of a cement factory. It is a thick steel cylinder of diameter varying from 3 meters to 8 meters, lined with refractory materials, mounted on roller bearings and capable of rotating about its own axis at a specified speed
- The slurry on being sprayed against a hot surface of flexible chain loses moisture and becomes flakes. These flakes peel off and fall on the floor.
- The rotation of the rotary kiln causes the flakes to move from the upper end towards the lower end of the kiln subjecting itself to higher and higher temperature.
- By the time the material rolls down to the lower end of the rotary kiln, the dry material undergoes a series of chemical reactions in the hottest part of the kiln, where the temperature is in the order of 1500°C, about 20 to 30 per cent of the materials get fused. Lime, silica and alumina get recombined.

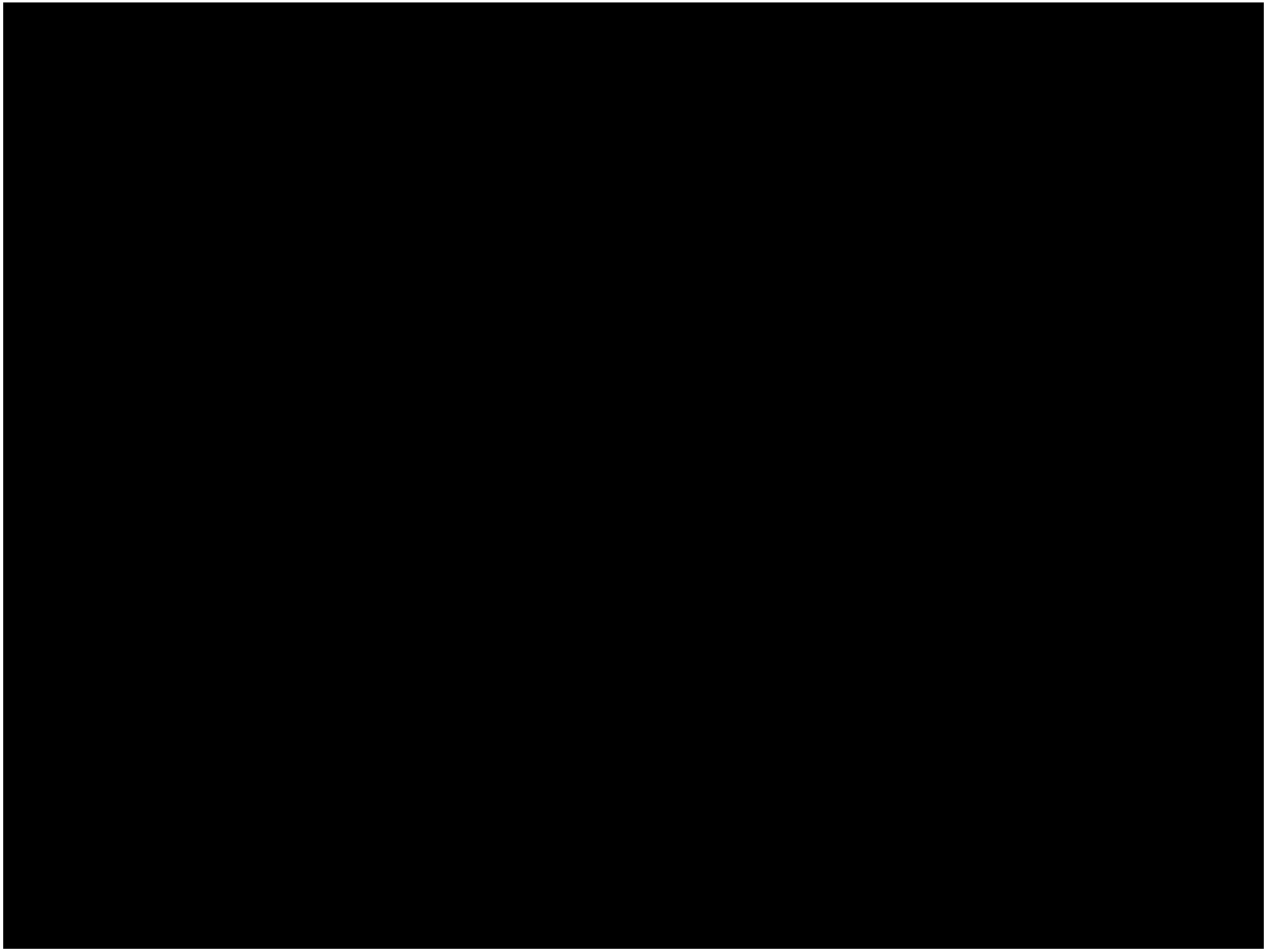
Rotary klin

- The fused mass turns into nodular form of size 3mm to 20 mm known as clinker. The clinker drops into a rotary cooler where it is cooled under
- controlled conditions.
- The clinker is stored in silos or bins. The clinker weighs about 1100 to
- 1300 g per liter. The liter weight of clinker indicates the quality of clinker
- The cooled clinker is then ground in a ball mill with the addition of 3 to 5 per cent of gypsum in order to prevent flash-setting of the cement.
- A ball mill consists of several compartments charged with progressively smaller hardened steel balls.
- The particles crushed to the required fineness are separated by currents of air and taken to storage silos from where the cement is bagged or filled into barrels for bulk supply to dams or other large work sites.

Ball mill



https://www.youtube.com/watch?v=YNUYMS9QKK8



Dry process:

- In the dry and semi-dry process the raw materials are crushed dry and fed in correct proportions into a grinding mill where they are dried and reduced to a very fine powder
- The dry powder called the raw meal is then further blended and corrected for its right composition and mixed by means of compressed air. The aerated powder tends to behave almost like liquid and in about one hour of aeration a uniform mixture is obtained.
- The blended meal is further sieved and fed into a rotating disc called granulator. A quantity of water about 12 per cent by weight is added to make the blended meal into pellets. Water is added to permit air flow for exchange of heat and for further chemical reactions and conversion of the same into clinker in the rotary kiln.

- The equipment‘s used in the dry process kiln is comparatively smaller. The process is quite economical.
- The total consumption of coal in this method is only about 100 kg when compared to the requirement of about 350 kg for producing a ton of cement in the wet process.

Animation video of manufacture of cement by dry process: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