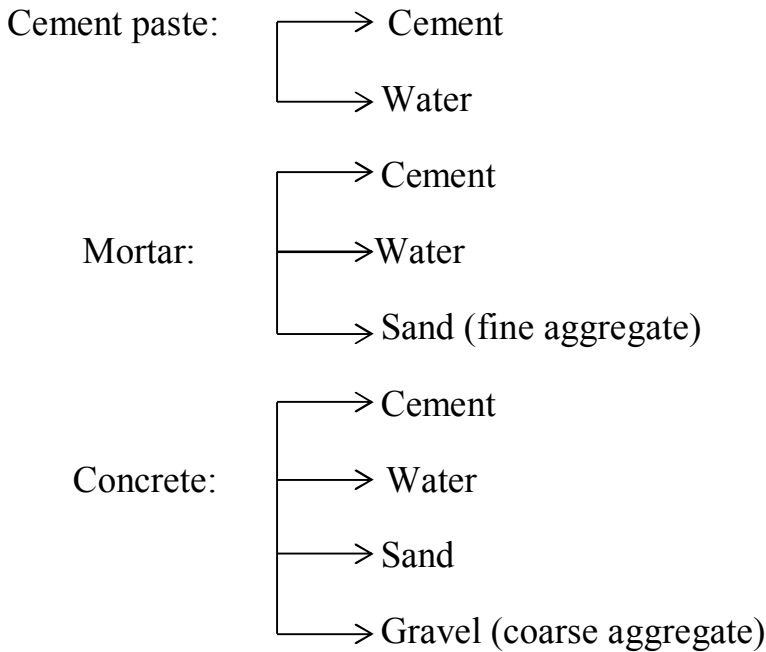


Cements

Cement is a building material which has a cohesive and adhesive properties in presence of water, these properties make cement able to connect mineral parts with each other and produced a solid mass.



Manufacture of Portland cement

Portland cement is essentially calcium silicate cement, which is produced by firing to partial fusion, at a temperature of approximately 1500°C, a well-homogenized and finely ground mixture of limestone or chalk (calcium carbonate) and an appropriate quantity of clay or shale.

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 which 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 depending upon whether the mixing and grinding of raw materials is done in wet or dry conditions.

1. Wet process

In the wet process, the limestone brought from the quarries is first crushed to smaller pieces. Then it is taken to a ball mill where it is mixed with clay or shale 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. The slurry is pumped to slurry tanks. The composition of the slurry is tested to give the required chemical.

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 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 length of the rotary kiln may vary from 30 meters to 200 meters. The slurry on being sprayed against a hot surface of flexible chain loses moisture and becomes flakes. 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. The kiln is fired from the lower end.

By the time the material rolls down to the lower end of the rotary kiln, the dry material undergoes a series of chemical reactions until finally, 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. The fused mass turns into nodular form of size 3 mm to 20 mm known as clinker. The clinker drops into a rotary cooler where it is cooled under controlled conditions, then it stored in silos or bins. 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. 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.

2. Dry Process

In the 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 blended and corrected for its right composition and mixed by means of compressed air. 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 solid balls. Fry the balls inside an iron mesh bars pre-heated by hot gases, and then feed it to rotary kiln and the following operations will be similar to the wet process.

The equipments used in the dry process kiln are 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.

Comparison between wet and dry process

Wet process	Dry process
1- Moisture content of the slurry is 35-50%	1- Moisture content of the pellets is 12%
2- Size of the kiln needed to manufacture the cement is bigger	2- Size of the kiln needed to manufacture the cement is smaller
3- The amount of heat required is higher, so the required fuel amount is higher	3- The amount of heat required is lower, so the required fuel amount is lower
4- Less economically	4- More economically
5- The raw materials can be mix easily, so a better homogeneous material can be obtained	5- Difficult to control the mixing of raw materials process, so it is difficult to obtain homogeneous material
6- The machinery and equipments do not need much maintenance	6- The machinery and equipments need more maintenance

Physical and chemical changes occurring in the rotary kiln

1. In (150 C°) limestone loss water in its combination.
2. In (450 C°) clay will decompose:

$$2\text{SiO}_2 \cdot \text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O} \xrightarrow{450\text{ C}} 2\text{SiO}_2 + \text{Al}_2\text{O}_3 + 2\text{H}_2\text{O} \uparrow$$
3. In (650 C°) Magnesium Carbonate will be decompose :

$$\text{MgCO}_3 \xrightarrow{\text{heat } 650\text{ C}^\circ} \text{MgO} + \text{CO}_2 \uparrow$$
4. In (950 C°) calcium carbonate will be decompose :

$$\text{CaCO}_3 \xrightarrow{\text{heat } 950\text{ C}^\circ} \text{CaO} + \text{CO}_2 \uparrow$$
5. In (1250 C°) 20 – 30 % of raw materials become a slurry and small balls called clinker start to form.
6. Grinding clinker with (2-3)% gypsum to produce cement.