

Cement

Concrete is widely used as a non-metallic material in construction of buildings, dams, bridges, high ways etc. In concrete, cement is a building material that possesses cohesive and adhesive properties and capable of bonding with stones, bricks, building blocks etc.

Portland cement

The name Portland cement is used because this powder on mixing with water gives a hard, stone like mass which resembles Portland rock (Leeds city UK). It is widely used as a non-metallic material in construction. It is a composition of calcium silicates, calcium aluminates and small amount of gypsum.

Composition of Portland cement:-

A sample of Portland cement contain following composition:

- i) Calcium Oxide or lime (CaO) : 60-70%
- ii) Silica (SiO_2) : 20-24%
- iii) Alumina (Al_2O_3) : 5-7.5%
- iv) Magnesia (MgO) : 2-3%
- v) Ferric Oxide (Fe_2O_3) : 1-2.5%
- vi) Sulphur trioxide (SO_3) : 1-1.5%
- vii) Sulphur Oxide (Na_2O) : 1%
- viii) Potassium Oxide (K_2O) : 1%

Manufacture of Portland Cement:

The steps involve in the manufacturing process are as follows:

- i) Crushing
- ii) Mixing
- iii) Burning
- iv) Grinding

i) **Crushing:**

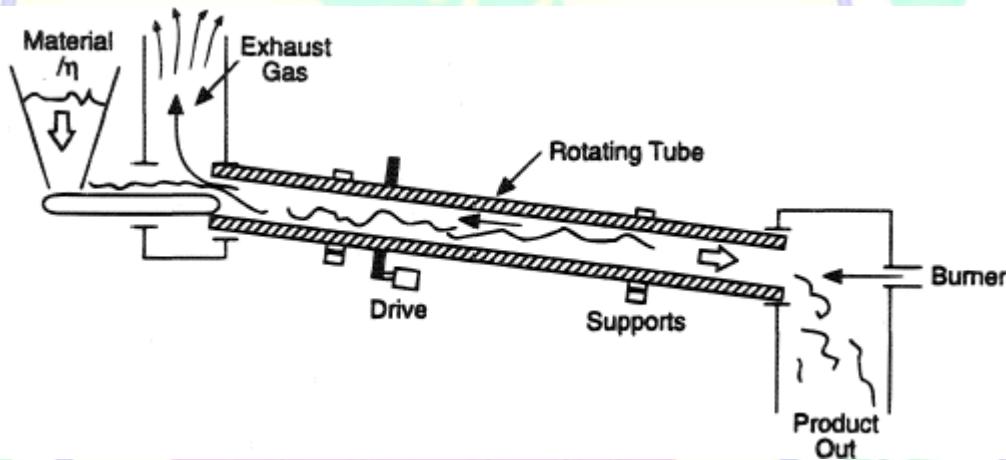
In this step raw material of Portland cement lime, Silica, Alumina, Magnesia, Ferric Oxide, Sulphur trioxide, Sulphur Oxide, Potassium Oxide are crushed and ground to fine powder through ball mill.

ii) **Mixing:**

In this step raw ingredients or fine powder are mixed in presence (wet process) or absence (dry process) of water to form slurry, then slurry is stored in storage tank.

iii) **Burning:**

The burning process is done in Rotary Kiln. The Rotary Kiln possesses three different temperature zone like drying zone, calcinations zone and Clinkering zone.



Drying zone:

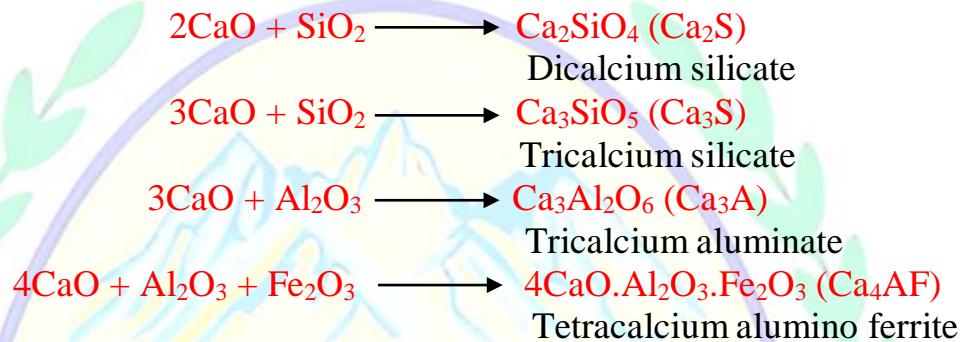
It is the upper part of Rotary Kiln having temperature around 250°C where the water from the slurry evaporates.

Calcinations zone:

It is middle portion of Rotary Kiln where temperature ranges from $700^{\circ}\text{-}1200^{\circ}\text{C}$. in this region limestone undergoes decomposition to form quick lime and carbon dioxide (escape out).

Clinkering zone:

It is the lower part of Rotary Kiln where quick lime with clay to form calcium silicate, aluminates and ferrite.



The aluminates and silicates are mixed with CaO to form stone like structure, known as clinkers.

iv) Grinding:

The cooled clinkers are ground to a fine powder in ball mill. At this time 2-3% of gypsum is added to prevent the early setting of cement.

Setting and hardening of cement

When water mixed with Cement, form a plastic paste. The past is subjected to hydration and gel and finally crystalline products are formed.



Tobermorite gel, calcium hydroxide crystallization and hydrated tricalcium aluminate are responsible for final setting and hardening of cement.



Role of gypsum:

2-3% of gypsum is added to prevent the early setting of cement.

