

# Cement

## # Introduction:

Cement is the most important material for construction manufacturing. It is the binding material that is obtained by burning at about  $1300 - 1500^{\circ}\text{C}$  of calcareous, siliceous and argillaceous raw materials mixed in definite proportion and crushing and grinding the resulting clinkers to a fine powder. Binding means it has the effect of gluing the substances together due to cohesive and adhesive action and then hardens and sets to become permanent.

## # Raw materials for cement production:

Basic raw materials for cement production are as follows:-

- (i) Limestone ( $\text{CaCO}_3$ )
- (ii) Clay ( $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$  and  $\text{Fe}_2\text{O}_3$ )
- (iii) Gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ )
- (iv) Magnesia ( $\text{MgO}$ )
- (v) Sulphur
- (vi) Alkalies

## # Main steps in cement production:

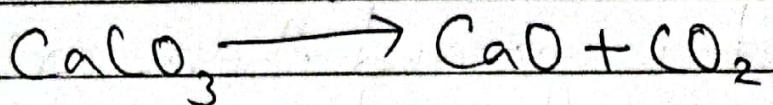
The main steps involved in cement production are as follows:-

1. Crushing: The raw materials are extracted from quarries by blasting, drilling or ripening using heavy machinery. The raw materials are then crushed in a rotating cylindrical ball or tube mill. The ores are crushed first to 6 inches and reduced them by a secondary crusher or hammer mill to 3 inches.
2. Grinding: The crushed ore and raw materials are mixed either in dry or wet ways and then grinded and made homogeneous by means of compressed gas in a grinding mill. The resulting material is known as slurry.
3. Heating: Slurry is then introduced in a rotary kiln with the help of a conveyor. The rotary kiln consists of a large cylinder, 8 to 10 feet in diameter and

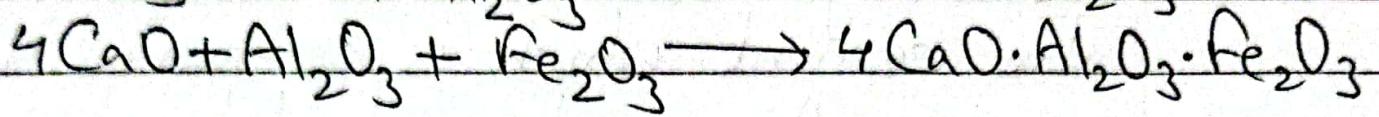
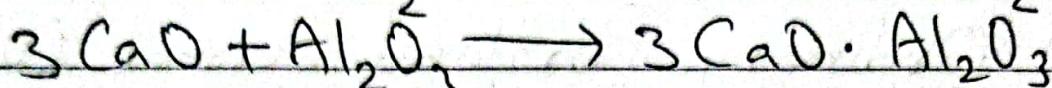
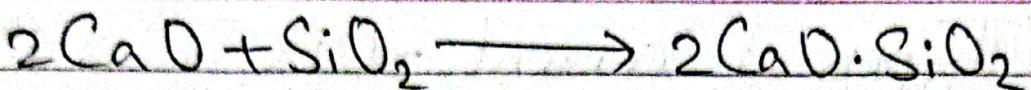
a height of 300-500 feet. It is made of steel and lined with firebricks. In a rotary kiln, the slurry is passed through different zones of temperature as follows:-

(i) Preheating zone: In this zone, the temperature is kept to  $500^{\circ}\text{C}$  and usually the moisture is removed and clay is broken into silica, aluminium oxide and iron oxide.

(ii) Decomposition zone: Temperature is raised upto  $800^{\circ}\text{C}$ . In this zone, limestone decomposes into quick lime and  $\text{CO}_2$ .



(iii) Burning zone: In this zone, temperature is maintained upto  $1500^{\circ}\text{C}$  and the oxide formed in above zone combines together and form respective silicate, aluminate and ferrite.



(iv) Cooling zone: This is last stage where the whole assembly is cooled upto  $150 - 200^\circ\text{C}$ .

4. Final grinding: The product which is obtained from rotary kiln is called clinker. It is usually in the form of greenish black or grey coloured solid. It is then air cooled and the cooled clinkers are collected in small trolleys and sent into mills. The clinker is grinded into powder in a ball mill or tube mill along with 2-3% powdered gypsum to produce cement.

## # Types of cement - OPC and PPC:

(i) Ordinary Portland cement (OPC):  
The cement which is prepared by grinding the mixture of limestone and other raw materials like argillaceous, calcareous and gypsum is called ordinary portland cement (OPC).

(ii) Portland Pozzolana cement (PPC):  
The cement which is prepared by adding a mixture of pozzolanic materials namely fly ash and volcanic ash to OPC is called portland pozzolana cement (PPC).

## # Difference between OPC and PPC:

OPC	PPC
(i) The cement which is prepared by grinding the mixture of limestone and other raw materials like argillaceous, calcareous gypsum is called ordinary portland cement (OPC).	(i) The cement which is prepared by adding a mixture of pozzolanic materials namely fly ash and volcanic ash to OPC is called portland pozzolana cement (PPC).
(ii) It is slightly costlier than PPC.	(ii) It is cheaper than OPC.
(iii) It has higher strength than PPC in the initial stage.	(iii) The strength of PPC is better than OPC in the long term.
(iv) It is not favourable in aggressive weather.	(iv) It is favourable in aggressive weather.
(v) It is available in three grades as 33 grade, 43 grade and 53 grade.	(v) There is no such grades in PPC, the strength of PPC matches the OPC 33 grade.

- (vi) The hydration process is fast resulting in the high heat of hydration. Therefore, it is unsuitable for mass concreting.
- (vi) The hydration process is slow resulting in low heat of hydration. Therefore, it is suitable for mass concreting.
- (vii) It has high % of chloride, sulphate, alkali, etc in its composition which makes the concrete less durable.
- (vii) It has low % of chloride, sulphate, alkali, etc in its composition which makes the concrete more durable.

## # Manufacture of portland cement with flow sheet diagram:

The different steps involved in the manufacture of portland cement are as follows:-

1. Quarrying: Raw materials are extracted from quarries by blasting or by ripping using heavy machinery. Wheel loaders and dumper trucks transport the raw materials to the crushing installations.
2. Crushing: Limestone produced are then crushed with the help of crushers installed at the mine sites which is transported to plant stack pile with the help of belt conveyor or ropeway.
3. Grinding, blending and homogenization: Crushed quarried limestone is further crushed into small pieces to provide fine materials for blending which is blended with corrective ingredients like clay, silica and iron ore in required proportion and

Mixed in a homogeneous way to produce clinker of the desired composition.

4. Pyro processing: In this process, materials are subjected to high temperature so as to cause a chemical or physical change. ~~It~~ Here, the blended material is heated at a high temperature at about  $1300-1500^{\circ}\text{C}$  in a rotatory kiln to produce clinker. The kiln is heated with the help of powdered coal so that hot flames are produced.

5. Storing clinker and grinding: The clinker coming from the burning kiln is very hot. It is cooled by admitting the air in a counter current direction at the base of the kiln and collected in small trolleys. The clinker is grinded in powder form in a ball mill along with gypsum to produce cement.

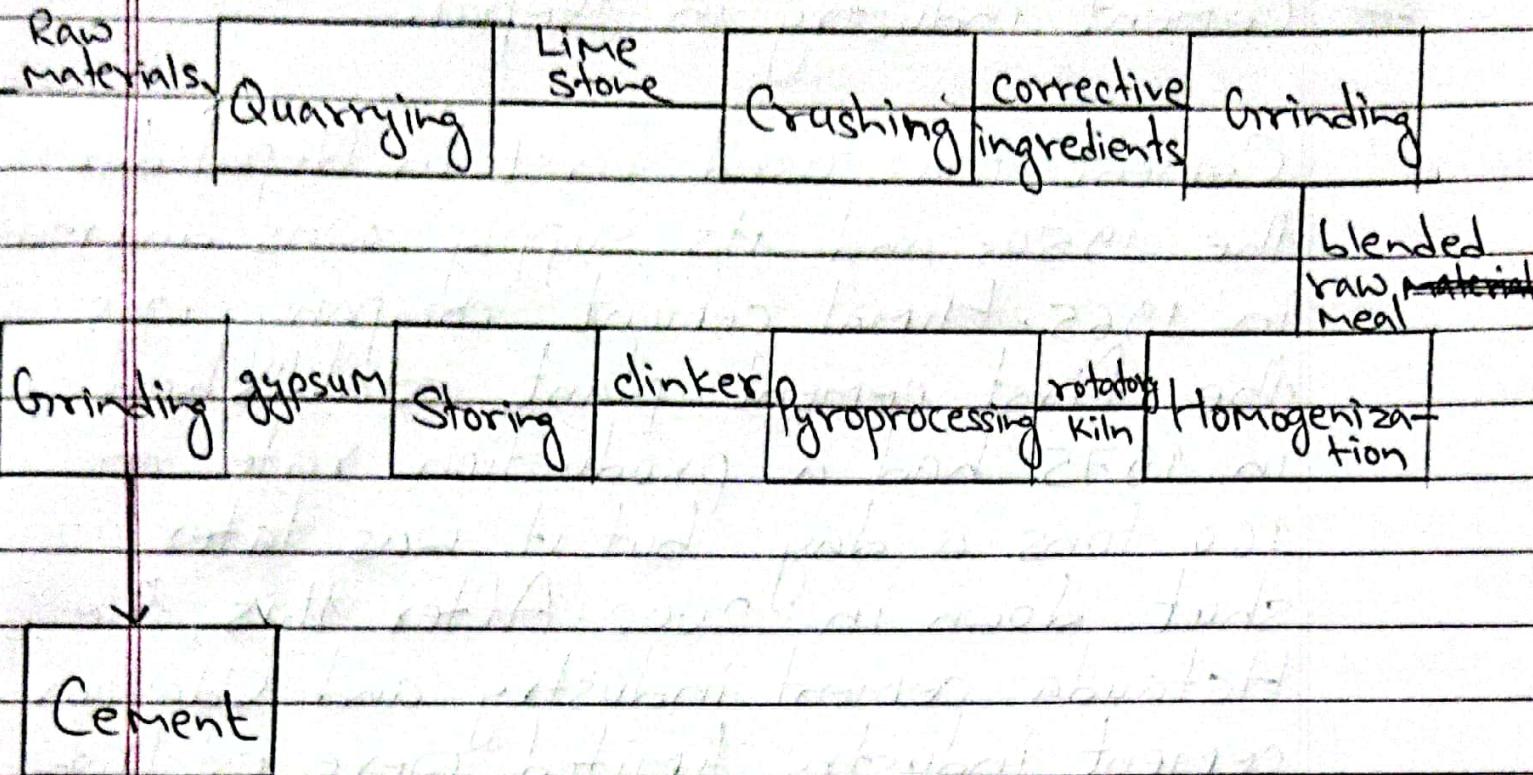


Fig: Flowsheet diagram for the manufacture of portland cement

## # Cement industry in Nepal:

Cement was used first in Nepal during the 1950s and its supply was diversified in 1965. Himal cement company was the first cement plant established in 1975 had a production rate of 160 tons a day but it was later shut down in 2002. After this, the Hetauda cement industry and Udaypur cement industry limited were established. Nepal's domestic cement production has been growing steadily over the past few years as the demand for cement continues to rise. Nepali cement producers are producing OPC, PPC of which OPC is widely used by consumers. Hongshi - Shivan cement private limited, a Nepal - China joint venture company has started cement production in 2018. It is the largest cement factory in Nepal with a daily production capacity of 6000 tons. According to the department of industries, 27 mini, medium and large

scale cement industries and more than 17 mini and mini clinker based cement industries have been registered in Nepal. Some cement industries established in the public and private sectors are mentioned below:-

Public sectors:

- (i) Himal cement company
- (ii) Hetauda cement industry
- (iii) Udaypur cement industry

Private sectors:

- (i) Jagadamba cement
- (ii) Butwal cement
- (iii) Shivam cement
- (iv) Agni cement
- (v) Arghakhanchi cement.