

CEMENT

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BEST



Cement is an extremely fine material having adhesive and cohesive properties which provides a binding medium for the discrete ingredients. It is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. They are not very water-soluble and so are quite durable in water and safe from chemical attacks.



- Cement is essentially a mixture of limestone and clay. Generally, It is a substance which in contact with sets to hard mass.
- it was commonly called portland cement.
- Cement is a product obtained by combining material rich in CaO(lime) with other materials like clay that contains silica(SiO₂), along with the oxide of aluminium, iron and magnesium.
- thus, the average composition of portland cement is CaO(50%-60%), SiO₂ (20%-25%), Al₂O₃(5-10%), MgO(2-3%), Fe₂O₃(1-2%), and S₂O₃ (1-2%).
- The most popular cement that are used in Nepal are Ordinary Portland Cement(OPC), Pozzolana Portland Cement (PPC) and white cement.
- therefore, when cement, sand gravel and water are mixed in appropriate amount , it is called concrete.
- If concrete cement is filled with wire netting and allowed to set, the structure thus formed is called reinforce concrete(RCC).

- **TYPES OF RAW MATERIALS;**

- **Primary Raw Materials:** It forms 85% of clinker. They are limestone, cement rocks, clay shale, sand etc. they supply Ca, Si, Al, and Fe.
- **Secondary Raw materials:** It forms less than 15% of clinker. They are slag, sandstone, bauxite, iron ore, etc.
- **Tertiary Raw Materials:** these substances are used for other than clinker formation specially, for reducing water contents. They are gypsum, slum, borax, etc.

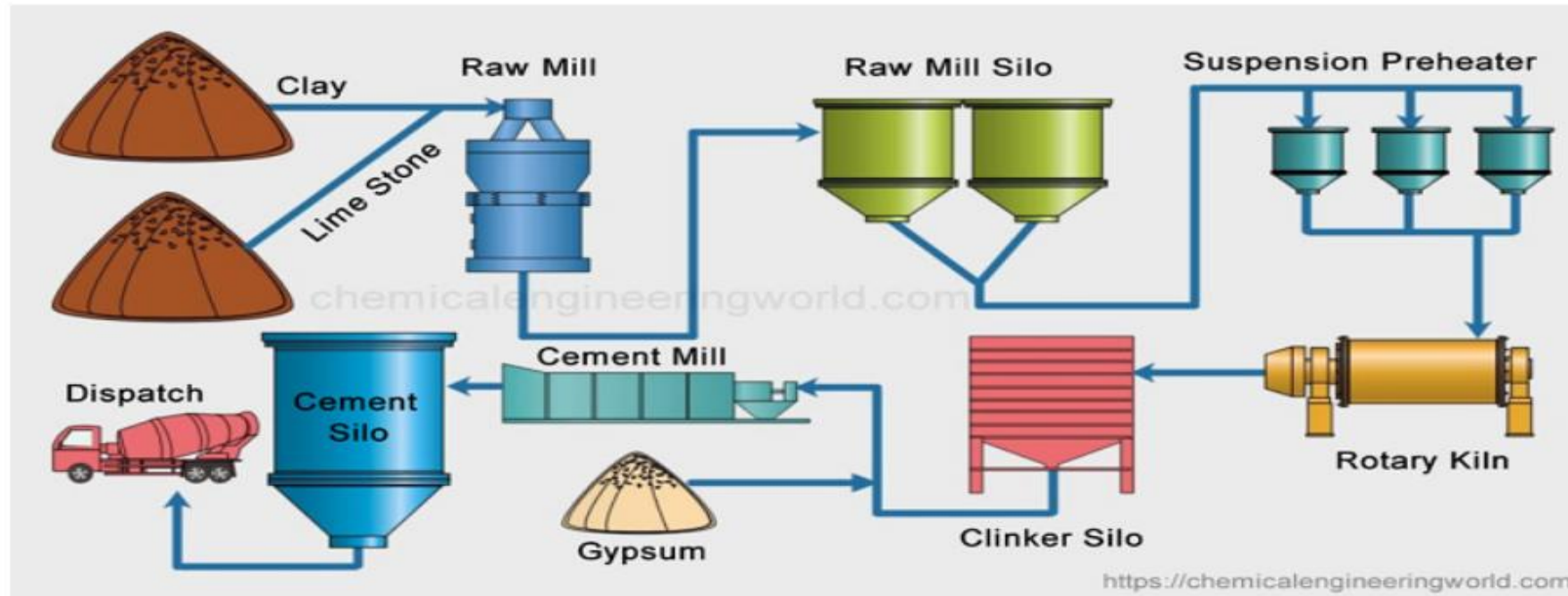
NOTE:

Clinker: The fused products of aluminates and silicates of calcium in the form of hard and small stones obtained by fusing limestone and clay.

The overall raw materials used for cement production are:

1. Limestone (CaCO_3)
2. Clay (SiO_2 , Al_2O_3 and Fe_2O_3)
3. Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$)
4. Magnesia (MgO)
5. Sulphur
6. Alkalies

Main steps in cement production



MAJOR STEPS IN CEMENT PRODUCTION

1. **Crushing:** Firstly, all the necessary materials are crushed using rotating cylindrical ball or tube mill and then mixed at first . The main components of materials are calcareous(which supply lime) and argillaceous(which supply silica, iron oxide and alumina).

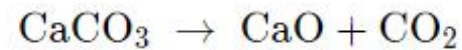
2. **Grinding:** The crushed ore is mixed either in dry or wet ways is then grounded and then made homogeneous by means of compressed gas in a grinding mill. The resulting material is known as slurry having 35-40 % water.

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. The whole process in the kiln is completed in 2 to 3 hours.

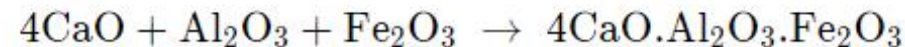
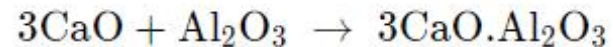
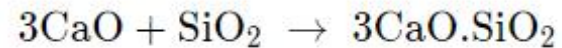
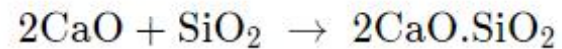
Different temperature zones

i. Preheating zone: In this zone, the temperature is kept to 500°C and usually the moisture is removed and clay is broken into silica, aluminium oxide and iron oxide.

ii. Decomposition zone: Temperature is raised to 800°C. In this zone, limestone decomposes into quick lime and CO₂.



iii. Burning zone: In this zone, the temperature is maintained up to 1500°C and the oxide formed in the above zone combines and forms respective silicate, aluminate and ferrite.



iv. Cooling zone: This is the last stage where the whole assembly is cooled up to 150-200°C.

4. Final grinding: The product which is obtained from the rotary kiln is called clinker. It is usually in the form of a greenish-black or grey-coloured solid. It is then air-cooled and the required amount of gypsum is mixed with the clinker to slow down the setting of cement so that cement is adequately hardened.

5. Packing and Shipping: Cement is conveyed from grinding mills to silos (large storage tanks) where it is packed in 20-40 kg bags. Most of the product is shipped in bulk quantities by trucks, trains or ships, and only a small amount is packed for customers who need small quantities.

Types of cement

Depending upon the hardening and setting behaviour, cement is mainly classified into two types:

i. Hydraulic cement

The cement that sets very quickly and hardens in addition to water is called hydraulic cement. It is mainly composed of limestone, gypsum and clay.

ii. Non-hydraulic cement

The cement which sets very slowly by the absorption of CO_2 from the atmosphere and cannot harden while in contact with water is called non-hydraulic cement. It is composed of lime, gypsum, clay and oxychloride.

Depending upon the composition and characteristics, two commercially available important types of cement are:

1. Ordinary Portland Cement (OPC)
2. Portland pozzolana cement (PPC)

	Ordinary Portland Cement (OPC)	Portland pozzolana cement (PPC)
Definition	A mixture of limestone and other raw materials like argillaceous, calcareous, gypsum is prepared and then grinded to prepare OPC.	It is prepared by adding pozzolanic materials to OPC. So, the main components are OPC clinker, gypsum and pozzolanic materials (15-35%) which include calcined clay, volcanic ash, fly ash.
Strength	Initial strength is higher than PPC.	-It has higher strength than OPC over a long period of time.
Heat of hydration	Generally more heat than PPC and makes it less suitable for mass casting.	It has a slow hydration process and thus generates less heat than OPC.
Durability	Less durable in aggressive weather.	More durable in aggressive weather.
Cost	Costlier than PPC.	Cheaper than OPC.
Environmental impact	Emits CO ₂ during the manufacturing process.	It constitutes industrial and natural waste which makes it eco-friendly.
Setting time	Lower than PPC. Its initial setting time is 30 minutes and final setting time is 280 minutes. Its faster setting time helps faster construction.	Setting time is higher than OPC. Its initial setting time is 30 minutes and final setting time is 600 minutes. Its lower setting time helps to get better finishing.
Grades available	33, 43 and 53	No specified grades
Resistance	Low resistance against alkali, sulphates and chlorides.	High resistance against alkali, sulphates and chlorides.
Application	It is suitable where fast construction is required.	It is suitable for all types of construction work.

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 in a ball mill along with gypsum to produce cement.

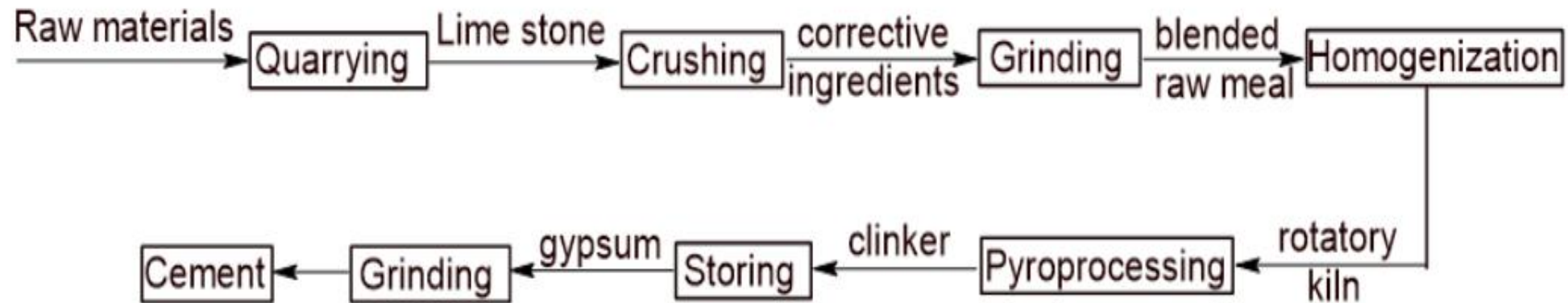


Fig: Flowsheet diagram of Portland Cement

Manufacture of portland cement process with flow sheet diagram

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: Limestones 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 conveyer 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 temperatures so as to cause a chemical or physical change. Its control improves efficiency in energy utilization and hence enhances production for good quality assurance.

Here, the blended material is heated at a high temperature at about 1300-1500°C in a rotatory kiln to produce clinker. The kiln is heated with the help of powdered coal so that hot flames are produced.

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-Shivam 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 (some list)

- i. Jagadamba cement
- ii. Butwal cement
- iii. Shivam cement
- iv. Agni cement
- v. Arghakachi cement

Clinker based cement industries (some list)

- i. Mittal cement
 - ii. Pashupati cement
 - iii. Ambe cement
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