

Summary of cement

Building material: any material which is used in any construction purpose:

1. Natural materials: clay, sand, wood, thatch, rocks, twigs and leaves.
2. Synthetic: cement, ceramics, plastics, glass, foam, fabric.
3. Green materials: produced to protect the environment from greenhouses gases.

Pozzolanic activity: binding ability of a material upon mixing with water.

Cement: is a finely ground powder consisting of a mixture of inorganic oxides.

Chemical composition of cement:

Oxide	CaO	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MgO	CaSO ₄
abbreviation	C	S	A	F	M	Gypsum
%	60-65	19-25	3-8	1-5	0-5	1-4

Raw materials in cement manufacture: limestone (CaCO₃) – clay (silica) - alumina.

Manufacture Process of cement includes:

- 1- Transportation of raw materials to the factory,
- 2- Mixing and crushing of raw materials through two processes:
 - a) Dry process: when raw materials are very strong and hard
 - b) Wet process: when raw materials are soft
- 3- Burning: in rotary kilns up to 1500-1650 oC to give clinkers
- 4- Grinding of clinkers after cooling and mixing with 1-4% gypsum to control the setting time of cement.
- 5- Finally, storing and packing the fine ground cement.

Functions of Cement Constituents:

Cement consists of mixture of oxides; their roles are as follow:

Lime, CaO: (2/3) of the cement, more than this causes expansion and disintegration.

Silica (SiO₂): (1/4) of the cement, more than this causes the cement to set slowly.

Alumina (Al₂O₃): 3-8 %, more than this reduces the strength of the cement. It causes a quick setting for cement and lowers the clinkering temperature.

Fe₂O₃ & MgO: give color to cement - responsible for hardness - reduce heat of burning of raw materials.

Gypsum (CaSO₄): It is added at the final stage of manufacturing to slow the cement setting.

Functions of Cement compounds

Cement oxides are combined to form cement compounds: C_2S , C_3S , C_3A , C_4AF .

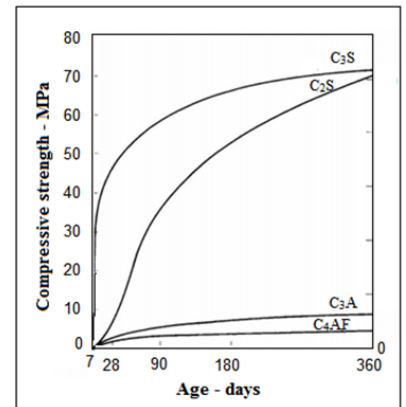
After mixing cement with water, each one of these compounds has its function:

C_3S : hydrates and hardens rapidly, responsible for the initial set of cement.

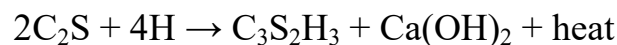
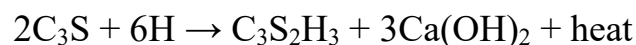
C_2S : hydrates and hardens slowly, responsible for increasing strength within 7 days.

C_3A : it hydrates and hardens quickly liberating a large amount of heat, and it contributes to early strength (1-3days).

C_4AF : it hydrates rapidly but contributes very little to strength.



Chemical reactions during the cement hydration: When cement is mixed with water, it forms a paste that sets and hardens through a chemical reaction called “hydration”. The chemical equations of this hydration are:



Environmental impacts of cement industry:

(A)Emissions to air: 5–7% of the total CO_2 emission. It can be:

Directly: during heating of limestone.

Indirectly: during burning of fossil fuels to heat the kiln Other emissions such as NO_x - SO_2 - volatile organic compounds, HF - HCl - CO.

Ways to reduce these emissions:

- 1- By replacing fossil fuels used in kiln by natural gas.
- 2- By Capturing CO_2 emissions through: - Carbon capture and storage” (CCS) units - Accelerated carbonation method by passing CO_2 through $Ca(OH)_2$ solution to form $CaCO_3$.

(B)Noise emissions: come through the cement manufacturing processes such as:

- Raw materials transportation process – crushing, milling - rotary furnace - storage - the shipping of the final products.
- Using heavy machinery during such as: Chutes, hoppers, exhaust fans, or blowers

Ways to reduce Noise emissions: Natural noise barriers, such as office buildings, walls, or trees.