Definition

Glass is an amorphous, hard, brittle, transparent or translucent super cooled liquid of infinite viscosity, having no definite melting point obtained by fusing a mixture of a number of metallic silicates or borates of Sodium, Potassium, Calcium, and Lead.

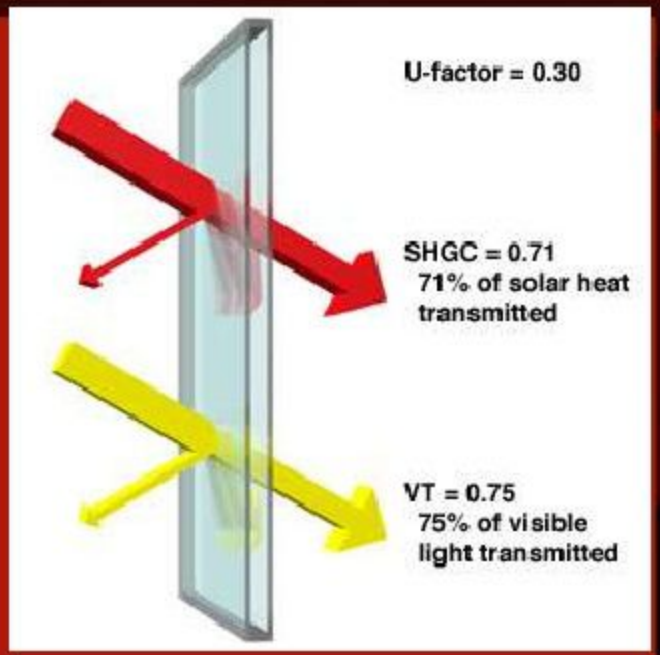
I

It possess no definite formula or crystalline structure.

- **"An inorganic product of fusion which has cooled to a rigid condition without crystallizing"**
- **Does not have a specific melting point**
- **Softens over a temperature range**

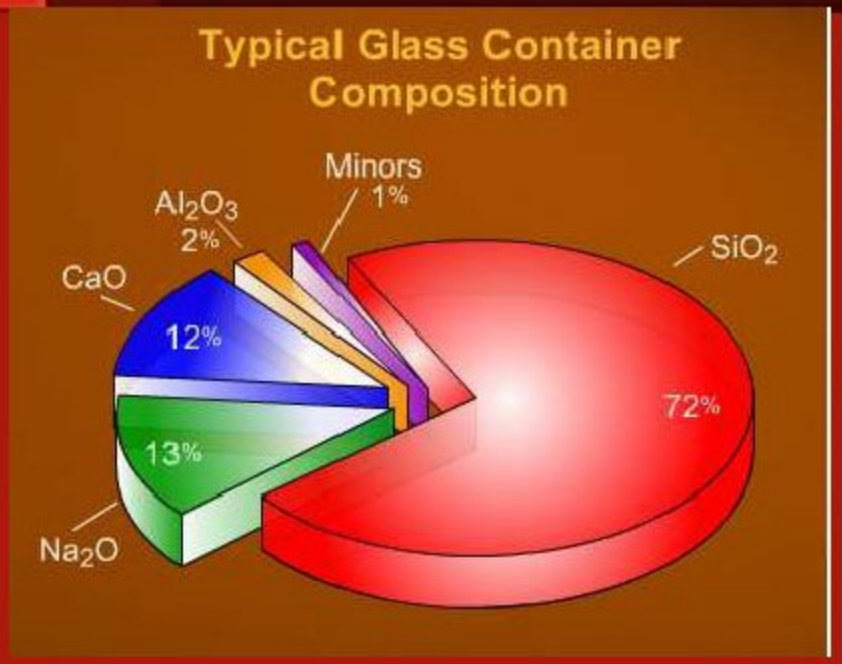
Properties of glass

Glass is:



- Amorphous
- Brittle
- Transparent / Translucent
- Good electrical insulator
- Unaffected by air, water, acid or chemical reagents except HF
- No definite crystal structure means glass has high Compressive strength
- Can absorb, transmit and reflect light

Raw materials used in manufacturing glass

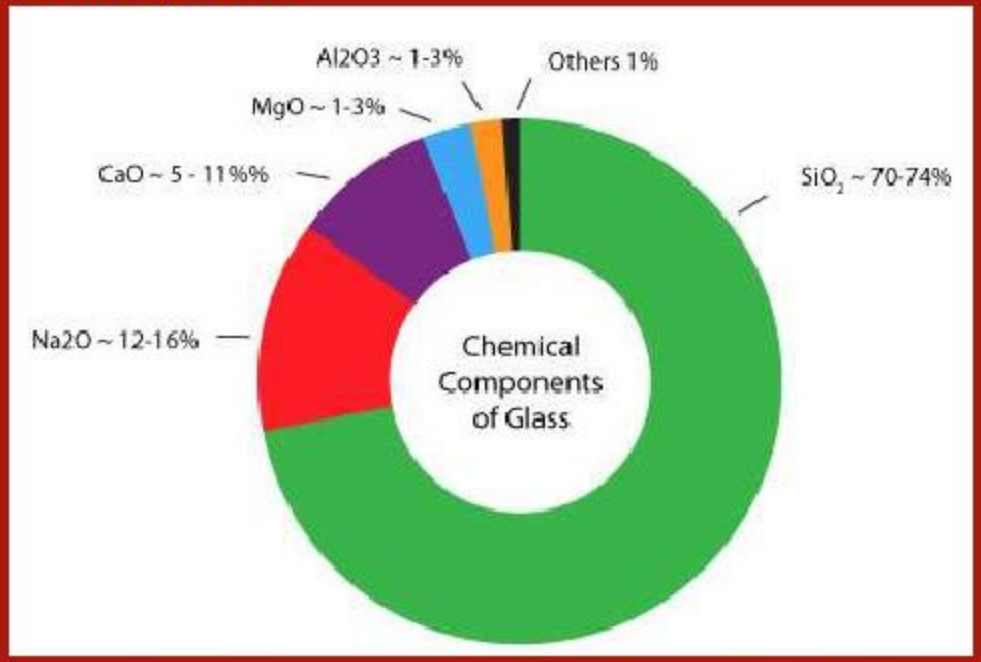


Raw Materials

- Sodium as Na_2Co_3 (used in soft glass).
- Potassium as K_2Co_3 (used in Hard Glass).
- Calcium as lime stone, chalk and lime.
- Lead as litharge, red lead (flint glass).
- Silica arc quartz, white sand and ignited flint.
- Zinc is zinc oxide (Heat and shock proof glass).
- Borates are borax, Boric acid (Heat and shock proof glass).
- Cullets or pieces of broken glass to increase fusibility.

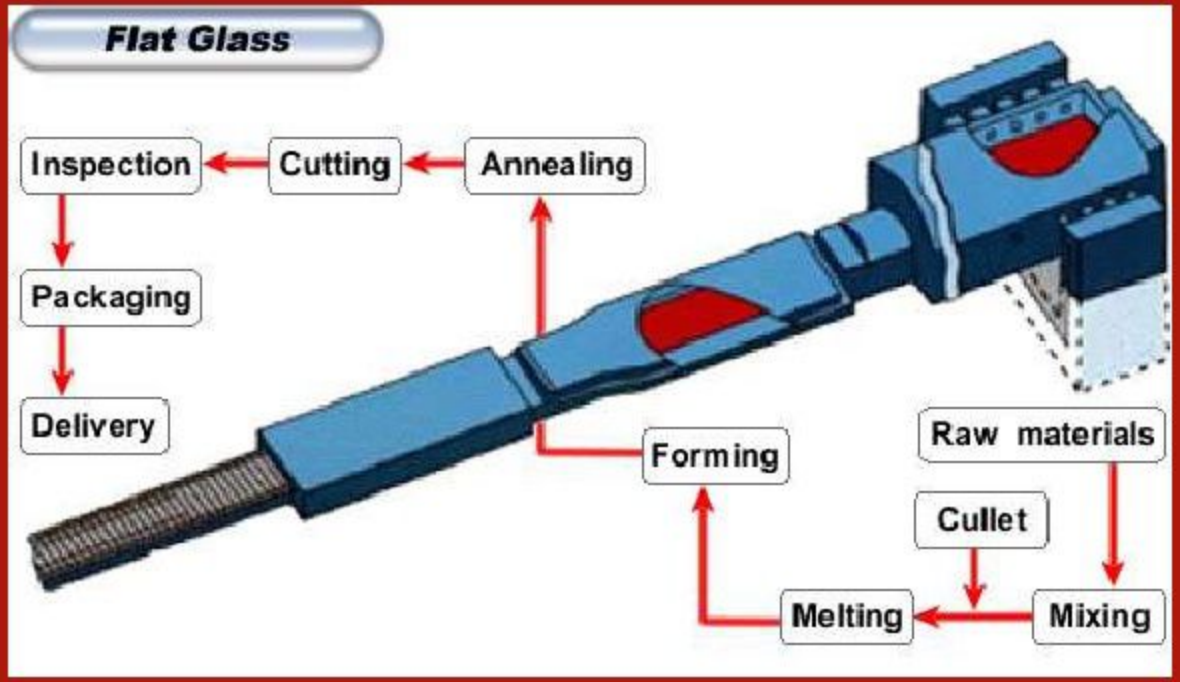
Glass Components

- **Formers – Network Formation**
  SiO_2, B_2O_3, P_2O_5, GeO_2, V_2O_5, As_2O_3, Sb_2O_5
- **Fluxes – Softeners**
  Na_2O, K_2O, LiO, Al_2O_3, B_2O_3, Cs_2O
- **Stabilizers – Provide Chemical Resistance**
  CaO, MgO, Al_2O_3, PbO, SrO, BaO, ZnO, ZrO



Manufacturing steps

- Melting
- Forming and Shaping
- Annealing
- Finishing



Melting process

Raw materials in proper proportions are mixed with cullets. It is finely powdered and intimate mixture called batch is fused in furnace at high temperature of 1800°C this charge melts and fuses into a viscous fluid.

$CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2\uparrow$

$Na_2CO_3 + SiO_2 \rightarrow Na_2SiO_3 + CO_2\uparrow$

After removal of CO_2 decolorizes like MnO_2 are added to remove traces of ferrous compounds and Carbon. Heating is continued till clear molten mass is free from bubbles is obtained and it is then cooled to about 800°C.

Forming, shaping, and annealing

- Forming and Shaping

  The viscous mass obtained from melting is poured into moulds to get different types of articles of desired shape by either blowing or pressing between the rollers.

- Annealing

  Glass articles are then allowed to cool gradually at room temperature by passing through different chambers with descending temperatures. This reduces the internal Strain in the glass.

finishing

Finishing is the last step in glass manufacturing. It involves following steps.

- Cleaning
- Grinding
- Polishing
- Cutting
- Sand Blasting

Varieties of glass

Soda lime or soft glass	Potash lime or hard glass	Lead glass or flint glass	Borosilicate or Pyrex glass
Alumino- Silicate glass	96% Silica glass	99.5% Silica glass(Vitreosil)	Safety glass
Optical or Crook's glass	Poly-crystalline glass	Toughened glass	Colored glass
Wired Glass	Glass Wool	Fiber glass	Photosensitive glass
Photo-chromic glass	Neutral glass	Laminated glass	Insulating glass

CEMENT

Definition:

"Cement is a crystalline compound of calcium silicates and other calcium compounds having hydraulic properties" (Macfadyen, 2006).

Another Definition:

Cement is a powdery substance made by calcining lime and clay, mixed with water to form mortar or mixed with sand, gravel, and water to make concrete.

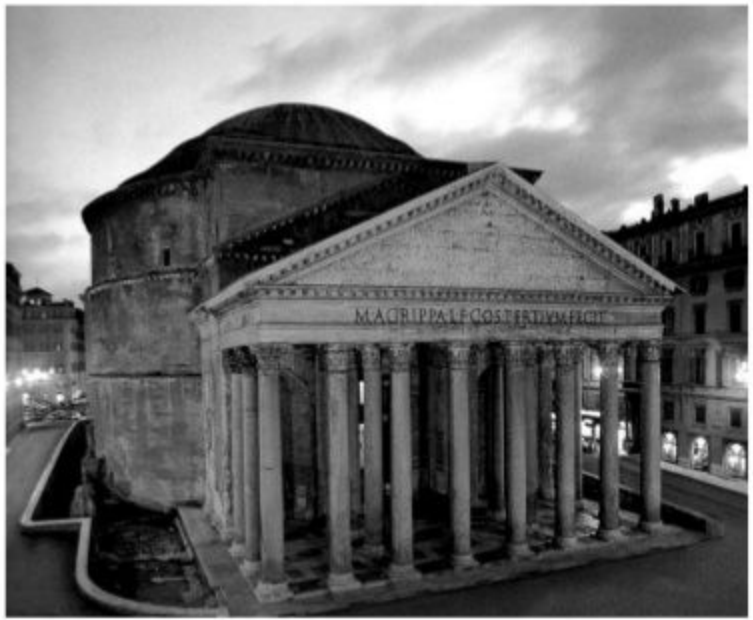
History:

The word "cement" can be traced back to the Roman word termed as ***Caementicium***,

Lime and clay have been used as cementing material on constructions through many centuries.

Best known surviving example is the **Pantheon in Rome**

In 1824 *Joseph Aspdin from England invented the Portland cement*



CEMENT INDUSTRY In Pakistan :

- Pakistan has inexhaustible reserves of limestone and clay, which can support the industry for another 50-60 years.

- The annual production of the cement at the time of the creation of Pakistan was only 300000 tones per year.

- At present there are more than 28 cement plants in Pakistan with installed capacity of over 19.5 million tonnes per annum. The present demand for cement in Pakistan is around 9.5 million tonnes per annum.

PORTLAND CEMENT

Portland cement is the most common type of **cement** in general use around the world, used as a basic ingredient of concrete, mortar, stucco(plaster), and most non-speciality grout.

SOURCE ROCKS

Calcareous Rocks(Limestone)

Argillaceous Rocks(Clay)

RAW MATERIALS:

Lime or calcium oxide, CaO: from limestone, chalk, shells, shale or calcareous rock

Silica, SiO_2: from sand, old bottles, clay or argillaceous rock

Alumina, Al_2O_3: from bauxite, recycled aluminum, clay

Iron, Fe_2O_3: from from clay, iron ore, scrap iron and fly ash

Gypsum, $CaSO_4.2H_20$: found together with limestone

GYPSUM

- The materials, without the gypsum, are proportioned to produce a mixture with the desired chemical composition and then ground and blended by one of two processes - dry process or wet process.
- The materials are then fed through a kiln at 2,600° F to produce grayish-black pellets known as **clinker.**

- The alumina and iron act as fluxing agents which lower the melting point of silica from 3,000 to 2600° F.
- After this stage, the clinker is cooled, pulverized and gypsum added to regulate setting time. It is then ground extremely fine to produce cement

Decomposition of raw materials -

- **Reactions at temperatures up to about 1300 °C**
- **It includes**

I. Water evaporation in the raw feed, if any.
II. Loss of carbon dioxide from the limestone (ie: calcining).
III. Decomposition of the siliceous and aluminosilicate fractions of the feed.
IV. Formation of a sulfate melt phase.
V. The decomposition products react with lime to form intermediate compounds which in turn form other compounds as clinkering proceeds.

$CaCO_3 \rightarrow CaO + CO_2$

The calcium oxide is then *spent* (slaked) mixing it with water to make slaked lime (calcium hydroxide):

$CaO + H_2O \rightarrow Ca(OH)_2$

Once the excess water is completely evaporated (this process is technically called *setting*), the carbonation starts:

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

Chemical Composition of Portland Cement:

- The proportions of these oxides determine the proportions of the compounds which affect the performance of the cement.
- Portland cement is composed of four major oxides (CaO, SiO_2, Al_2O_3, Fe_2O_3 ≥90%) & some minor oxides. Minor refers to the quantity not importance.

Compound Composition of Portland Cement:

- Oxides interact with eachother in the kiln to form more complex products (compounds). Basically, the major compounds of P.C. can be listed as:

Name	Chemical Formula	Abbreviations
Tri Calcium Silicate	$3CaO.SiO_2$	C_3S
Di Calcium Silicate	$2CaO.SiO_2$	C_2S
Tri Calcium Aluminate	$3CaO.Al_2O_3$	C_3A
Tetracalcium Aluminoferrite	$Ca_4Al_2Fe_2O_{10}$	C_4AF

Types of Cement Manufacturing Processes

- Wet Process
- Dry Process

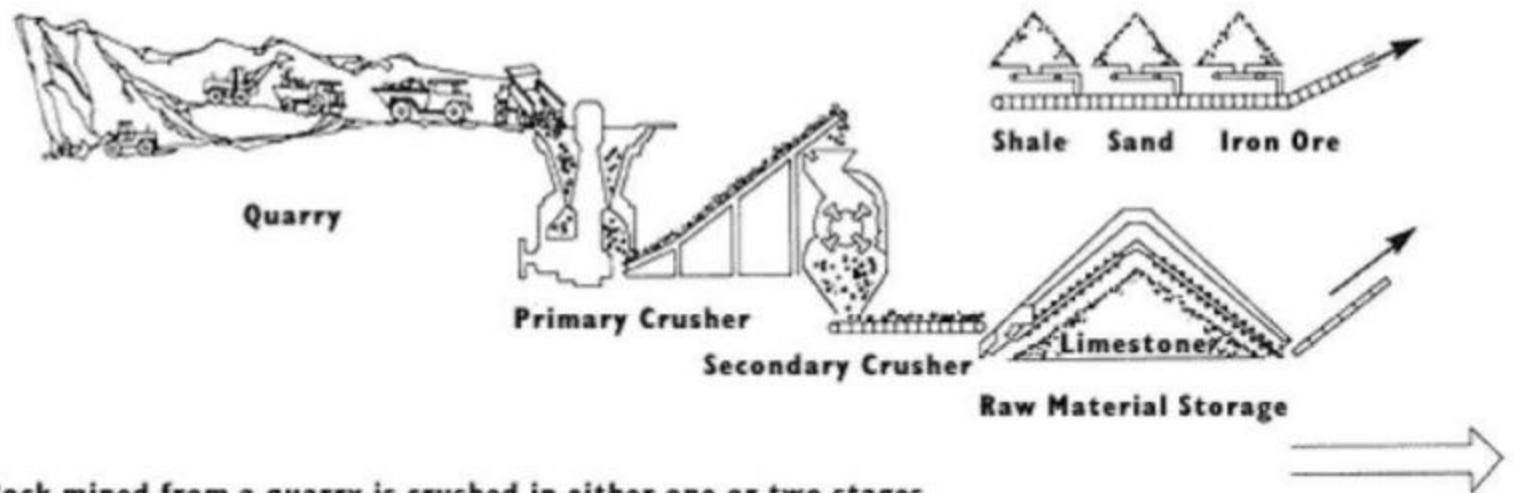
Comparison between wet and dry process

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

Manufacturing Process of Cement:

- Quarry
- Grinding
- Burning
- Grinding
- Storage
- Packing
- Dispatch

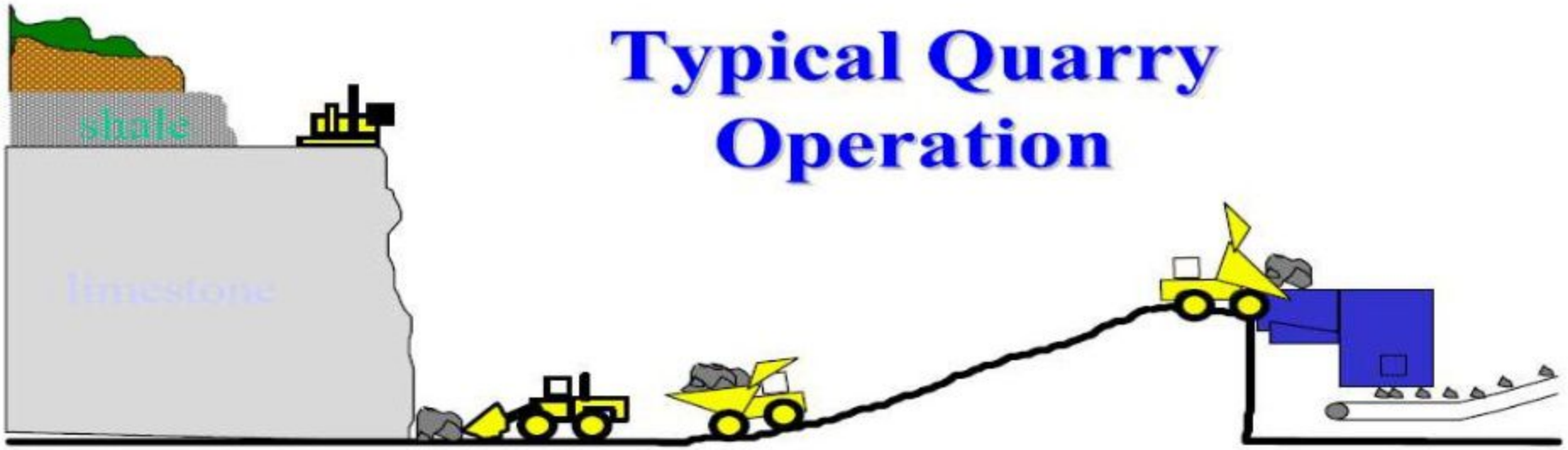
Steps in the Manufacture of Portland Cement



Rock mined from a quarry is crushed in either one or two stages, then stored with other raw materials to await further processing.

To Proportioning and Grinding

Typical Quarry Operation

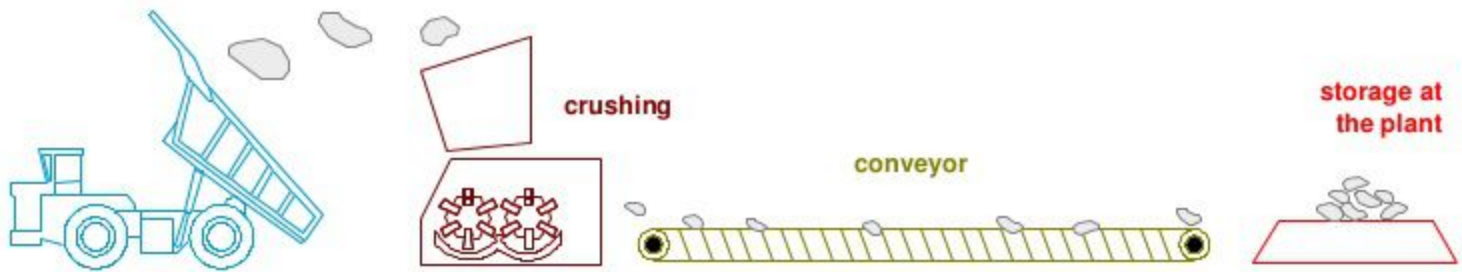


- Typically shale provides the argillaceous components:
  - Silica (SiO_2, Aluminum(Al_2O_3) & Iron (Fe_2O_3)
- Limestone provides the calcareous component:
  - Calcium Carbonate ($CaCO_3$)
- Raw materials may vary in both composition and morphology.

THE CEMENT MANUFACTURING PROCESS

1. BLASTING

2. TRANSPORT



3. CRUSHING & TRANSPORTATION

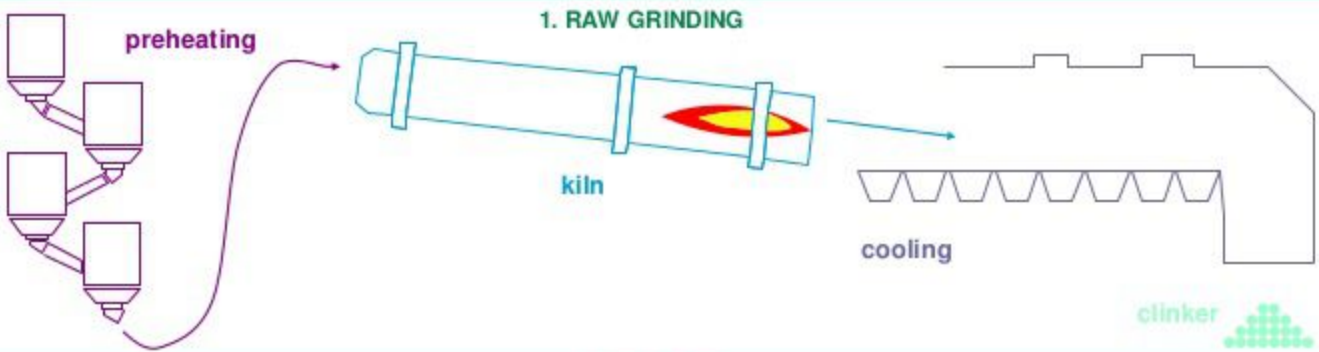
1. BLASTING : The raw materials that are used to manufacture cement (mainly limestone and clay) are blasted from the quarry.

2. TRANSPORT : The raw materials are loaded into a dumper.

3. CRUSHING AND TRANSPORTATION : The raw materials, after crushing, are transported to the plant by conveyor. The plant stores the materials before they are homogenized.

Next

THE CEMENT MANUFACTURING PROCESS



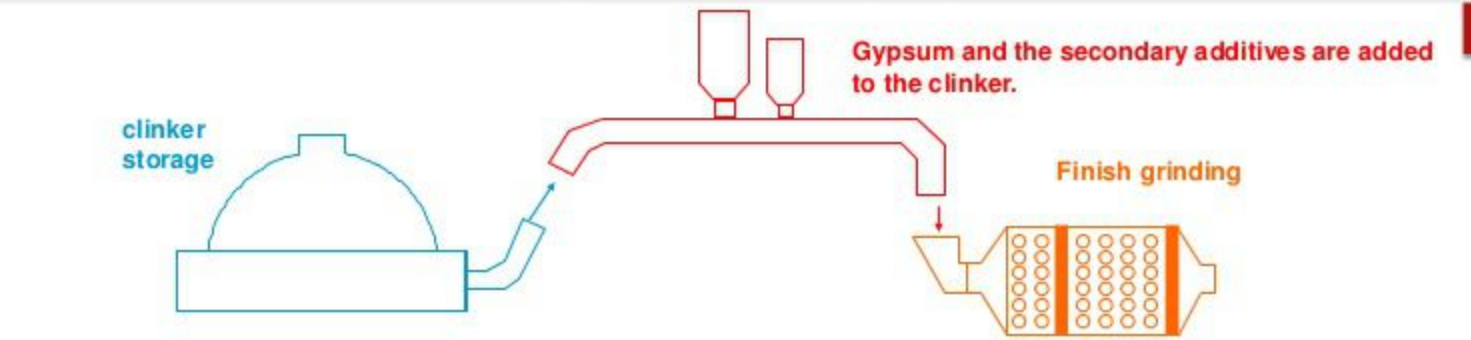
2. BURNING

1. RAW GRINDING : The raw materials are very finely ground in order to produce the raw mix.

2. BURNING : The raw mix is preheated before it goes into the kiln, which is heated by a flame that can be as hot as 2000 °C. The raw mix burns at 1500 °C producing clinker which, when it leaves the kiln, is rapidly cooled with air fans. So, the raw mix is burnt to produce clinker : the basic material needed to make cement.

Back Next

THE CEMENT MANUFACTURING PROCESS



1. GRINDING

2. STORAGE, PACKING, DISPATCH

1.GRINDING : The clinker and the gypsum are very finely ground giving a "pure cement". Other secondary additives and cementitious materials can also be added to make a blended cement.

2. STORAGE, PACKING, DISPATCH : The cement is stored in silos before being dispatched either in bulk or in bags to its final destination.

Back Home page

USES OF CEMENT:

- Cement is a very useful binding material in construction.
- It is used in mortar for plastering, masonry work, pointing, etc.
- It is used for making joints for drains and pipes.
- It is used for water tightness of structure.
- It is used in concrete for laying floors, roofs and constructing lintels, beams, stairs, pillars etc.