# CHAPTER 5

## CLAY AND CLAY PRODUCTS

**Clays: -** are finely grained soils resulted from decay of rocks. (They could be residual clays formed from the decay of the underlying rocks, or sedimentary if removed from the parent rock, transported and deposited somewhere else by water or wind.

- Chemical constituents of clay
  - The formation of hydrate of alumina silicate ($A1_20_3$. $2Sio_2.2H_20$) is, in fact, one of the commonest minerals in clay.
  - Silica ($Si\ O_2$)
  - Ferric Oxide ($Fe_2O_3$)
  - Lime (Cao)
  - Magnesia (Mgo)
  - Carbon dioxide ($Co_2$)
  - Alkalies, water, etc.

On account of the different phases they might have gone through and their history of formation, clays are generally found mixed with other materials (impurities) which influence their properties.

## BRICKS

- Are building materials manufactured from clays (raw material)
- Are most extensively used materials of construction because of their strength, durability, insulating property against heat and sound, & their being handy to work with and most availability near building sites at relatively cheap price.

### ***Raw material***

- A *clay soil for brick making should be such that when prepared with water*, it can be molded, dried and burnt with out cracking or changing its shape or wrapping. Such material should preferably have the following composition:

Clay 20 - 40%

Sand 30 - 50%

Others (lime, silt, cement, etc.) - 20 - 35%

Each of the components and their constituents play different rolls in the manufacture of bricks and influence the characteristics of the final product.

## ***Functions Of Constituent Materials***

a) **Alumina**: - is a fine-grained mineral, which makes the major part.

- Bec omes plastic when mixed with water and is capable of being molded to the desired shape. On drying it loses its plasticity and becomes hard. This can be accompanied with shrinkage, which might result in warping & cracking depending on the speed and magnitude of drying.
- When burnt, alumina becomes stronger and harder as a result of the homogeneity created by fusion. Bricks of very high alumina content are likely to be refractory.
- Thus form hard material when burnt & mixed with other constituents.

b) **Silica:** - course grained mineral, which can be present either in the form of pure sand or compound of silicate of alumina.

- is useful in reducing shrinkage & wrapping in burning.
- its presence in bricks produce hardness and durability; however, a large percentage of uncombined silica is undesirable because it leads to brittleness of the product.
- silica fuses only at very high temperature (which is lowered in the presence of alumina and iron oxide) and hence increases the refractoriness of low alumina clay and makes bricks resistant to heat. In fire bricks silica content may rise to 98%.

c) **Lime: -** When present in small quantities, lime acts as a flux and lower the fusion point of silica.

- It also acts as a binder to the clay & silica particles leading to greater strength.
- Excess of lime may cause the bricks to melt & loose their shape.

d) **Iron Oxide:-** Lowers fusion point of silica & the clay and hence helps the fusion of brick particles.

- Imparts the colour of the clay and the burnt product. (Light yellow to red depending on its percentage) .Higher % make bricks dark blue.
- The appropriate iron type should be used - eg. if iron present in the form of pyrites (sulphides of iron), it can get oxidized, crystallize and split the bricks to pieces.

e) **Magnesia:-** Usually present in small quantity (1%) in clay and together with the iron oxide, it gives the brick darker or even black colour.

- It also lessens wrapping of bricks in burning.

**MANUFACTURE OF BRICKS**

Raw material (clay) should be - excavated and crushed.

- made free of stones, boulders, coarse sand or lime.
- mixed with water to the desired consistency.

- Sandy soil and or lime may be added to the dry raw material if it is found deficient in silica and lime.
  - mix until the whole mass becomes homogenous and plastic(=**tempering**).
  - the tempered clay is then fed in to moulds made of timber or metal & pressed (hand **moulding**) or extruded through a rectangular hole( mechanical moulding) and cut to desired length. The brick at this stages called ***green brick***.
  - **Drying** green brick: giving strength to be handled &staked in kilns with out being damaged which is done in the open - air driers (open shades) or in drying zone of a continuous kiln.
  - **Burning: -** (900 - 1200$^0$c) in a kiln. Is required to make bricks stronger, harder, more durable and less absorbent. During burning - dehydration completed before

$100^0$c, oxidation completed at about $900^0$c, sintering if $T^o$ is raised to $1200^0$c.At these $T^0$ hard - burnt bricks are produced which contain melted components acting as binder to the non melted minerals.

***Hard burnt bricks: -*** are stronger and harder.

-more durable

- less absorptive on wetting with water.

- **Cooling:** two to three days for kiln burnt bricks
- **Then we have the brick.**

***Quality Of Bricks Depend On:***

- Constituent materials.
- efficiency of the kiln eg. bricks burnt at low $T^0$ will contain salts which when become in contact with water the salt dissolve & brought to surface and when the water evaporates the salt remain on surface. This is called efflorescence.
- mix proportioning (proportion of $H_2O$, Sand, Lime and additives).
- burning temperature.

**TYPES OF BRICKS**

Two types of clay bricks are manufactured in Ethiopia at present.

**These are** 1) Solid clay bricks

2) Hollow clay bricks and beam tiles

Nominal dimensions: 6 x 12 x 25 cm

Tolerance ± 0.25, ± 0.5, ± 0.81 cm

- **Hollow clay bricks and beam tiles**

a) with two faces keyed ( combed, or scared) for plastering or rendering.

b) with two faces smooth and suitable for use with out plastering or rendering on either side.

## CLASSES OF BRICKS

- **Adobe brick** - brick that is not burnt in a kiln at all.
  - traditional
  - adding lime increases bonding
- **Sand-lime brick** - not burnt at high temperature.
  - cement can sometimes be used.
- **Kiln burned brick** - brick burnt at high $T^0$.
- **Concrete bricks** - is like a concrete block
  - relatively coarser agg. (6mm $\phi$) is used.
  - are lighter in wt than concrete blocks - lees density.
  - are fire resistant.
  - less sound transmission.

## TYPES OF BRICKS (DEPENDING ON FUNCTION)

- **Common bricks** - for general building purpose.
- **Facing bricks –** with a better quality control - for better appearance.
- **Glazed face bricks** - have shiny characteristic due to spraying of some salts which results a shiny luster after burning.
- **Firebricks** - bricks for fire resistance.
  - dark in colour.
- **Paving bricks** - used in walkways, pavements.
- **Engineering bricks** - for use where high strength and / or low water absorption are required.
- **Efflorescence :** white salts brought to the surface by water and deposited after evaporation.
  - These salts may: o have an external origin (for example soil

water in contact with the brick work).

- be derived from mortar.
- be derived frequently in bricks them selves.

- may be disfiguring but often not harmful and disappears after a few seasons.

- Efflorescence salts usually contain substantial amounts of sulphates & there may be possibility of sulphate attack on susceptible mortar joints.

***Testing And Classification Of Bricks***

**Tests** - visual inspection - as shape, colour, blister, checks, cracks.

- Checking of dimension and plainness, compressive strength.
- Compressive strength.
- Water absorption
- Saturation coefficient
- Efflorescence - assed by repeated wetting and drying of test bricks.
- paint.