Lecture 1: BRICKS

Brick: Processed earth when burnt or baked in a particular shape is known as bricks.

Brick Earth:

- Composition
- Purpose
- Percentages

	Composition	Purposes	Percentages	Remarks
1	Alumina, A_2lO_3	Exists in all clays, give adhesion to the soil, excess amount produces cracks during burning	30 - 35	
2	Silica, SiO_2	Reacts with alumina and forms silicates of alumina or exists as free sand, excess amount makes brick fragile	50 – 55	
3	Iron oxide	Imparts colour, prevents water absorption and gives permanency	2 – 5	
4	Lime, CaO	Enables silica to melt at furnace heat and thereby binds the brick particles together, excess lime damages shape of bricks	1 – 2	
5	Magnesia, MgO	Small amount decreases shrinkage and gives a yellow tint to the bricks		
6	Slight alkali and organic compounds	Helps burning of bricks and excess causes bricks to melt and damage the shape		

Requirements of Good Brick Earth:

- Must have proper proportion of sand, silt and clay
- Must be homogeneous
- Should have sufficient plasticity
- Must be free from lumps of lime or nodules of kankar
- Must be free from earth containing alkaline salts
- Must be free from pebbles, grits and lumps of earth
- Must not contain vegetable and organic matter
- Should not be mixed with salty water

Manufacture of Bricks:

- Selection of brick earth
    - Appropriate soil
    - Soil should posses all good qualities
    - Tested to find composition
    - Tested by making a few bricks
- Preparation of brick earth
    - Selection of site ~ WT 1m below floor, availability of soil, access to transport
    - Unsoiling ~ removal of top layer of 200 mm in depth
    - Digging & weathering ~ soil is dug, laid on leveled ground, sand and other materials are mixed at this stage, left to weathering for few months
    - Clearing from stones ~ if small amount, picked up by hand, large amount sieved
    - Grinding ~ brick is ground to powder by clay crushing roller
    - Tempering ~ ground earth is watered, kneaded to a homogeneous mass and cured for moulding either by hand or by using pugmills

- **Moulding,** methods are,
  - Hand moulding
    - On ground or
    - On table
  - Slop moulding
  - Sand moulding
  - Box moulding
  - Machine moulding
    - Plastic clay machine
    - Dry clay machine

- **Drying**
  - Factors for drying
    - Temperature
    - Humidity
    - Air movement
    - Moisture in wet bricks
    - Heating on the exposed surface

  - Drying is accompanied by shrinkage
    - Depends on type of clay
    - Plasticity
    - Soft clay shrinks 10%
    - Stiff clay shrinks 5%

  Methods of drying:

  - Natural drying ~ hack drying, arranging wet bricks in rows on their edges, may be under temporary shed
  - Artificial drying

    - For large scale drying
    - For rapid drying
    - Heated in special chambers or tunnels

- Burning of bricks ~ a well burnt brick is sound compact, uniform in texture and weathering agents such as temp., rain, wind have almost no effect on it, so burning

  - Imparts hardness and strength
  - Increases density and thereby durability

- During burning, at about 1200^{o}F chemically combined water is removed, organic matter contained in the brick earth is oxidized. At about 2000^{o}F, certain chemical changes take place between constituent minerals. Two important constituent of brick clay, namely, alumina and sand, bind themselves together resulting in the increase of strength and density of bricks. Further heating is not desirable as a great amount of fusible glassy mass is formed and the bricks are said to be vitrified which produces shapeless bricks.

Methods of Burning: Bricks are burnt in kilns which are,

  - Clamp or open kilns
  - Intermittent kilns
    - Up-draught type
    - Down-draught type
  - Continuous kilns

۞ **Manufacturing process is continuous with the operations of**

- Loading
- Drying
- Preheating
- Burning
- Cooling and
- Unloading are kept continuous

۞ Types of continuous kilns are,

- Bull's trench kiln - underground
- Hoffman's kiln - overground
- Tunnel kiln - underground

۞ Hoffmans Kiln: An annular continuous kiln is suggested by a Berlin Master Builder Friedrich Hoffman in 1856. Viennese City Councillor A. Licht also contributed to building this exiting phase in the history of brick firing technology.

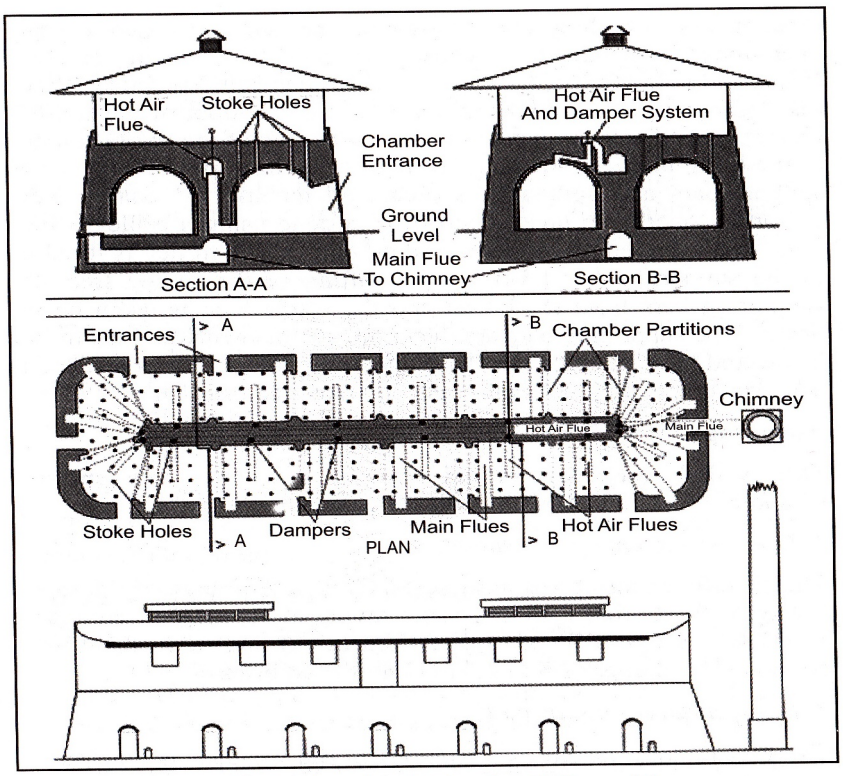


Fig.7.6 A modern 16 chamber Hoffmann kiln

Advantages of Hoffman's kilns:

- They are fuel efficient
- They have capacity to fire large quantities of bricks evenly with minimal wastage
- Down or cross draught system provides an even firing throughout he kiln
- Firing can be controlled from outside

Disadvanges:

- Expensive to build and needs regular maintenance
- Occupy lot of spaces
- Some bricks get overburnt directly beneath the stockholes

Comparison:

- Clamp burning is cheap, for small number and produces less good quality bricks
- Continuous kilns are expensive, for large numbers, continuous operations, produces high number of good bricks
- Continuous kilns are described in any Engg Material book
- Hoffman's kiln are mostly used in modern brick burning.

Question: Why is burning necessary? What happens during burning?

Requirements of Good Bricks:

Qualities of good bricks: Bricks to be used in important structures

- Should be uniform and bright in color, uniform in shape and size
- Should give a clear metallic ringing sound when struck with each other
- Should not break into pieces when dropped flat on hard ground from a height of 1 m.
- Should have low thermal conductivity and be sound proof.
- Should be hard, compact, durable and have no cracks or holes
- Should not absorb more than $1/6^{th}$ of its weight when submerged under water for 24 hrs
- Will not increase in volume when under water
- Should have low salt content to prevent efflorescence
- Should be neither overburnt or underburnt
- Should be non-inflammable and incombustible
- Should be of required weight and strength

Strength of bricks depend on the following factors,

- Composition of brick earth
- Preparation of brick clay and blending of ingredients
- Nature of moulding adopted
- Care taken in drying and staking of raw bricks
- Type of kiln and fuel used and its feeding
- Burning and cooling processes
- Care taken in unloading

Shape and Size: Shape and size depends on,

- The custom of the country
- Whims of the makers, and
- The type of usage

In Bangladesh context, 9.5 X 4.5 X 2.75 inch bricks are usually manufactured.

BDS 208:2002 in clause 3.1 states the standard dimension of common burnt clay bricks in Table 1

as length = 24 cm, Width = 11.5 cm, Height/Depth = 7 cm

Question: What are the requirements of good bricks in building construction? What is the standard size of bricks?

Classification of Bricks: Well burnt bricks are commercially classified as

¤ First class ¤ Second class ¤ Third class

Overburnt bricks are classified as jhama bricks which are divided into,

- Picked jhama
- Lump jhama
- Spongy jhama, and underburnt bricks are called pila bricks

BDS 208: 2002 classified bricks as per strength and water absorption in clause 4 and 5 as,

Grade	Strength, mean for twelve halved bricks	Min. strength for individual halved bricks	Maximum water absorption
S	280 kg/cm^2	245 kg/cm^2	10 %
A	175 kg/cm^2	154 kg/cm^2	15%
B	140 kg/cm^2	105 kg/cm^2	20%

BDS 208:2002 also specifies the method for measuring size and testing for strength and water absorption. Appendix B contains field tests of bricks for dimension, water absorption and efflorescence.

Besides, there are ISI and BSI classification of bricks.

Characteristics of commercial classification is **described in Aziz's book**.

Special Types of Bricks:

These bricks differ from the commonly used building bricks with respect to their shape, specifications and special purpose for which they are made. The types are,

- Specially shaped bricks
- Burnt clay facing brick
  - To use in the exposed face of masonry without any further surface protection
  - Economical for frequent renewal of plastering and for high rise buildings
- Heavy duty bricks: these are characterized by
  - High compressive strength
  - Low water absorption
  - High durability
  - High bulk density
  - Are used in bridge structure, multistoried buildings and in industrial foundations
- Perforated bricks
  - Contain cylindrical holes throughout their thickness
  - Light in weight
  - Easy to burn
  - Are used in panel walls and partition walls
- Sand lime bricks
  - Are also called calcium silicate brick
  - Are used in masonry construction

- Sewer bricks
    - Are manufactured from surface clay, fire clay or shale or a combination of these
    - Intended for lining of walls roofs and floors of sewers

- Acid resistant bricks
    - Are made of clay or shale of suitable composition with low lime and iron content, feldspar, flint or sand and vitrified at high temperatures in a ceramic kiln
    - Are used for masonry constructions, floorings subject to acid attacks, lining of chambers and towers in chemical plants, lining of sewers carrying industrial effluents

- Refractory bricks: made from refractory clays which can withstand very high temperature without becoming soft on melting

- Paving bricks

    - Made from clay containing high percentage of iron to make air free
    - Machine moulded and burnt in continuous kiln
    - Unaffected by weather and traffic wear
    - Possess high resistance to impact and abrasion
    - Dense, compact, strong and less absorptive

Testing of Bricks:

The following are the tests for good building bricks.

1. **Shape and size**: discussed earlier

    - Test for warpage: is measured with the help of a flat surface of steel or glass and a steel measuring rule or wedge.
        - For concave warpage: departure of brick surface from the plane surface is measured at different locations by the wedge, avg. of the readings is reported as the concave warpage
        - For convex warpage: brick is placed on the plane surface with the convex surface in contact, the departures of the corners from the surface are measured, the largest departure is reported as convex warpage.

2. **Compressive strength**

    a. ASTM requires 5 specimens of halved bricks

    b. BDS 208: 2002 requires 12 halved bricks, immersed in water at 15-20^{o}C for 24 hrs, drained for 5 minutes after removing, frogs filled with 1:1.5 cement sand mortar, stored in damp for 24 hrs, immersed in water for 6 days, area measured, tested mortar face upward between plywood sheets (ASTM capping required) with rate of loading of 140 kg/cm^{2} or 2000psi per minute. BDS208:clause 7)

3. **Water absorption**: ASTM requires 5 halved bricks, BDS requires 6 whole bricks (BDS 208: clause 8)

4. **Efflorescence:** BDS 208:2002 clause 10

5. **Other tests**

    a. Transverse strength
    b. Porosity and permeability
    c. Presence of soluble salts
    d. Resistance to weathering

e. Thermal conductivity and sound insulation
f. Fire resistance
g. Expansion of bricks

Field Tests of Bricks: field tests for 1st class or class 'S' bricks are,

- When struck, metallic sound and no breakage
- No scratching marks by nails
- Does not break when dropped on hard floor from 2 m
- T – test: two bricks as T shape when dropped from 2 m height do not break

Uses of bricks:

- Construction of walls
  - Load bearing
  - Non-load bearing
  - As facing material
- Paving purposes
  - As blocks on top of a cushioning course
  - As brick soling
- Production of aggregates
  - For roads
  - For structural concrete

Brick Masonry:

As load-bearing wall material, bricks should possess

- Required strength
- Good appearance, and with
- Appropriate protection of wall surface

Bricks as facing material require,

- Accurate bonding, and
- Careful control of mortar joints

Standard boding techniques are,

- English bond
- Flemish bond
- Rat-trap bond
- Quetta bond
- Stretcher bond

Brick Aggregates: Bricks are crushed by crusher or manually to small sizes in order to use as alternative for natural aggregates in Bangladesh. The crushed brick aggregates is largely used in road base subbases and for the manufacture of brick aggregate concrete.