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COIMBATORE

DEPARTMENT OF CIVIL ENGINEERING

19GET102 – BASIC CIVIL AND MECHANICAL ENGINEERING

I YEAR / I SEMESTER

BRICKS

WHAT IS BRICK?

- A brick is building material used to make walls, pavements and other elements in masonry construction. Traditionally, the term brick referred to a unit composed of clay, but it is not used denote any rectangular units laid in mortar.

INTRODUCTION

Bricks are made chiefly from clay and shale.

- Clay is plastic earth, is constituted largely of sand an alumina and may contain various quantities of chalk, iron, manganese, dioxide, etc.
- Shale is soft finely stratified sedimentary rock that formed from consolidated mud or clay and can be split easily into fragile plates

Shale

Clay

STRENGTH OF BRICKS

Following factors affect the strength of bricks:

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

ADVANTAGES OF BRICKS

- Better thermal insulation
- Economical
- Masonry is easier, faster and stronger
- Bricks have greater fire resistance
- Its size enables easy handling and placement in walls.
- It can be easily adapted to small scale and large scale structure to give pleasing appearance and texture.
- It enhances good sound absorption
- Very low maintenance cost is required

DISADVANTAGES OF BRICKS

- Time consuming construction
- Cannot be used in high seismic zones
- Very less tensile strength
- Since bricks absorbs water easily, therefore it causes fluorescence when not exposed to air
- Rough surfaces of bricks may cause mould growth if not properly cleaned

PROPERTIES OF BRICKS

- Colour
- Texture
- Porosity
- Fire resistance
- Size variations
- Compressive strength
- Absorption

USES OF BRICKS

1. Construction of walls of any size.

2. Construction of floors.

USES OF BRICKS

3. Construction of arches and cornices.

4. Construction of brick retaining wall.

USES OF BRICKS

5. Manufacture of surkhi (powder bricks).

6. Staircase

USES OF BRICKS

7. Foundation.

8. Masonry veneer walls.

CLASSIFICATION OF BRICKS

Bricks used in construction works are burnt bricks and they are classified into the following four categories.

Burnt bricks	Unburnt bricks

↓

First class bricks
Second class bricks
Third class bricks
Fourth class bricks

CLASSIFICATION OF BRICKS

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First class bricks:

- These bricks are table- moulded and of standard shape.
- The surfaces and edges of the bricks are sharp, Square, smooth and straight.
- They complete with all the qualities of good bricks.
- These bricks are used for superior work of permanent nature.

CLASSIFICATION OF BRICKS

Second class bricks:

- These bricks are ground moulded and they are burnt in kilns.
- The surface of these bricks is some what rough and shape is also slightly irregular.
- These bricks are commonly used at places where brickwork is to be provided with a coat of plaster.

CLASSIFICATION OF BRICKS

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Third class bricks:

- These bricks are ground moulded and they are burnt in clamps.
- These bricks are not hard and they have rough surfaces with irregular and distorted edges.
- These bricks gives dull sound when stuck together.
- They are used for unimportant and temporary structures and it places where rainfall is not heavy.

CLASSIFICATION OF BRICKS

Fourth class bricks:

- These bricks are used as aggregate for concrete in foundation, floors, roads etc.
- These bricks are over burnt with irregular shape and dark in colour.
- Because of the fact that the overburnt bricks have a compact structure and hence, they are sometimes found to be stronger than even the first class bricks.

TYPES OF BRICKS

1. Ordinary bricks: They are rectangular solids.

2. Curved sector bricks: these bricks are in the form of curved sector and they are used in the construction of circular brick masonary, pillars, brick chimneys.

TYPES OF BRICKS

2. Curved sector bricks:

TYPES OF BRICKS

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3. Channel bricks: these bricks are moulded to the shape of a gutter or a channel and they are very often glazed. These bricks are used to function as drains.

TYPES OF BRICKS

4. Coping bricks: these bricks are made of suit the thickness of walls on which coping is to be provided. Such bricks take various forms such as chamfered, half round or saddle-back.

TYPES OF BRICKS

5. Bull nose bricks: A brick moulded with a rounded angle is termed as a "bull nose". It is used for a rounded quoin. A connection which is formed when a wall takes a turn is known as a quoin. The centre of the curved portion is situated on the long centre line of brick.

TYPES OF BRICKS

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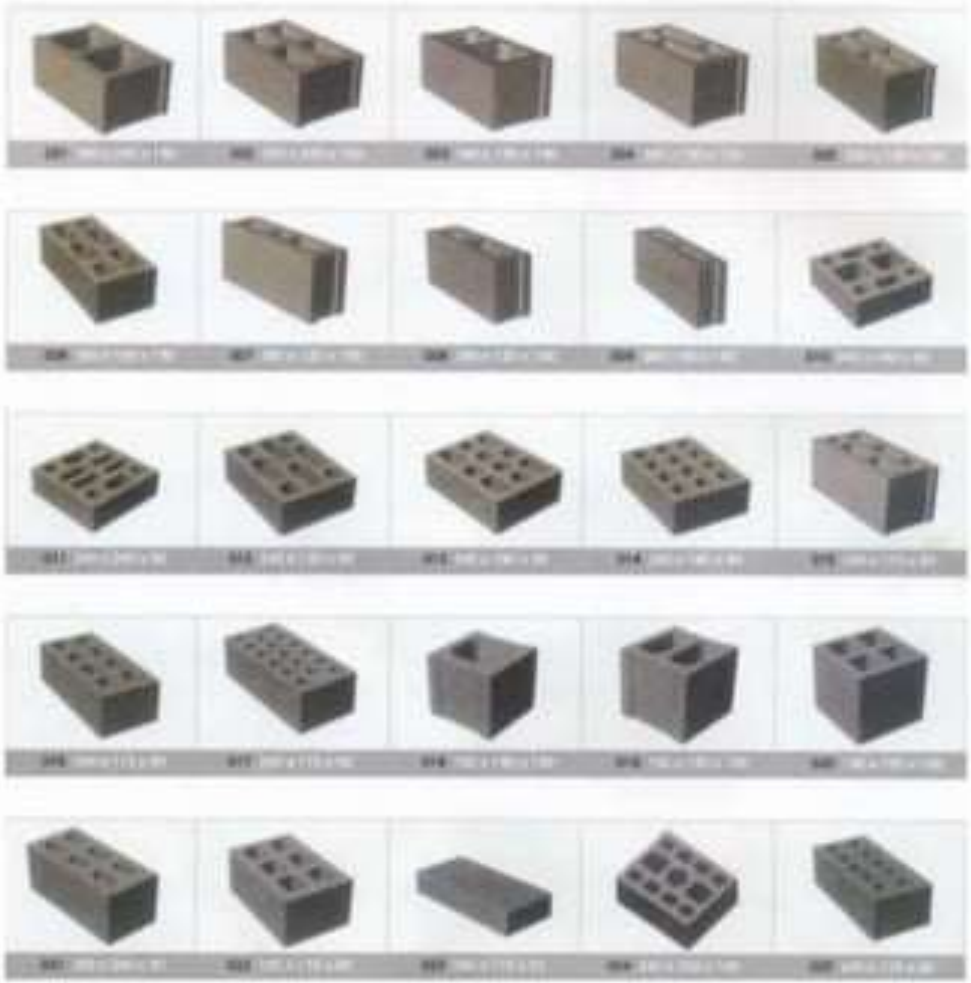
6. Hollow bricks:

- These are also known as cellular or cavity bricks.
- Such bricks have wall thickness of about 20 cm to 25cm.
- They are prepared from special homogeneous clay.
- They are light in weight about one-third the weight of the ordinary brick of the same Size.
- These bricks can be laid almost about four times as fast as they ordinary bricks and thus the use of such bricks leads to speedy construction.
- They also reduce the transmission of heat, sound and damp. They are used in the construction of brick partitioning.

TYPES OF BRICKS

6. Hollow bricks:



TYPES OF BRICKS

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7. Paving bricks:

- These bricks are prepared from clay containing a higher percentage of iron.
- Excess iron vitrifies the bricks at a low temperature.
- Such bricks resists better the abrasive action of traffic.
- Paving bricks may be plain or chequered.

TYPES OF BRICKS

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8. Perforated bricks:

- These bricks contain cylindrical holes throughout their thickness.
- these bricks are light in weight and they require less quantity of clay for their preparation.
- The dying and burning of these bricks are also easy.
- The perforated bricks are used in the construction of brick panels for light weight structures and multistoried framed structure.
- The perforation may be circular, square, rectangular or any other regular shape in cross section.

TYPES OF BRICKS

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9. Purpose-made bricks:

- In order to achieve certain purpose, these bricks are made.
- The arch brick are made of wedge shape to keep mortar joint of uniform thickness.
- The ornamental brick are prepared for corbels, cornices.
- The gutter bricks are used to construct gutter.
- The plinth bricks are used to emboss the plinth level.
- These bricks are usually more costly than the ordinary bricks but they grant safe,
- clean and quick construction.

TYPES OF BRICKS

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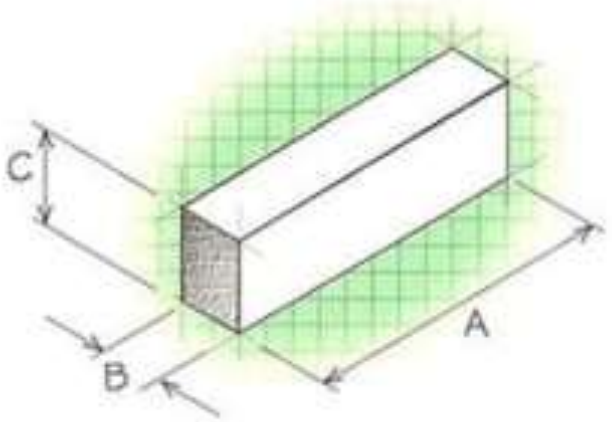
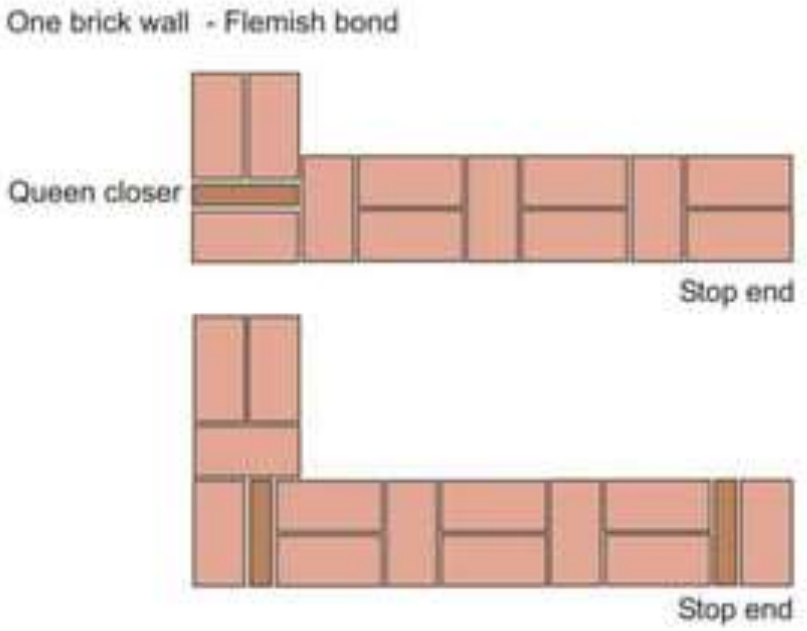
10. Queen closer bricks:

- The queen closer is usually placed next to the first brick in header course. The queen closer-1/2 is obtained by cutting an ordinary brick into half bats and then splitting one into half.
- The queen closer quarter is more often used than queen closer-half as it is easier to cut, all though it is generally produced a 56mm wide continuous vertical joint.





TYPES OF BRICKS

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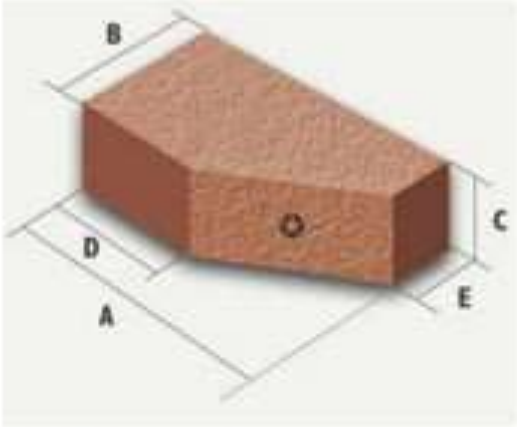
11. King closer bricks:

The king closer is formed by removing a corner and leaving half-header and half stretcher faces.



12. Mitred bricks:

These are used only in exceptional cases when the ends are required to be mitred.

13. Splay bricks:

These are used only in exceptional cases when the ends are required to be mitred.

TYPES OF BRICKS

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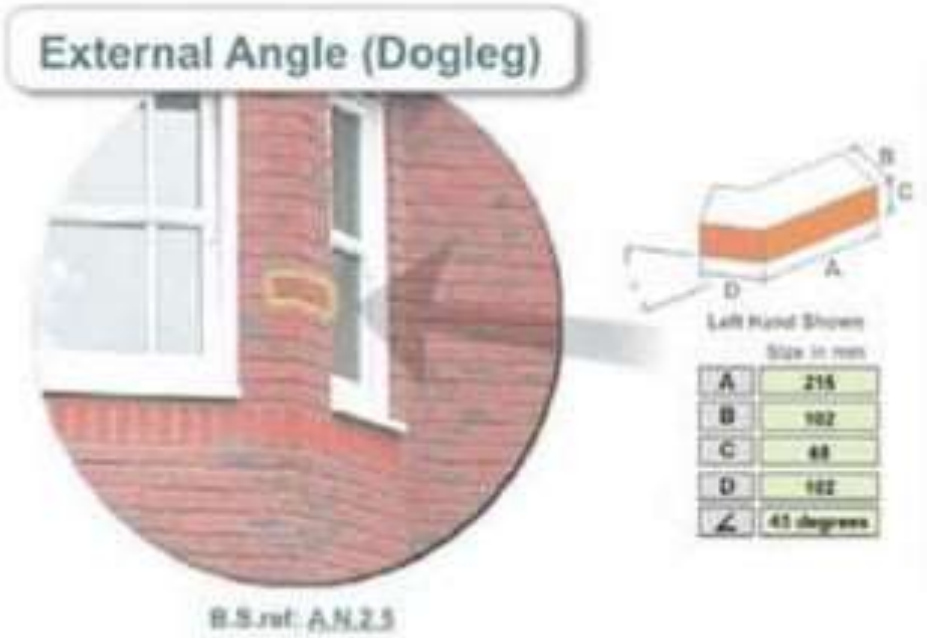
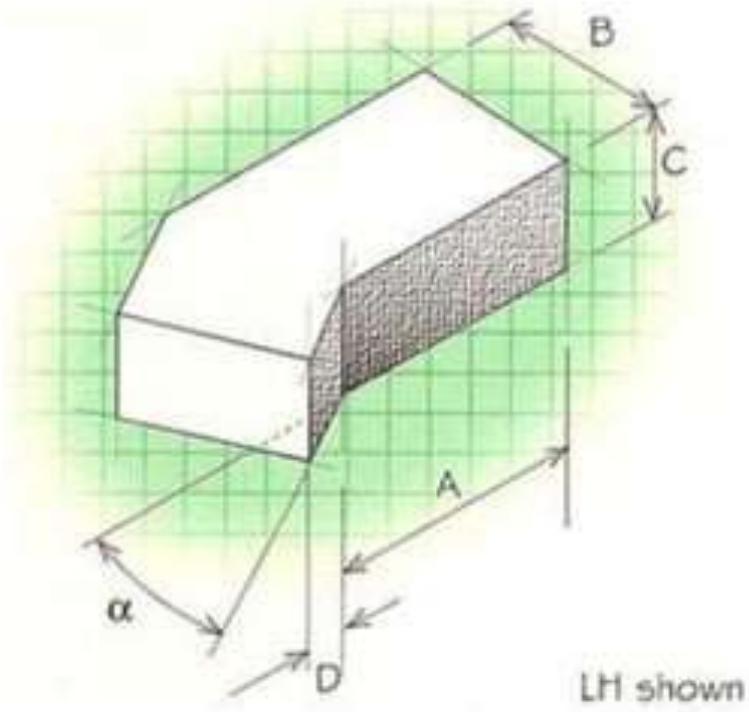
14. Dogleg / angle :

- This brick are used to ensure a satisfactory bond at quoins which depart from a
- right angle and to be prepared to the mitred closers.
- The angle and lengths of faces forming the dogleg vary.





TYPES OF BRICKS

15. Wirecut

The clay is continuously extruded to a required size and shaope and then cut into individual bricks by means of a wire, much like a cheese is cut by cheesewire. Thousands of variations in colour and texture. Usually the cheapest facings available as the manufacturing process is highly automated.

TYPES OF BRICKS

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16. Stock

The clay is wetted to a so-called "soft mud" and then moulded to shape, before being allowed to dry prior to firing in the kiln. Much of the process is automated. Tend to be slightly irregular in shape. Usually a bit more expensive than wirecuts.

17. Handmade

Usually made on a bench, in a mould, much as described above for a stock brick Because the clay isn't firmly compacted by machine, each brick normally has distinctive creasing known as a 'smile'. Very desirable, and the most expensive of the facings, but well worth it on prestige jobs.

CHARACTERISTICS OF BRICKS

- Good bricks should be thoroughly burnt, this makes them hard and durable
- A hard ringing sound emitted when two bricks are stuck together indicates that they have been brunt satisfactorily.
- Bricks should be true to size and shape, with straight edges and even surfaces.
- They should be free from cracks, chips, and larger particles of lime.
- Brick when broken should show a bright homogeneous and compact structure free from voids.
- Brick should not absorb water more than 20% by weight for 1st brick and 22% by weight from 2nd brick, when soacked in cold water for a period of 24 hours.

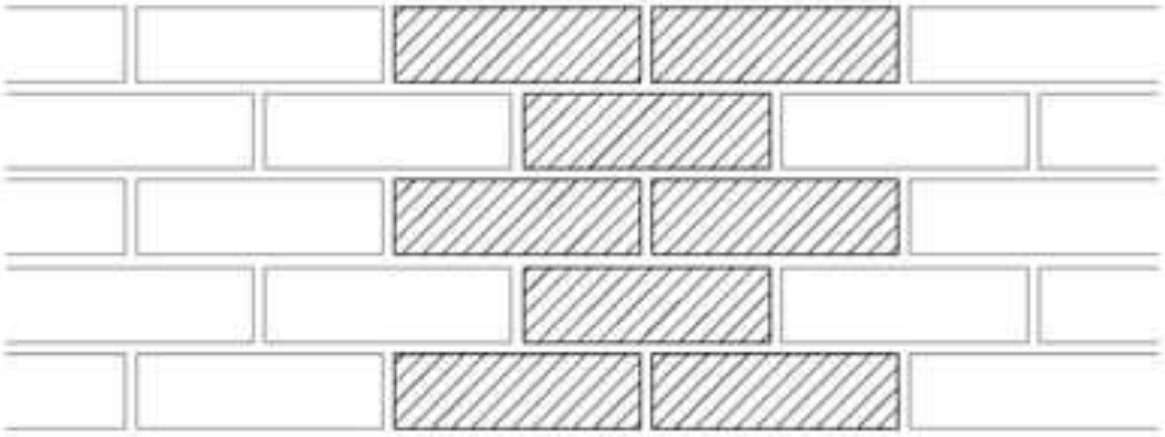
CHARACTERISTICS OF BRICKS

- No impression should be left on brick surface when it is scratched with finger nail.
- Brick should not break when dropped flat on hard ground from a height of about 1m.
- Bricks should have low thermal conductivity and they should be sound proof.
- Brick when soacked in water for 24 hours should not deposited of white salt when allowed to dry in shape.

BRICK BONDS

Stretcher Bond

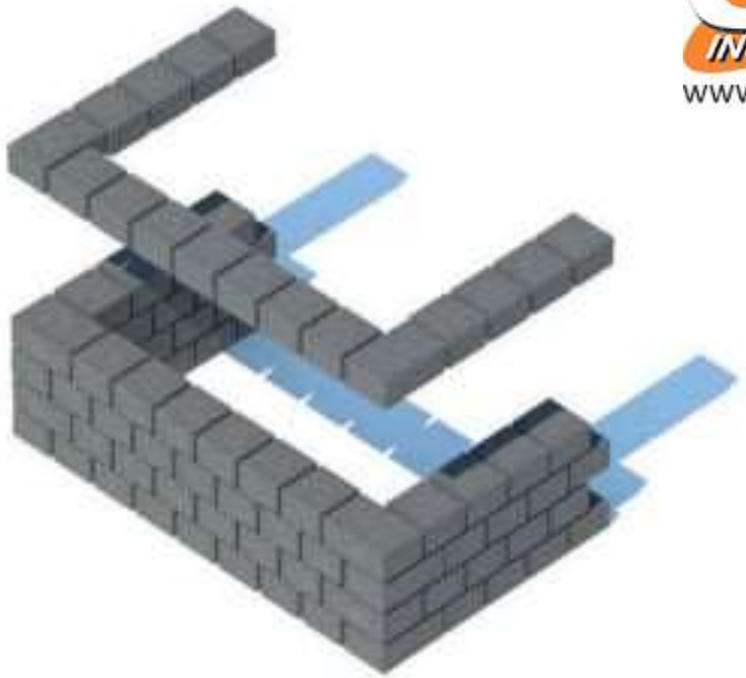
Originally used for single brick walls, it became the obvious choice for cavity walls with the least amount of cutting required. It is therefore the most economical bond pattern and is extensively used in modern building.

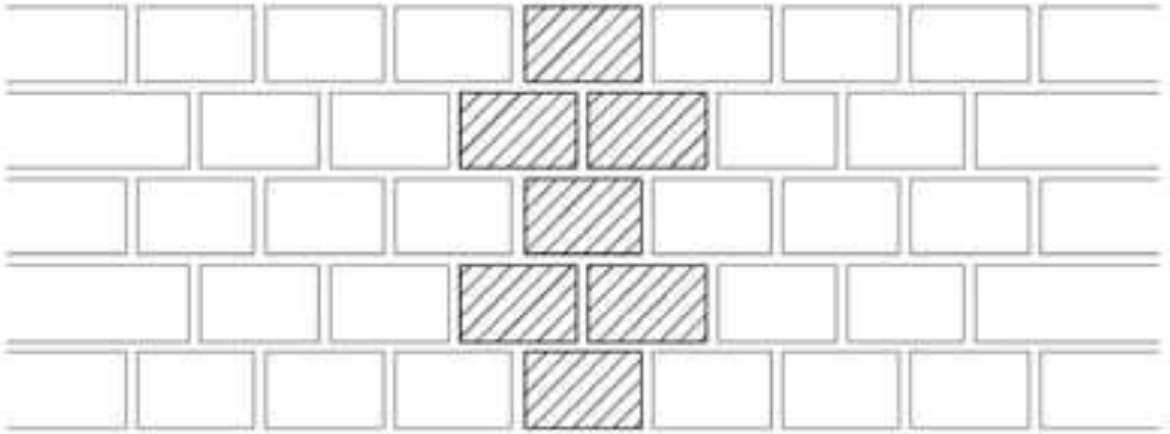


BRICK BONDS

Header Bond

A brick course laid flat with the short end of the brick exposed. This method is particularly strong as the width of the wall is the whole length of a brick. Historically it was used for buildings of high quality, often used for curved brickwork.





BRICK BONDS

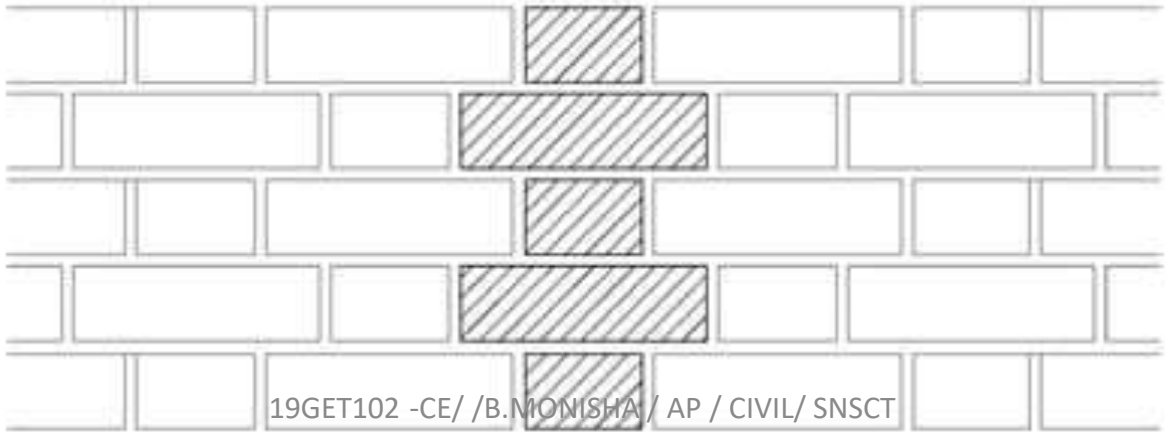
English Bond

It comprises of alternative courses of headers and stretchers. It provides a strong bond when the wall is one brick thick. It is the preferred bonding pattern for bridges, viaducts, embankment walls and other civil engineering architectures

BRICK BONDS

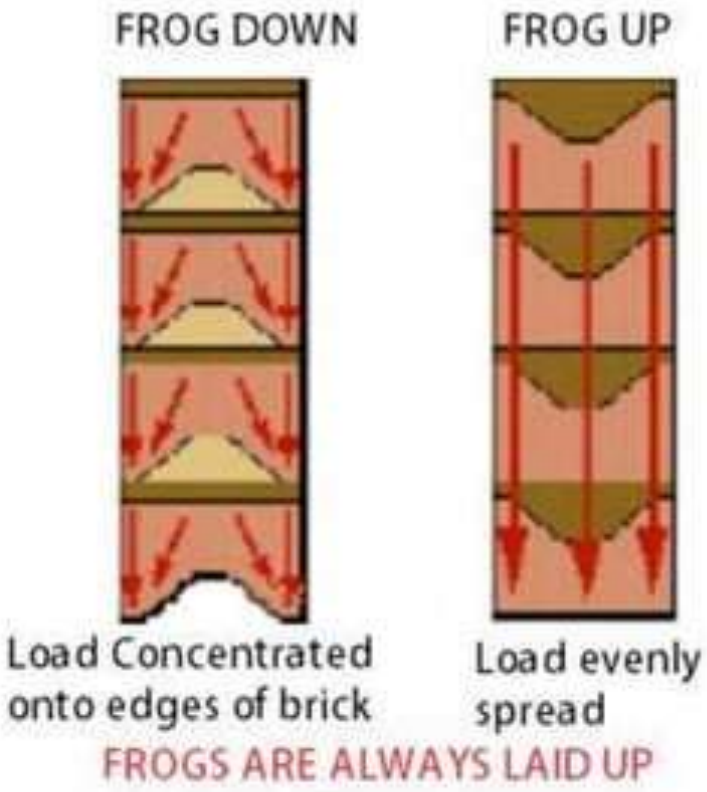
Flemish Bond

Flemish bonds can be replicated in the half-brick outer leaf of a cavity wall by using whole bricks as stretchers, while the headers are created by half bricks called bats or snap-headers. It is not as strong as English bond at one brick thick.



BRICK BONDS

With solid or perforated bricks, the orientation of the brick doesn't matter, but with frogged bricks, the frog should always be laid uppermost. This ensures that the loading of the wall is evenly spread across its width, rather than being concentrated onto the edges, and that there are no voids within the brickwork that could be weak spots.



MANUFACTUCTING PROCESS

MANUFACTURE OF CLAY BRICKS

1. **Preparation of brick clay**
   - Unsoiling, Digging , Cleaning, Weathering , Blending , Tempering
2. **Moulding the bricks**
   - Hand Moulding , Machine Moulding
3. **Drying the bricks**
   - Natural , Artificial
4. **Burning the bricks**
   - Burning in clamps, Burning in klins

MANUFACTUCTING PROCESS

- Raw material is dug out of the ground

MANUFACTUCTING PROCESS

SITE FOR OBTAINING CLAY/ EARTH

DIGGING

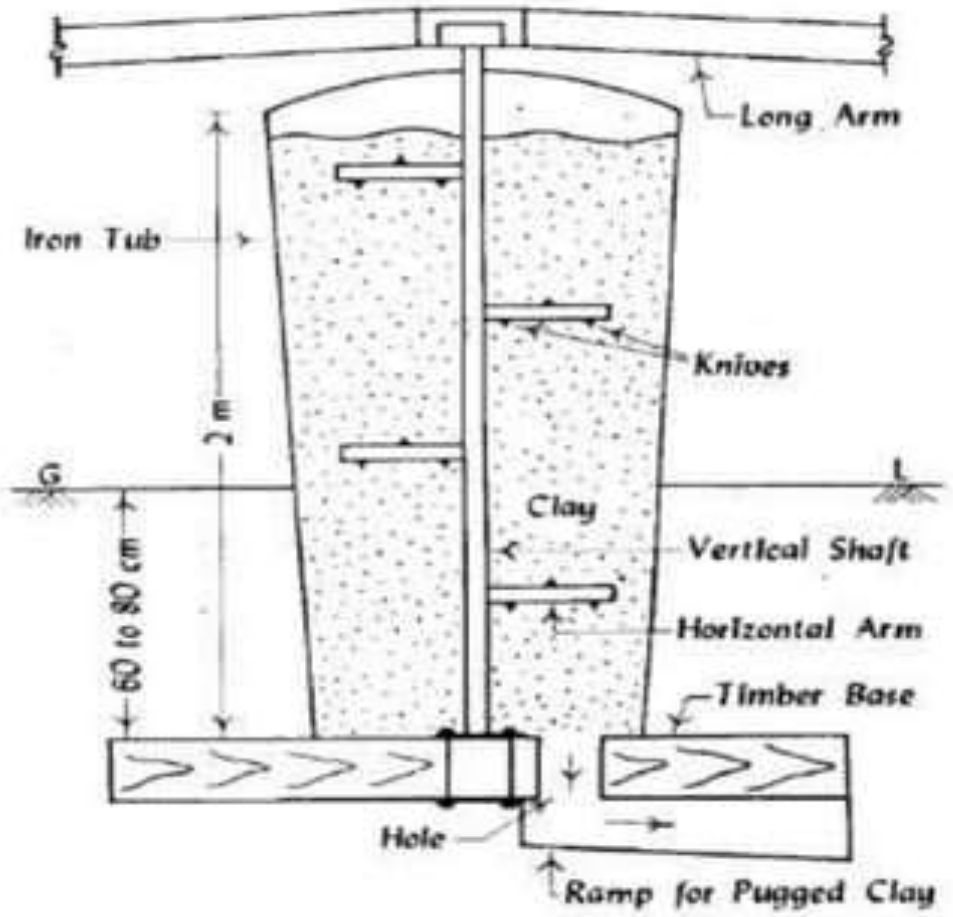
MANUFACTUCTING PROCESS

PREPARATION OF CLAY

- *Unsoiling* :- Top layer of 20cm depth is removed as it contains impurities.
- *Digging:* - Clay dug out from ground is spread on levelled ground (just a little deeper than the general level) in about 60cm to 120cm heaps.
- *Cleaning:*-Stones, pebbles, vegetable matter, etc. are removed and lumps of clay are converted into powder form.
- *Weathering:*- Clay is exposed to atmosphere from few weeks to full season for softening and mellowing. (Preferably dug before monsoon)
- *Blending:*- Clay is made loose and any ingredient to be added to it is spread out at top and blended by turning it up and down in vertical direction.
- *Tempering:*- Clay is brought to a proper degree of hardness, then water is added to clay and whole mass is kneaded or pressed under the feet of men or cattle. For large scale, tempering is usually done in pug mill as shown in the figure.

MANUFACTUCTING PROCESS

Pug mill used for tempering of clay



MANUFACTUCTING PROCESS

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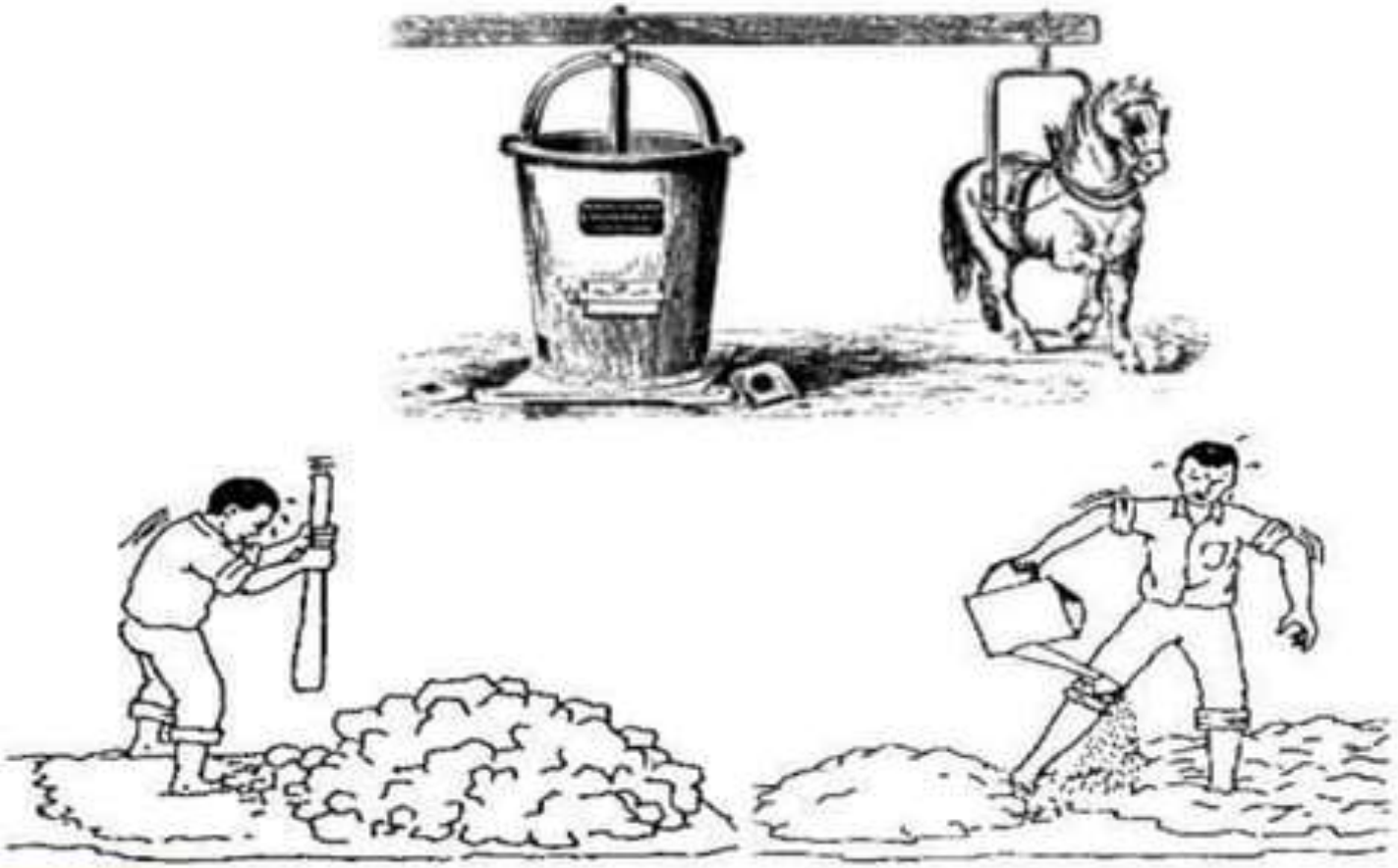
TEMPERING/KNEADING OF CLAY WITH THE HELP OF CATTLE OR MEN



MANUFACTUCTING PROCESS

PROCESS OF TEMPERING

- Clay with water is placed in pug mill from the top. When the vertical staff is rotated by using electric pair, steam or diesel or turned by pair of bullocks. Clay is thoroughly mixed up by the actions of horizontal arms and knives when clay has been sufficiently pugged, hole at the bottom of tub, is opened out and the pugged earth is taken out from ramp for the next operation of moulding.

MANUFACTUCTING PROCESS

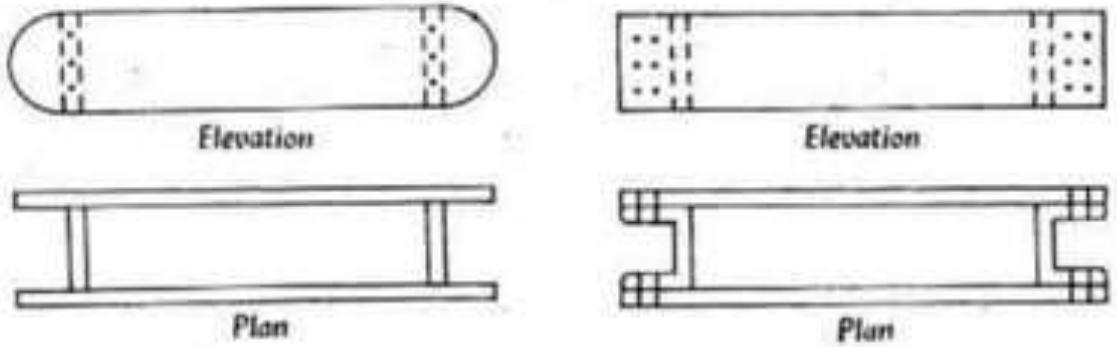
MOULDING

- Clay, which is prepared from pug mill, is sent for the next operation of moulding.
- Following are the two ways of moulding.
  - Hand Moulding
  - Machine Moulding.

MANUFACTUCTING PROCESS

HAND MOULDING

- Moulds are rectangular boxes of wood or steel, which are open at top and bottom. Steel moulds are more durable and used for manufacturing bricks on large scale as shown in figure.



Bricks prepared by hand moulding are of two types.

a) Ground moulded bricks
b) Table moulded bricks

MANUFACTUCTING PROCESS

(a) Ground moulded bricks: ground is first made level and fine sand is sprinkled over it. Mould is dipped in water and placed over the ground to fill the clay. Extra clay is removed by wooden or metal strike after the mould is filled forced mould is then lifted up and raw brick is left on the ground. Mould is then dipped in water every time lower faces of ground moulded bricks are rough and it is not possible to place frog on such bricks.

Ground moulded bricks of better quality and with frogs on their surface are made by using a pair of pallet boards and a wooden block

(b) Table-moulded bricks: Process of moulding these bricks is just similar to ground bricks on a table of size about 2m x 1m.

MANUFACTUCTING PROCESS

DIFFERENT MOULDS

GROUND MOULDING

MANUFACTUCTING PROCESS

MACHINE MOULDING

- This method proves to be economical when bricks in huge quantity are to be manufactured at the same spot. It is also helpful for moulding hard and string clay. These machines are broadly classified in two categories

  (a) Plastic clay machines
  (b) Dry clay machines

a) *Plastic clay machines:* This machine containing rectangular opening of size equal to length and width of a brick. Pugged clay is placed in the machine and as it comes out through the opening, it is cut into strips by wires fixed in frames, so there bricks are called wire cut bricks.

b) *Dry clay machines:* In these machines, strong clay is first converted into powder form and then water is added to form a stiff plastic paste. Such paste is placed in mould and pressed by machine to form hard and well shaped bricks. They carry distinct frogs and exhibit uniform

MANUFACTUCTING PROCESS

DRYING

- The damp bricks, if burnt, are likely to be cracked and distorted. Hence moulded bricks are dried before they are taken for the next operation of burning. Bricks are laid along and across the stock in alternate layers. The drying of brick is by the following means

  (i) Artificial drying – drying by tunnels usually 1200C about 1 to 3 days

  (ii) Circulation of air- Stacks are arranged in such a way that sufficient air space is left between them free circulation of air.

  (iii)Drying yard- special yards should be prepared slightly higher level prevent the accumulation of rain water

  (iv) Period for drying – usually about 3 to 10 days for bricks to become dry

  (v) Screens – screens are necessary, may be provided to avoid direct exposure to wind or sun.

MANUFACTUCTING PROCESS

Newly-formed bricks are dried under shelters in a natural way.

When the bricks are almost dry, they are set vertically in order to make room for the next batch of bricks.

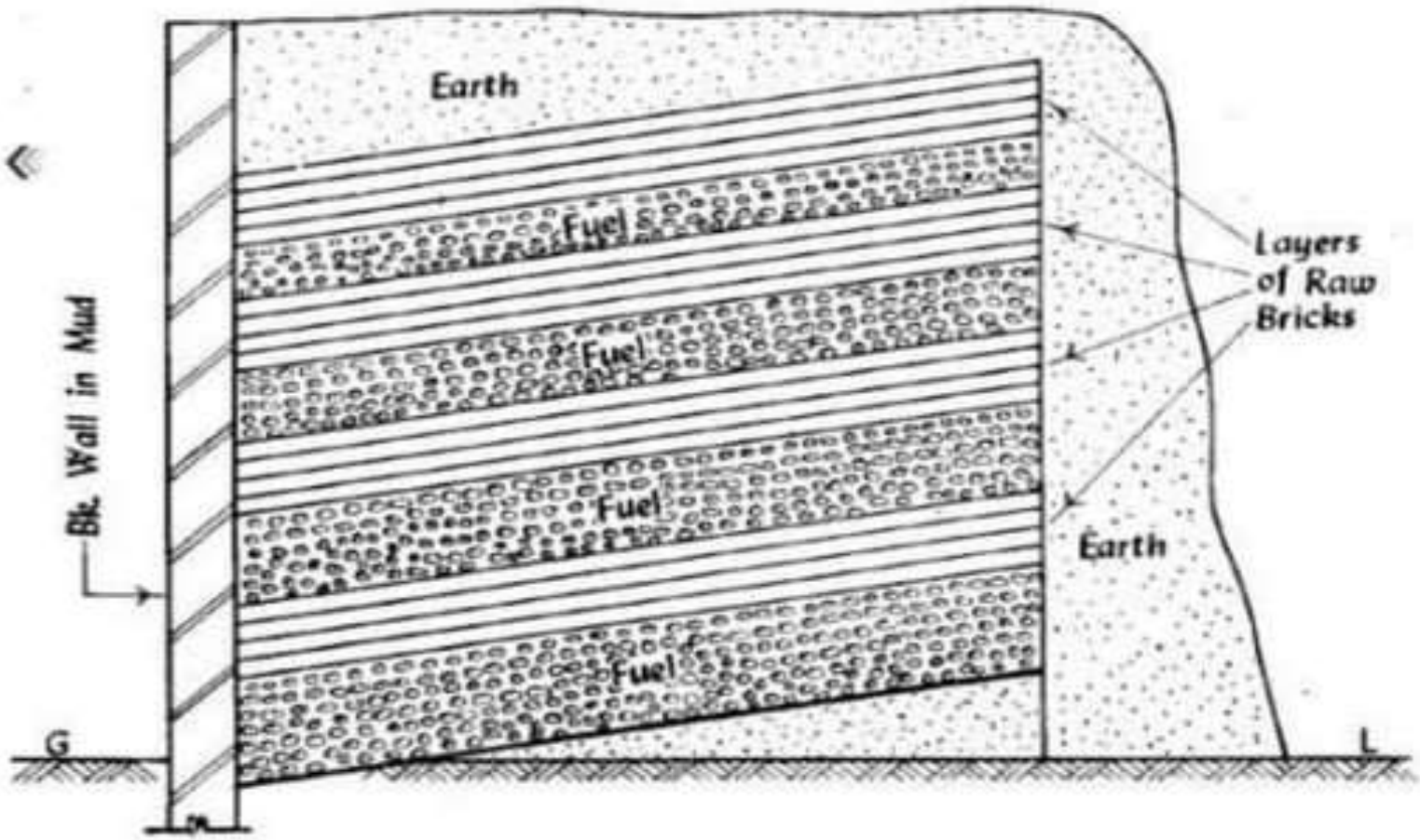
MANUFACTUCTING PROCESS

BURNING

- This is very important operation in the manufacturing of bricks to impart hardness, strength and make them dense and durable.
- Heating clay upto 640 degree C produces physical changes. If such clay is cooled back, it absorbs moisture from air and gets hydrated back to its original state. Such poorly burnt clay is unstable
- However, if clay is heated up to 700-1000 deg C chemical changes take place by which alumina and silica in clay fuse together resulting in a compound which is strong and stable.
- Burning of bricks is done either in clamps or in kilns.
  - Clamps are temporary structures and they are adopted to manufacture bricks on small scale.
  - Kilns are permanent structures and they are adopted to manufacture bricks on a large scale.

MANUFACTUCTING PROCESS

A typical clamp is as shown in figure



MANUFACTUCTING PROCESS

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KILNS

- A kiln is a large oven, which is used to burn bricks by
  1) Intermittent kilns
  2) Continuous kilns

- ***Intermittent kilns:***
  These are intermittent in operation, which means that they are loaded, fired, cooled and unloaded.
  a) Intermittent up-draught kilns
  b) Intermittent down-draught kilns
- ***Continuous kilns***
  These kilns are continuous in operations. This means that loading, firing, cooling and unloading are carried out simultaneously in these kilns. There are three types of continuous kilns.
  a) Bull's trench kiln
  b) Hoffman's kiln
  c) Tunnel kiln

MANUFACTUCTING PROCESS

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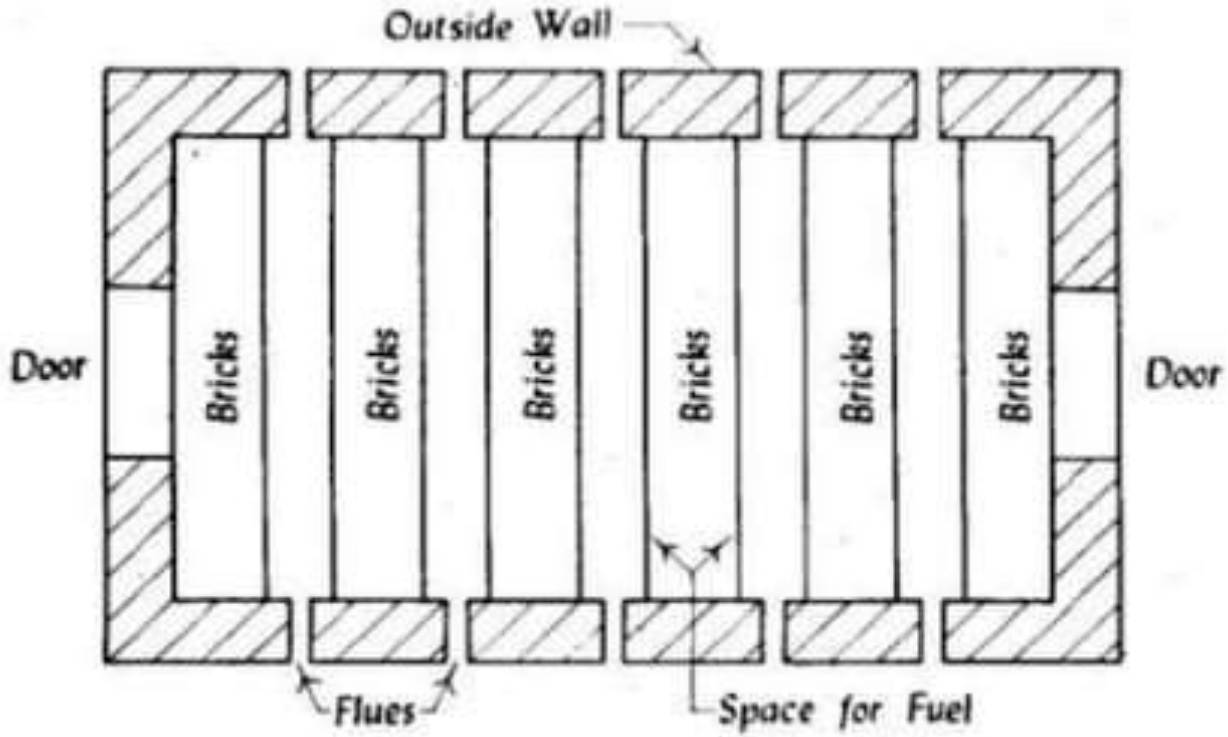
Intermittent kiln

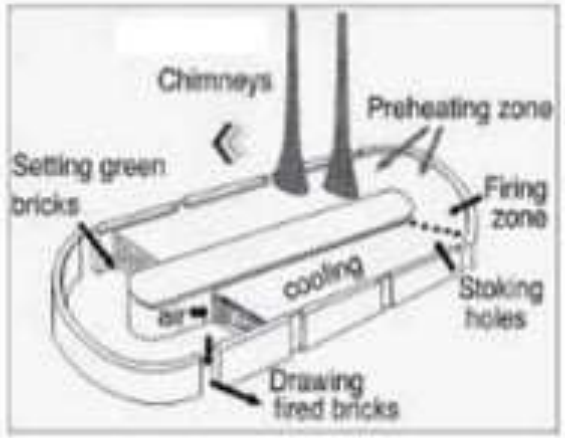


MANUFACTUCTING PROCESS

Bulls Trench Kiln–

- Invented in England 1876
- Commonly used in India, Bull Trench kiln has a permanent brick chimney over 30 meters high.
- The chimney requires skilled labors to construct and is costly to build.
- The kiln can only be operated in continuous mode.
- It has no roof and can only be used outside the monsoon season.

MANUFACTUCTING PROCESS



Design of a Bulls trench kiln

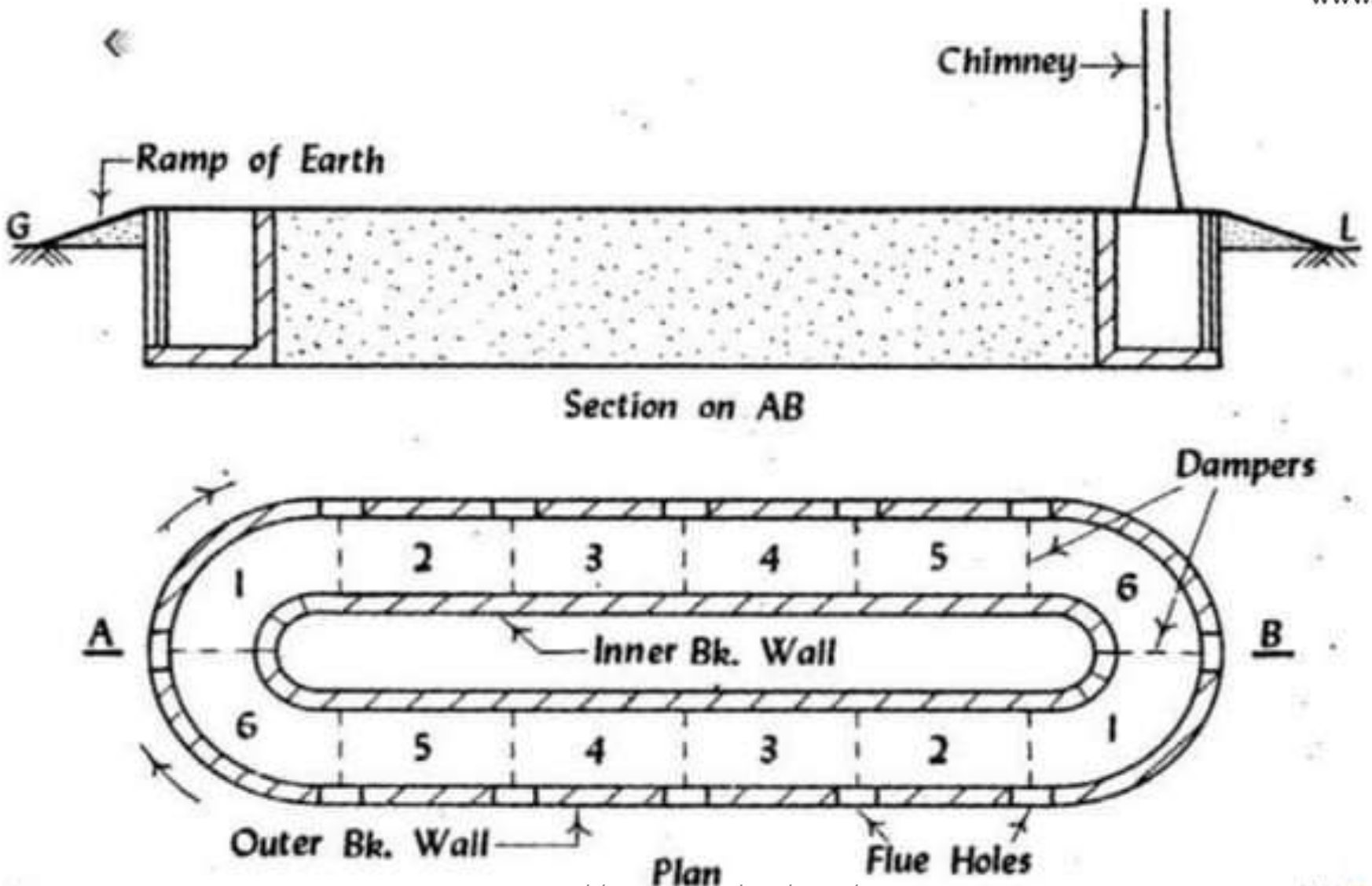
A Bulls trench kiln with a fixed chimney

Bulls trench kiln seen from the loading en

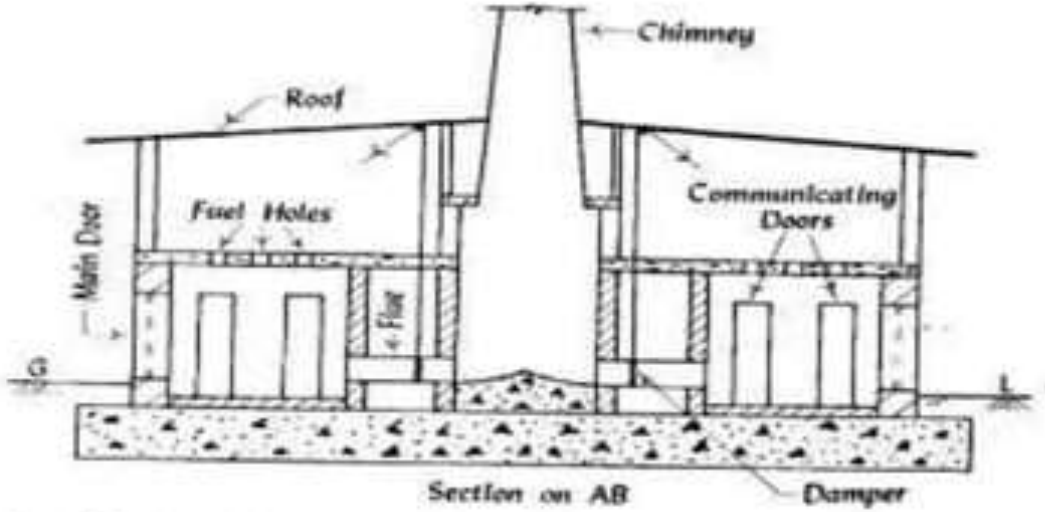
A canvas prevents air from entering the kiln from the wrong end

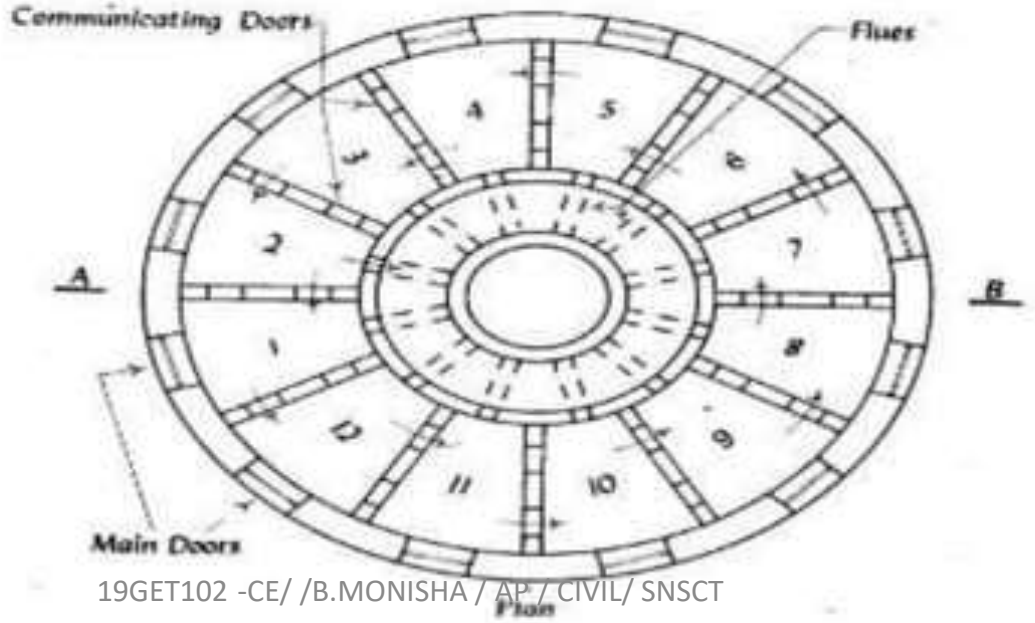
Fired bricks being drawn from the kiln

MANUFACTUCTING PROCESS



MANUFACTUCTING PROCESS





HOFFMAN'S KILN

MANUFACTUCTING PROCESS

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COMPARISON –

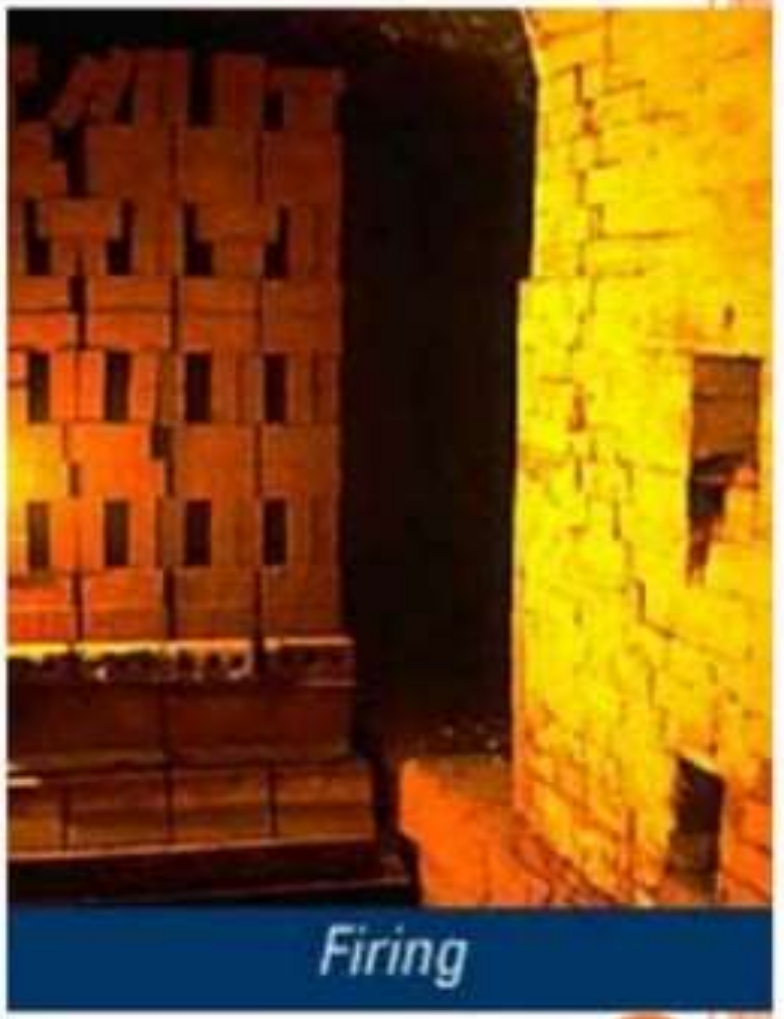
CLAMP BURNING

Vs

KILN BURNING

No	Item	Clamp burning	Kiln burning
1.	Capacity	About 20000 to 100000 bricks can be prepared at a time.	Average 25000 bricks can be prepared per day.
2.	Cost of fuel	Low as grass, cow dung, litter, etc. may be used.	Generally high as coal dust is to be used.
3.	Initial cost	Very low as no structures are to be built.	More as permanent structures are to be constructed.
4.	Quality of bricks	Percentage of good quality bricks is small about 60% or so.	Percentage of good quality bricks is more about 90% or so.
5.	Regulation of fire	It is not possible to control or regulate fire during the process of burning.	Fire is under control throughout the process of burning.
6.	Skilled supervision	Not necessary throughout the process of burning.	Continuous skilled super vision is necessary.
7.	Structure	Temporary structure.	Permanent structure.
8.	Suitability	Suitable when bricks are to be manufactured on a small scale and when the demand of bricks is not continuous.	Suitable when bricks are to be manufactured on a large scale and when there is continuous demand of bricks.
9.	Time of burning and cooling.	It requires about 2 to 6 months for burning and cooling of bricks.	Actual time for burning of one chamber is about 24 hours and only about 12 days are required for cooling of bricks.
10.	Wastage of heat	There is considerable wastage of heat from top and sides and hot flue gas is not properly	Hot flue gas is used to dry and pre-heat raw bricks. Hence wastage of heat is the least.

MANUFACTUCTING PROCESS



Firing Process

MANUFACTUCTING PROCESS

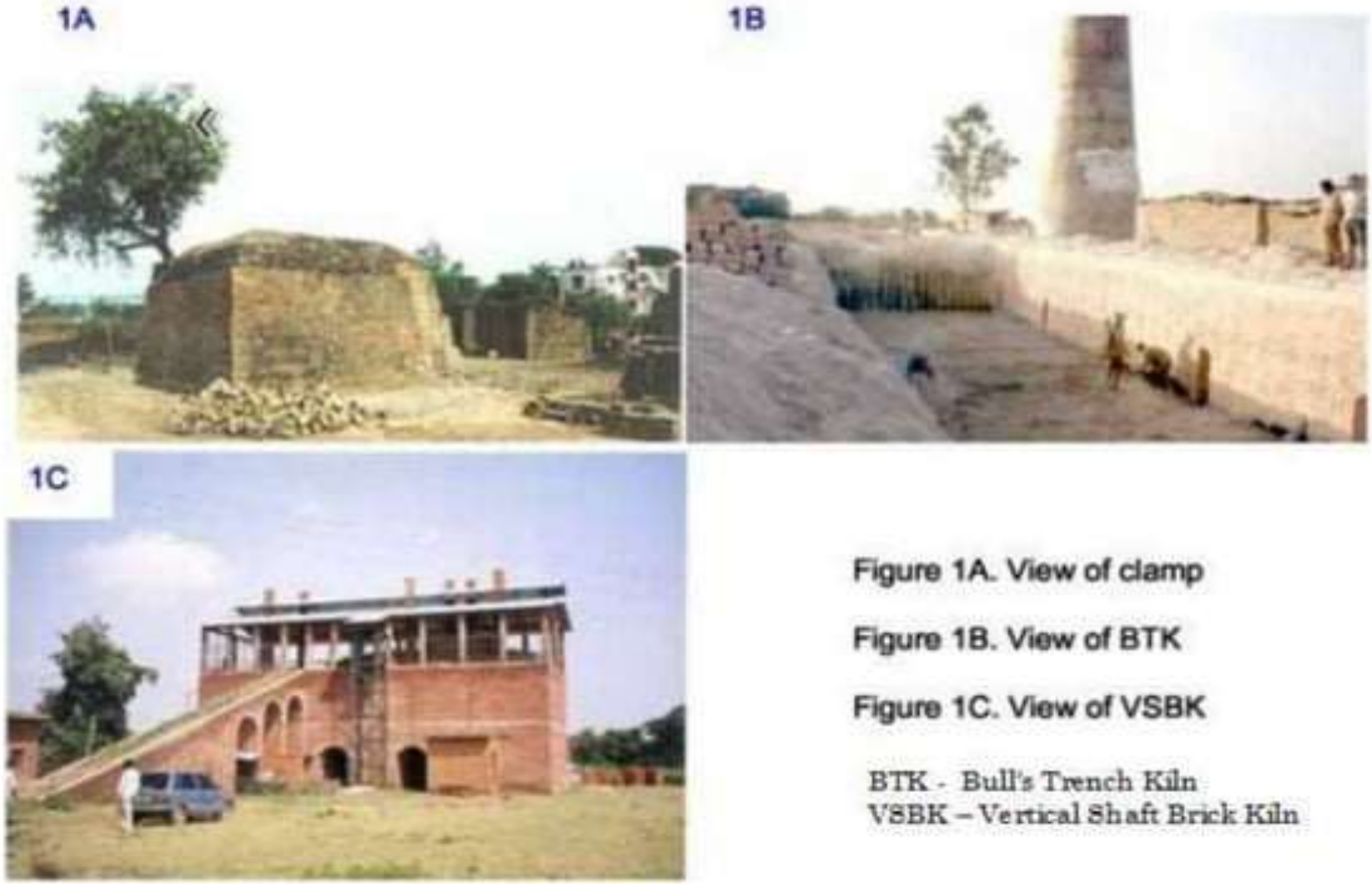


Figure 1A. View of clamp

Figure 1B. View of BTK

Figure 1C. View of VSBK

BTK - Bull's Trench Kiln
VSBK – Vertical Shaft Brick Kiln

Figure . View of different types of brick kilns

(Source : TERI)

MANUFACTUCTING PROCESS

Traditional indian clay brick kiln

Vertical Shaft Brick Kiln

Bull's trench brick kiln

Brick clamp

MANUFACTUCTING PROCESS

COLOURS OF BRICKS

Table shows the colours produced by clays with various constituents.

COLOUR	CONSTITUENTS PRESENT IN CLAY
Black	Manganese and large proportion of iron
Bluish green	Alkalis (burnt at high temperature)
Bright red, dark blue or purple	Large amount of iron oxide
Brown	Lime in excess
Cream	Iron and little lime
Red	Iron in excess
White	Pure clay
Yellow	Iron in magnesia

COLOURS OF BRICKS

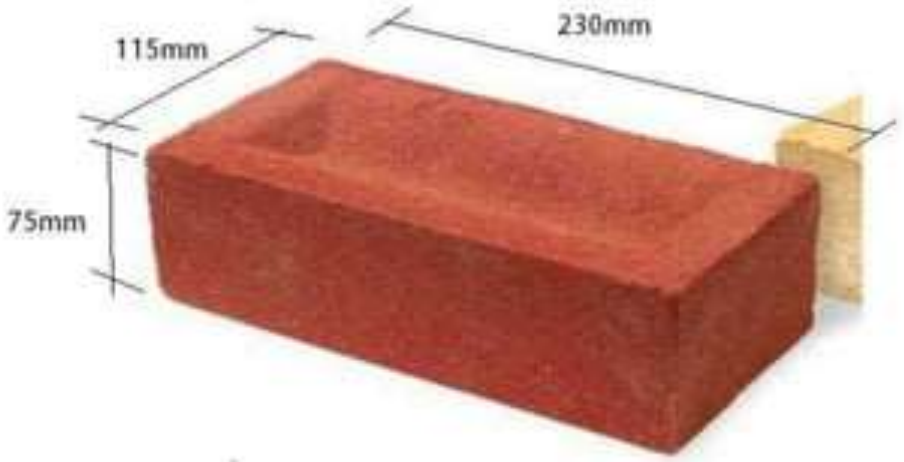
Colours of bricks, as obtained in its natural course of manufacture, depend on the following factors:

1. Degree of dryness achieved before burning.
2. Natural colours of clay and its chemical composition
3. Nature of sand used in moulding operation
4. Quality of fuel used in burning operation
5. Quality of air admitted to the kiln during burning.
6. Temperature at which bricks are burnt.

BRICKS

The length of brick should be twice its width plus the thickness of one vertical joint in order that a proper bond may be maintained. Brick in common use vary in size from 210 to 230mm long by 100 to 115 mm wide by 38 to 75 mm thick.

Clay bricks are mostly 230 X 115 X 75 mm, using a 10mm joint this gives a nominal size or format of 240 X 125 X 85 mm.



BRICKS

Fire clay:

- Fire clay is refractory clay which is capable or resisting a high temperature without being melted or softened.
- It is used for making refractory material.
- A refractory material is able to stand a high temperature without losing its shape.
- Thus fire clay is used in manufacture of fire bricks, crucibles, lining construction of a good fire-clay are two- alumina and silica.

BRICKS

Depending upon the fire resistance capacity, fire clays are classified into the following three categories.

1. High duty fire clay: These clay can resist temperature range of 1482C to 1648C.
2. Medium duty fire clay: These clay can resist temperature range of 1315C to 1482C.
3. Low duty fire clay: These clay can resist temperature upto 870C only.

BRICKS

Fire bricks :

- Fire bricks are made from fire clay, process of manufacture is the same as that of ordinary clay bricks. Burning and cooling of fire-bricks are done gradually.

BRICKS

Following are varieties of fire bricks:

1.Acidic bricks
2.Basic bricks
3.Neutral bricks

TEST ON BRICK

1. Absorption
2. Crushing strength
3. Hardness
4. Presence of soluble salts
5. Shape and size
6. Soundness
7. Structure

TEST ON BRICK

Absorption

- Water absorption is brick is carried out by immersing it in water for 24 hours.
- It is again weighed and the different is in indicated the amount of water absorbed by brick.
- It should not in any case exceed 20% of wet of dry bricks.

Crushing Strength

- Crushing strength of brick is found out by placing it in compressive test machine.
- It is pressed till it breaks
- The minimum crushing strength of brick is 55kg/cm2
- In this test, a stretch is made on brick surface with the help of finger nail.
- If no impression is left on surface, the brick is treated to be sufficiently hard.

TEST ON BRICK

Presence of soluble salts

- The soluble salts, if present in bricks will cause efflorescence in the surface of bricks.
- For finding out the presence of soluble salts in a brick, it is immersed in water for 24 hrs.
- It is than taken out and allowed to dry in shed.
- The absence of grey or white deposits in its surface indicates absence of soluble salts.
- It the white deposit cover about 20% surface, the efflorescence are said to be as moderate, when deposits are to be more than50% the efflorescence become heavy and it is treated as serious when such deposits are converted into powdery mass.

TEST ON BRICK

Soundness

- In this test, two bricks are taken and than struck together with each other, the bricks should not break and a clear ringing sound should be produced.

Structure

- A brick is broken and its structure is examined.
- It should be homogeneous, compact and free from any defects.