BRICKS

BUILDING MATERIALS II

Asst Prof Farha Shermin

DEFINITION

A molded rectangular block of clay baked by the sun or in a kiln until hard and used as a building and paving material.

CLASSIFICATION OF BRICKS

Bricks are classified as :

(i)un-burnt or sun-dried bricks; and
(ii) burnt bricks.

The unburnt or sun-dried bricks are those bricks which are dried with the help of heat that is received from sun after the process of moulding. The unburnt bricks can only be used in the construction of simple temporary and cheap structures. Unburnt bricks should not be used at places exposed to heavy rains.

The bricks used in construction works are burnt bricks and they are classified into the following *four* categories:

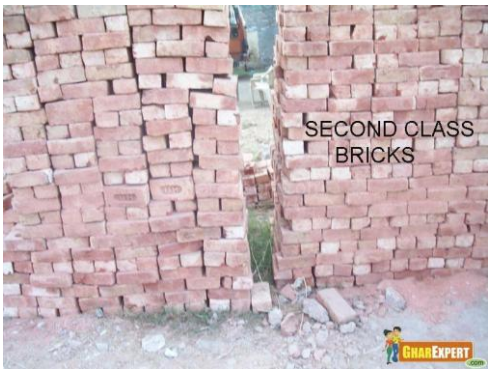
- ***(1) First class bricks***
- ***(2) Second class bricks***
- ***(3) Third class bricks***
- ***(4) Fourth class bricks.***

FIRST CLASS BRICKS

These first class bricks are table moulded and of uniform shape and they are burnt in kilns. The surfaces and edges of the bricks are sharp, square, smooth and straight. They comply with all the qualities of good bricks. These bricks are used for important work of permanent nature.

SECOND CLASS BRICKS

The second class bricks are ground moulded and they are burnt in kilns. The surface of the second class bricks is slightly rough and shape is also slightly regular. These bricks may have hair cracks and their edges may not be sharp and uniform. These bricks are commonly used at places where brickwork is to be provided with a coat of plaster.



THIRD CLASS BRICKS

These bricks are ground-moulded and they are burnt in clamps. These bricks are not very hard and they have rough surfaces with irregular and blunt edges. These bricks give dull sound when they are struck together. They are used for unimportant works, temporary structures and at places where rainfall is not heavy.

FOURTH CLASS BRICKS

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

BASED ON STRENGTH.

The Bureau of Indian Standards (BIS) has classified the bricks on the basis of compressive strength and is as given in Table below.

Table 2.1 Classification of Bricks based on Compressive Strength (IS: 1077)

Class	*Average compressive strength not less than (N/mm^2)*
35	35.0
30	30.0
25	25.0
20	20.0
17.5	17.5
15	15.0
12.5	12.5
10	10.0
7.5	7.5
5	5.0
3.5	3.5

Note:

The burnt clay bricks having compressive strength more than 40.0 N/mm2 are known as ***heavy duty bricks*** and are used for heavy duty structures such as bridges, foundation for industrial buildings, multistory buildings, etc. the water absorption of these bricks is limited to 5%.

Each class of bricks as specified above is further divided into ***subclasses A and B based on tolerances and shape.*** *Subclass-A bricks should have smooth rectangular faces with sharp corners and uniform color. Subclass-B bricks may have slightly distorted and round edges.*

ON THE BASIS OF USE

Common brick is a general multi-purpose unit manufactured economically without special reference to appearance. These may vary greatly in strength and durability and are used for filling, backing and in walls where appearance is of no consequence.

Facing bricks are made primarily with a view to have good appearance, either of color or texture or both. These are durable under severe exposure and are used in fronts of building walls for which a pleasing appearance is desired.

Engineering bricks are strong, impermeable, smooth, table moulded, hard and conform to defined limits of absorption and strength. These are used for all load bearing structures.

ON THE BASIS OF MANUFACTURE.

Hand made: These bricks are hand moulded.

Machine made; Depending upon mechanical arrangement, bricks are known as wire-cut bricks—bricks cut from clay extruded in a column and cut off into brick sizes by wires; pressed bricks—when bricks are manufactured from stiff plastic or semi-dry clay and pressed into moulds; moulded bricks—when bricks are moulded by machines imitating hand mixing.

ON THE BASIS OF FINISH.

Sand-faced brick has textured surface manufactured by sprinkling sand on the inner surfaces of the mould.

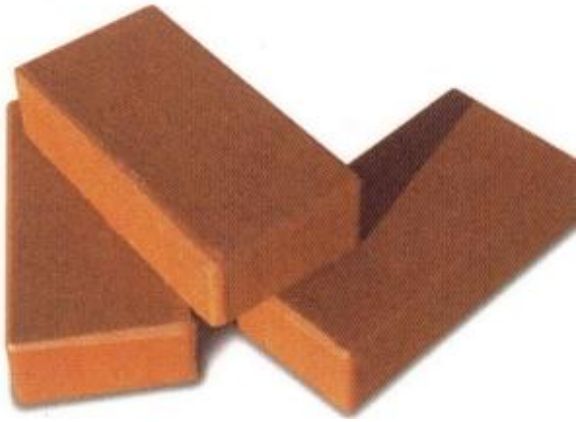
Rustic brick has mechanically textured finish, varying in pattern.

ON THE BASIS OF BURNING.

Pale bricks are under burnt bricks obtained from outer portion of the kiln.
Body bricks are well burnt bricks occupying central portion of the kiln.
Arch bricks are over burnt also known as clinker bricks obtained from inner portion of the kiln.

ON THE BASIS OF TYPES.

Perforated bricks; Small holes may exceed 25 per cent of the total volume of the brick.



Solid bricks; Small holes not exceeding 25 per cent of the volume of the brick are permitted; alternatively, frogs not exceeding 20 per cent of the total volume are permitted.

Hollow bricks; The total of holes, which need not be small, may exceed 25 per cent of the volume of the brick.

Cellular; Holes closed at one end exceed 20 per cent of the volume.

CHARACTERISTIC OF GOOD BRICK

SIZE AND SHAPE

Should have uniform size and plane, rectangular surfaces with parallel sides and sharp straight edges. The surfaces should not be too smooth to cause slipping of mortar.

COLOUR

Uniform deep red as indicative of uniformity in chemical composition and thoroughness in the burning of the brick.

TEXTURE AND COMPACTNESS

Precompact and uniform texture. A fractured surface should not show fissures, holes , lumps of lime etc.

HARDNESS AND SOUNDNESS

Hard enough such that when scratched by a finger nail no impression is made. When two bricks are struck together a metallic sound should be produced.

WATER ABSORPTION

Should not exceed 20 % of its dry weight when immersed in water for 24 hours.

CRUSHING STRENGTH

Should not be less than 10.5 N/mm^2

INGREDIENTS OF GOOD BRICK EARTH

For the preparation of brick, the clay or other suitable earth is molded to the desired shape after several processes. After drying, it should not shrink nor cracks should appear.

The clay used for making brick basically consists of :

Silica 50-60%

Alumina 20-30%

Lime 10%

Magnesia <1%

Ferric Oxide <7%

Alkalis <10%

Carbon dioxide, Sulphur trioxide, Water } Very small %

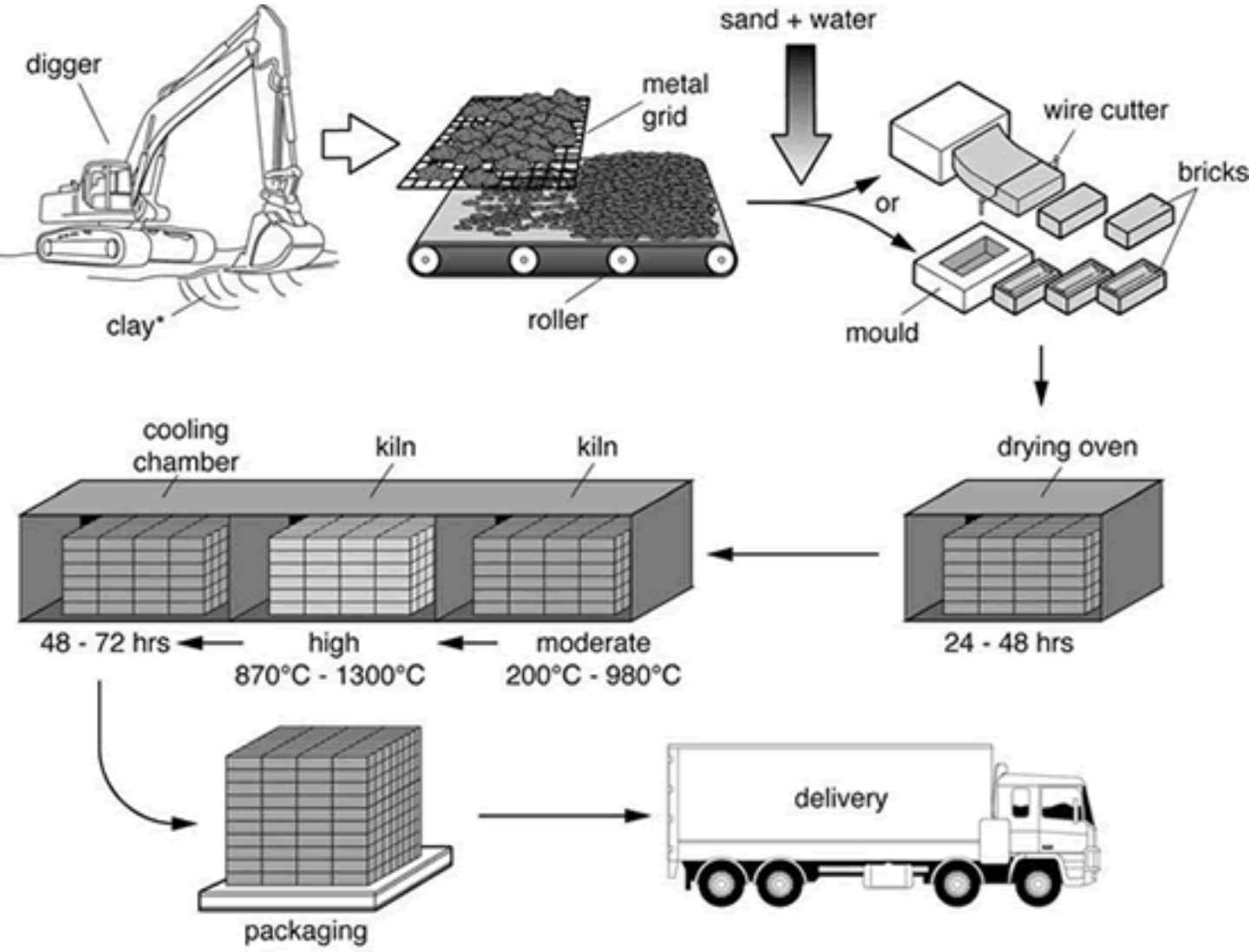
Silica enables brick to retain its shape and imparts durability, prevents shrinkage and warping. Excess of silica makes the brick brittle and weak.

Alumina absorbs water and renders the clay plastic. Excess of alumina produces cracks.

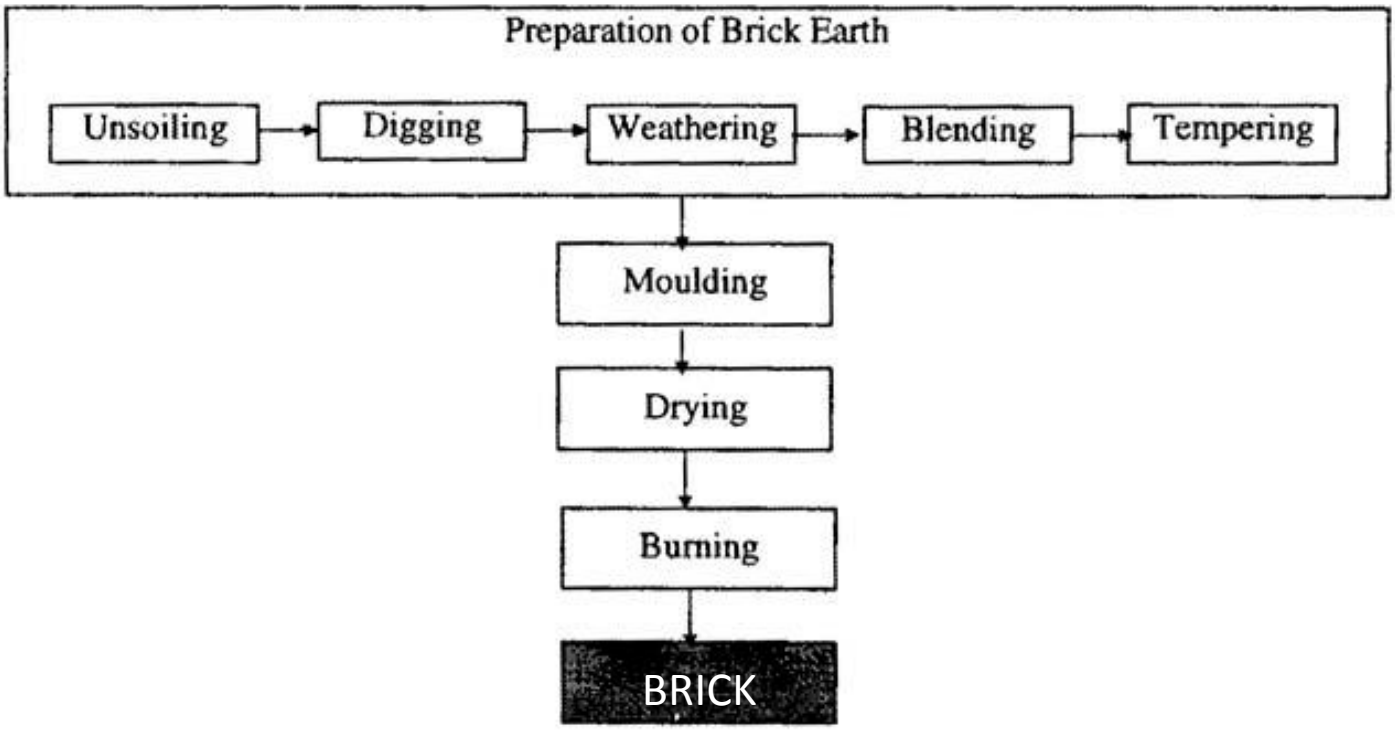
Lime reduces shrinkage, causes silica to melt on burning and thus helps to bind it. Excess of lime causes the brick to loose its shape.

Iron oxide gives the red color, improves impermeability and durability, gives strength and hardness.

MANUFACTURING OF BRICKS



MANUFACTURING OF BRICKS



UNSOILING : The soil used for making building bricks should be processed so as to be free of gravel, coarse sand (practical size more than 2 mm), lime and kankar particles, organic matter, etc. About 20 cm of the top layer of the earth, normally containing stones, pebbles, gravel, roots, etc., is removed after clearing the trees and vegetation.

DIGGING : After removing the top layer of the earth, proportions of additives such as fly ash, sandy loam, rice husk ash, stone dust, etc. should be spread over the plane ground surface on volume basis. The soil mass is then manually excavated, puddled, watered and left over for weathering and subsequent processing.

MANUFACTURING OF BRICKS

WEATHERING : Stones, gravels, pebbles, roots, etc. are removed from the dug earth and the soil is heaped on level ground in layers of 60–120 cm. The soil is left in heaps and exposed to weather for at least one month in cases where such weathering is considered necessary for the soil. This is done to develop homogeneity in the mass of soil, particularly if they are from different sources, and also to eliminate the impurities which get oxidized. Soluble salts in the clay would also be eroded by rain to some extent, which otherwise could have caused scumming at the time of burning of the bricks in the kiln.

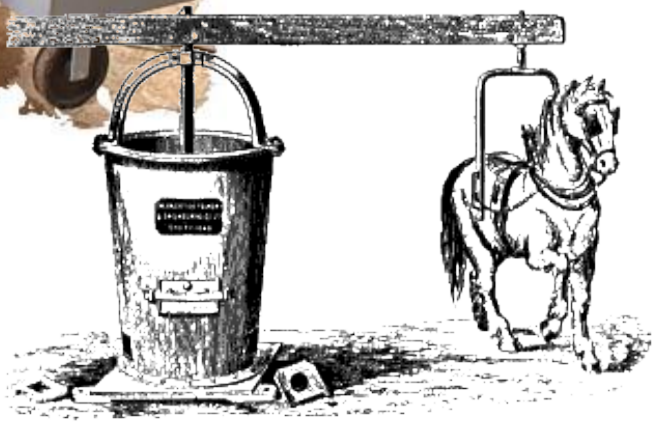
BLENDING : The earth is then mixed with sandy-earth and calcareous-earth in suitable proportions to modify the composition of soil.

Moderate amount of water is mixed so as to obtain the right consistency for moulding. The mass is then mixed uniformly with spades.

MANUFACTURING OF BRICKS

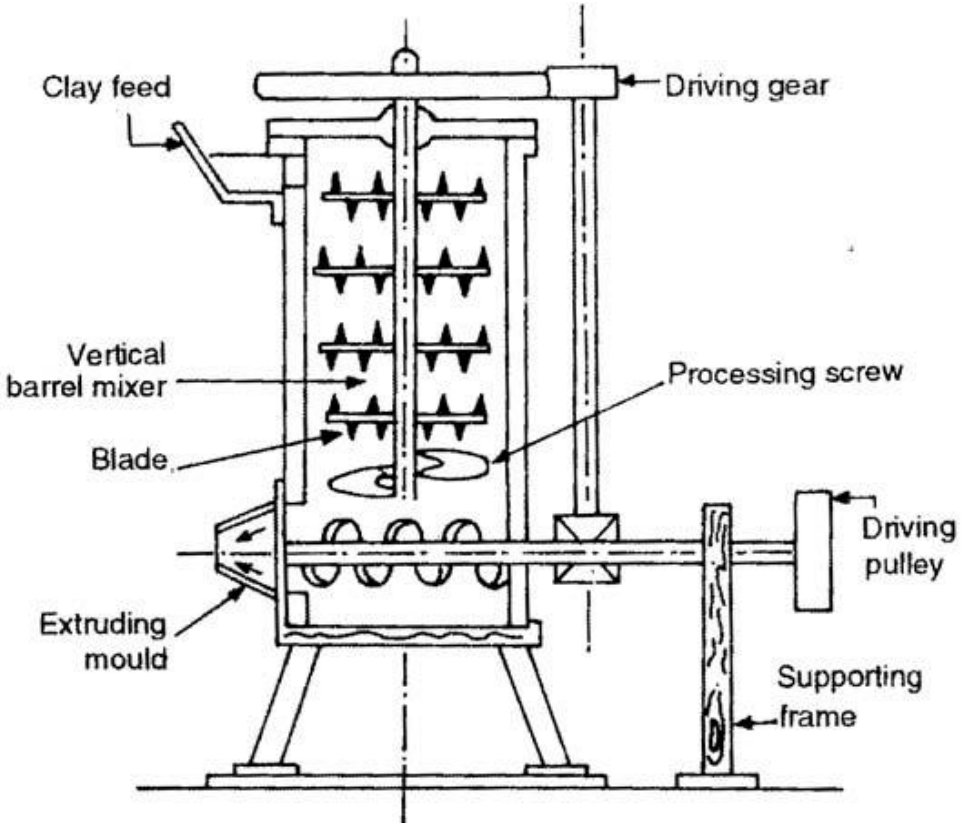
TEMPERING : Tempering consists of kneading the earth with feet so as to make the mass stiff and plastic (plasticity, means the property which wet clay has of being permanently deformed without cracking).

It should preferably be carried out by storing the soil in a cool place in layers of about 30 cm thickness for not less than 36 hours. This will ensure homogeneity in the mass of clay for subsequent processing. For manufacturing good brick, tempering is done in pug mills and the operation is called *pugging.*



MANUFACTURING OF BRICKS

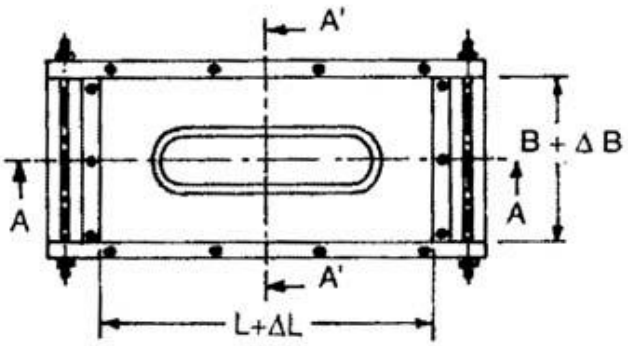
Pug mill consists of a conical iron tube as shown in Figure. The mill is sunk 60 cm into the earth. A vertical shaft, with a number of horizontal arms fitted with knives, is provided at the centre of the tube. This central shaft is rotated with the help of bullocks yoked at the end of long arms. However, steam, diesel or electric power may be used for this purpose. Blended earth along with required water, is fed into the pug mill from the top. The knives cut through the clay and break all the clods or lump-clays when the shaft rotates. The thoroughly pugged clay is then taken out from opening provided in the side near the bottom. The yield from a pug mill is about 1500 bricks.

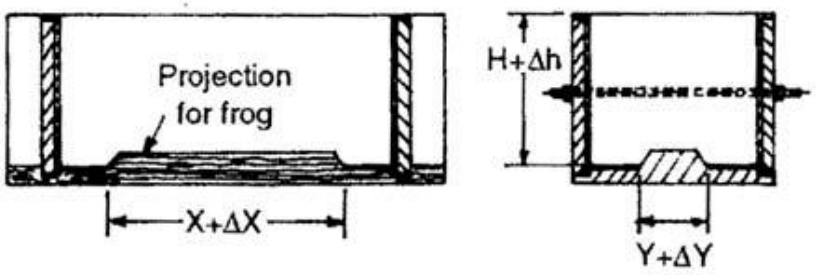


MANUFACTURING OF BRICKS

MOULDING : It is a process of giving a required shape to the brick from the prepared brick earth. Moulding may be carried out by hand or by machines. The process of moulding of bricks may be the soft-mud (hand moulding), the stiff-mud (machine moulding) or the dry press process (moulding using maximum 10 per cent water and forming bricks at higher pressures).

- **HAND MOULDING** ***A typical mould is shown in*** Figure. Hand moulding is further classified as ground moulding and table moulding.

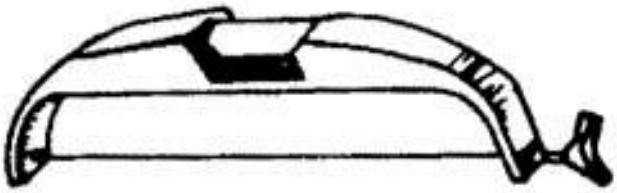




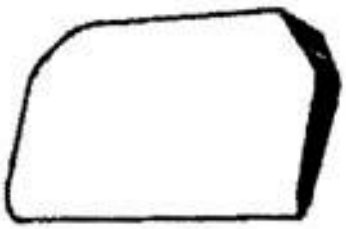
MANUFACTURING OF BRICKS

GROUND MOULDING : In this process, the ground is levelled and sand is sprinkled on it. The moulded bricks are left on the ground for drying. Such bricks do not have frog and the lower brick surface becomes too rough. To overcome these defects, moulding blocks or boards are used at the base of the mould. The process consists of shaping in hands a lump of well pugged earth, slightly more than that of the brick volume. It is then rolled into the sand and with a jerk it is dashed into the mould.

The moulder then gives blows with his fists and presses the earth properly in the corners of the mould with his thumb. The surplus clay on the top surface is removed with a sharp edge metal plate called *strike or with a thin wire stretched* over the mould. After this the mould is given a gentle slope and is lifted leaving the brick on the ground to dry.



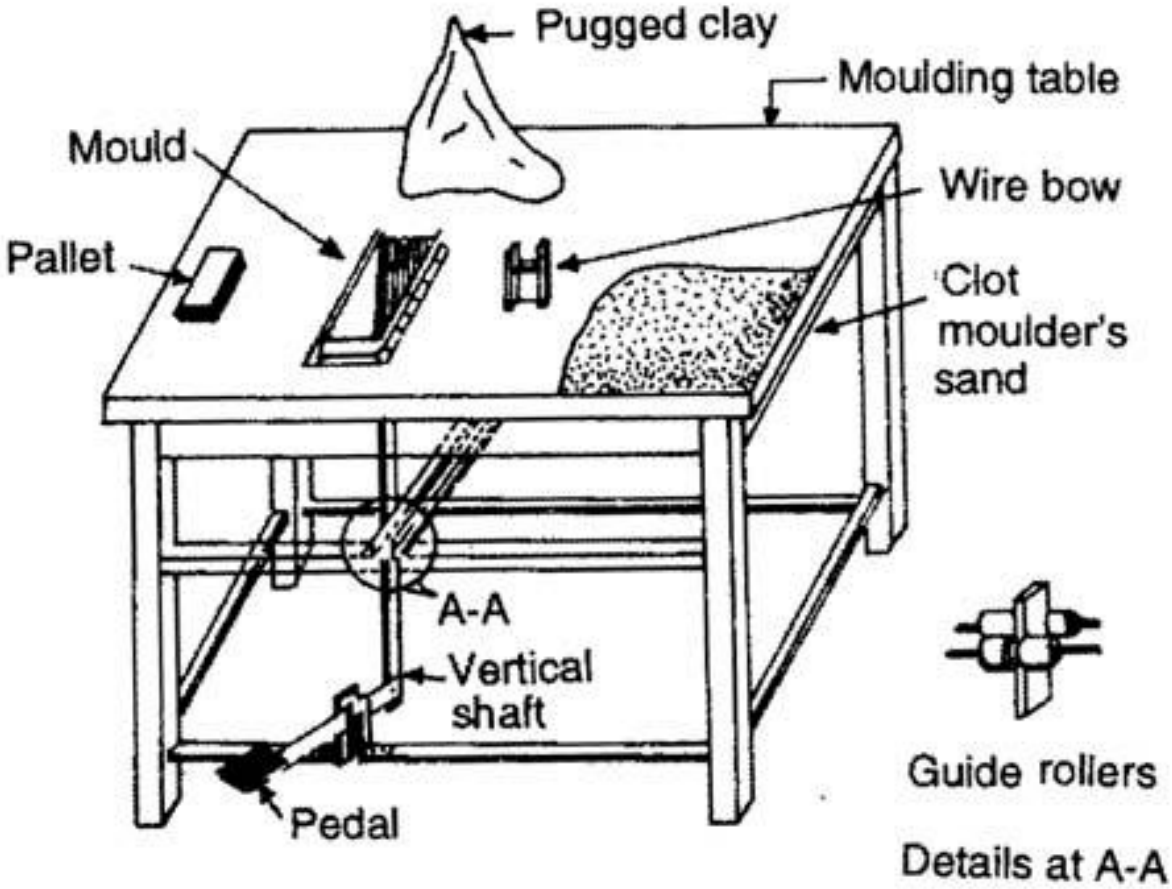
Wire strike



Wooden strike

MANUFACTURING OF BRICKS

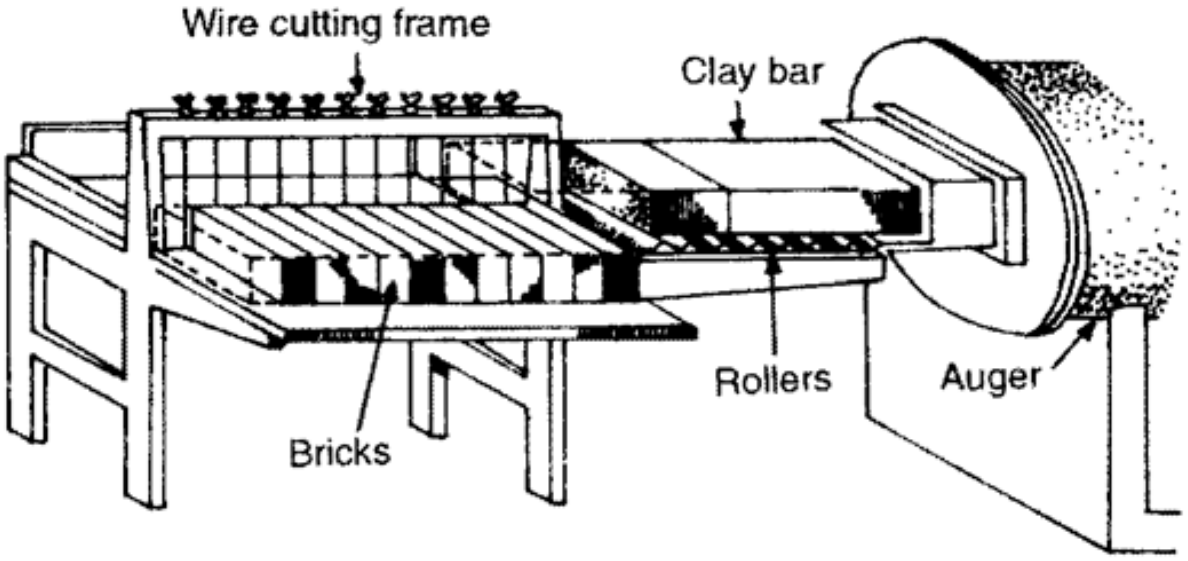
TABLE MOULDING : The bricks are moulded on stock boards nailed on the moulding table. Stock boards have the projection for forming the frog. After this, a thin board called pallet is placed over the mould. The mould containing the brick is then smartly lifted off the stock board and inverted so that the moulded clay along with the mould rests on the pallet. The mould is then removed as explained before and the brick is carried to the drying site.



MANUFACTURING OF BRICKS

MACHINE MOULDING can be done by either of the following processes:

The pugged, stiffer clay is forced through a rectangular opening of brick size by means of an auger. Clay comes out of the opening in the form of a bar. The bricks are cut from the bar by a frame consisting of several wires at a distance of brick size as shown in Fig. This is a quick and economical process.



DRY PRESS METHOD The moist, powdered clay is fed into the mould on a mechanically operated press, where it is subjected to high pressure and the clay in the mould takes the shape of bricks. Such pressed bricks are more dense, smooth and uniform than ordinary bricks. These are burnt carefully as they are likely to crack.

MANUFACTURING OF BRICKS

DRYING : Green bricks contain about 7–30% moisture depending upon the method of manufacture. The object of drying is to remove the moisture to control the shrinkage and save fuel and time during burning. The drying shrinkage is dependent upon pore spaces within the clay and the mixing water. The addition of sand or ground burnt clay reduces shrinkage, increases porosity and facilities drying.

The moisture content is brought down to about 3 per cent under exposed conditions within three to four days. Thus, the strength of the green bricks is increased and the bricks can be handled safely. Clay products can be dried in open air driers or in artificial driers. The artificial driers are of two types, **the hot floor drier and the tunnel drier.**

MANUFACTURING OF BRICKS

BURNING : The burning of clay may be divided into three main stages :

This is also known as water smoking stage. **During dehydration,**
(1) the water which has been retained in the pores of the clay after drying is driven off and the clay loses its plasticity,
(2) some of the carbonaceous matter is burnt,
(3) a portion of sulphur is distilled from pyrites.
(4) hydrous minerals like ferric hydroxide are dehydrated, and
(5) the carbonate minerals are more or less decarbonised. Too rapid heating causes cracking or bursting of the bricks.

During the oxidation period,
(1) remainder of carbon is eliminated and,
(2) the ferrous iron is oxidized to the ferric form. The removal of sulphur is completed only after the carbon has been eliminated. Sulphur on account of its affinity for oxygen, also holds back the oxidation of iron.
Sand is often added to the raw clay to produce a more open structure and thus provide escape of gases generated in burning.

MANUFACTURING OF BRICKS

VITRIFICATION : To convert the mass into glass like substance — the temperature ranges from 900–1100°C for low melting clay and 1000–1250°C for high melting clay. Great care is required in cooling the bricks below the cherry red heat in order to avoid checking and cracking.

Vitrification period may further be divided into

(a) incipient vitrification, at which the clay has softened sufficiently to cause adherence but not enough to close the pores or cause loss of space—on cooling the material cannot be scratched by the knife;

(b) complete vitrification, more or less well-marked by maximum shrinkage;

(c) viscous vitrification, produced by a further increase in temperature which results in a soft molten mass, a gradual loss in shape, and a glassy structure after cooling.

Generally, clay products are vitrified to the point of viscosity.

However, paving bricks are burnt to the stage of complete vitrification to achieve maximum hardness as well as toughness.

Burning of bricks is done in a clamp or kiln. A clamp is a temporary structure whereas kiln is a permanent one.

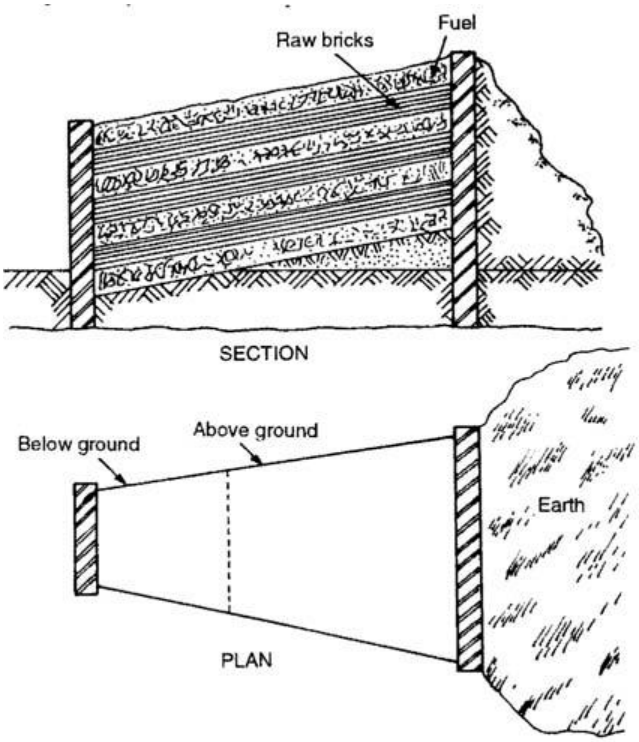
MANUFACTURING OF BRICKS

BURNING IN CLAMP OR PAZAWAH : The bricks and fuel are placed in alternate layers. The amount of fuel is reduced successively in the top layers.

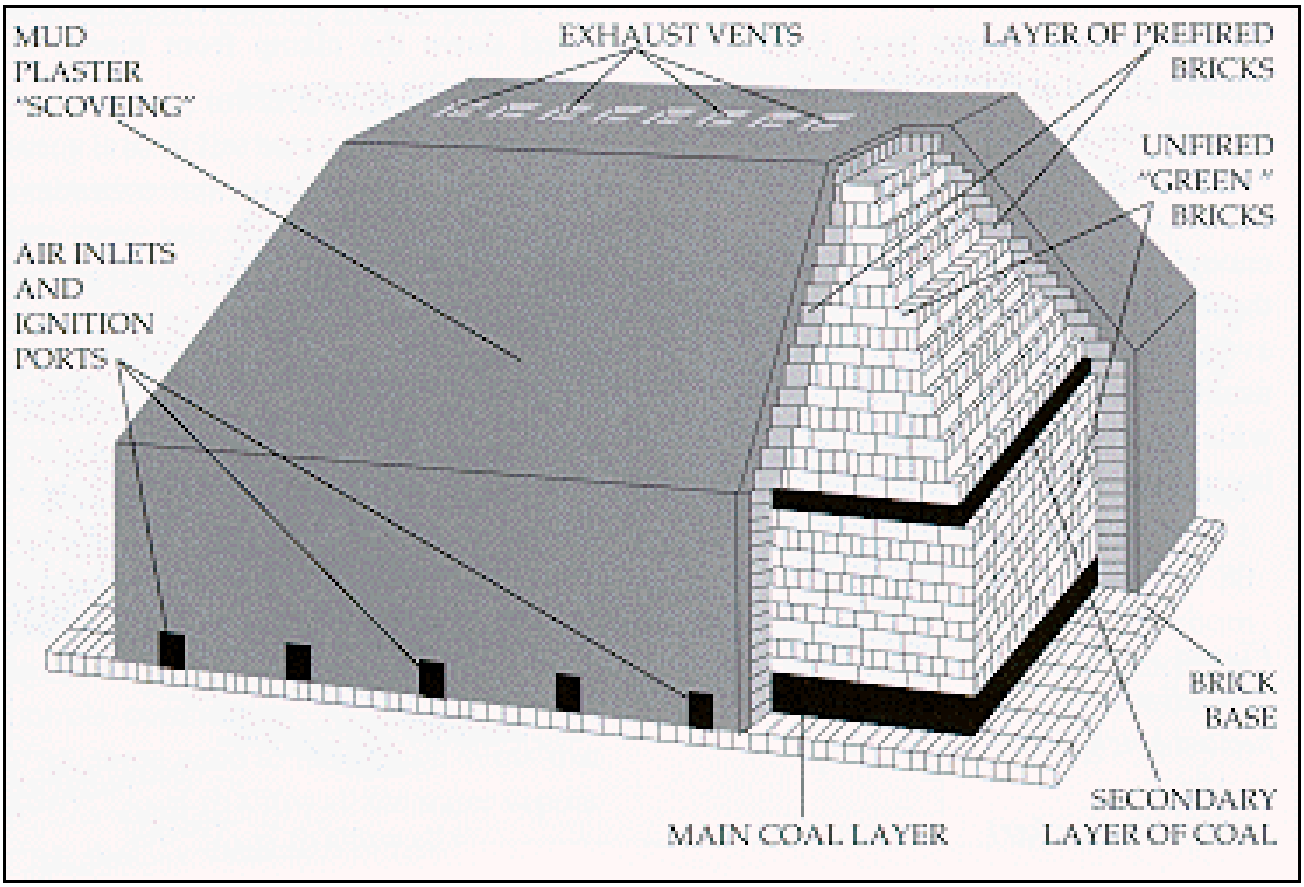
Each brick tier consists of 4–5 layers of bricks. Some space is left between bricks for free circulation of hot gasses. After 30 per cent loading of the clamp, the fuel in the lowest layer is fired and the remaining loading of bricks and fuel is carried out hurriedly.

The top and sides of the clamp are plastered with mud. Then a coat of cowdung is given, which prevents the escape of heat.

The production of bricks is 2–3 lacs and the process is completed in six months. This process yields about 60 per cent first class bricks.



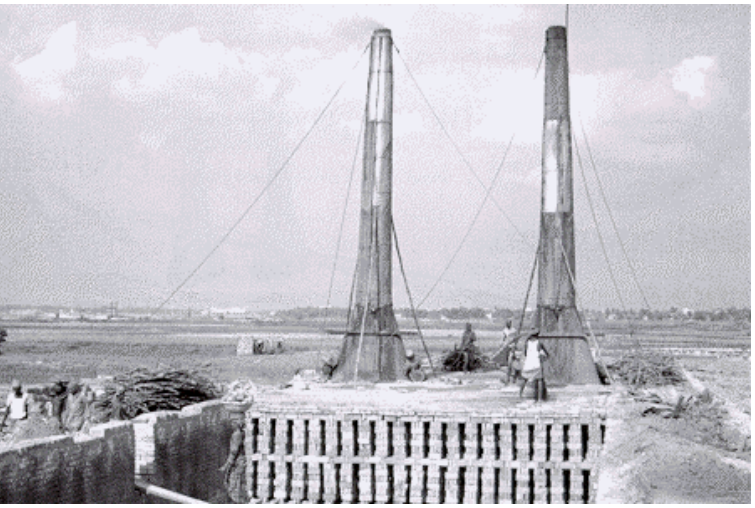
MANUFACTURING OF BRICKS

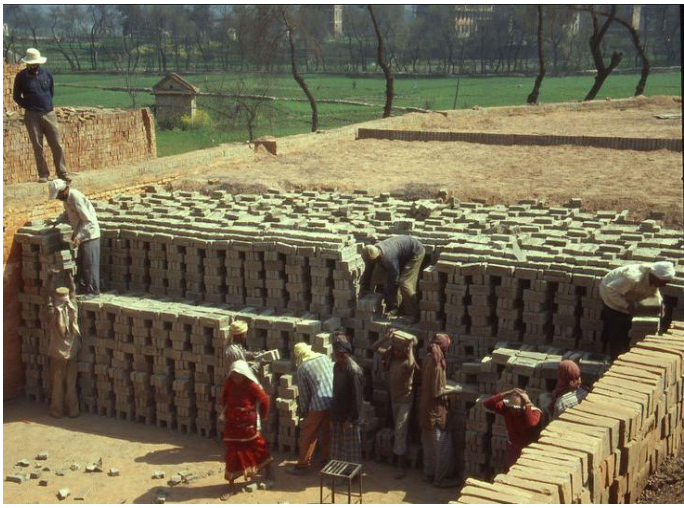


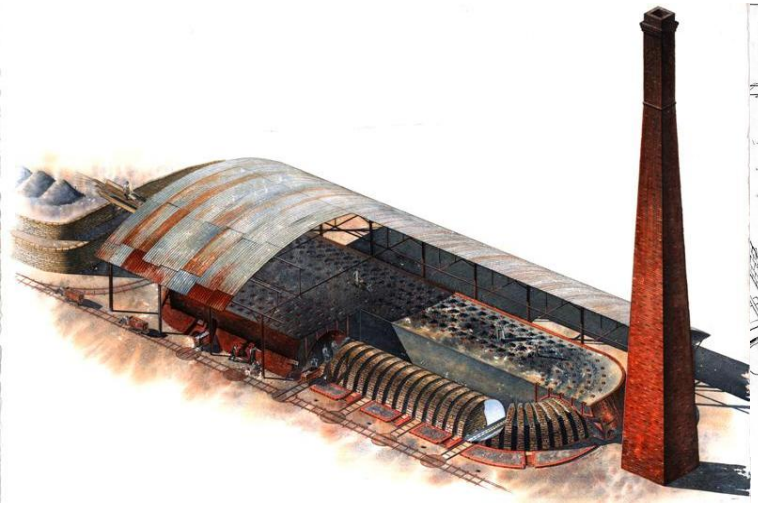
MANUFACTURING OF BRICKS

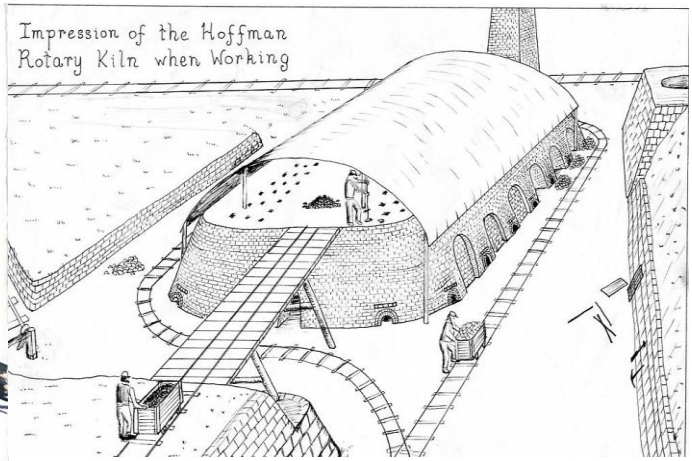
KILN BURNING *:* The kiln used for burning bricks may be underground, e.g. Bull's trench kiln or over ground, e.g. Hoffman's kiln. These may be rectangular, circular or oval in shape.

When the process of burning bricks is continuous, the kiln is known as continuous kiln, e.g. Bull's trench and Hoffman's kilns. On the other hand if the process of burning bricks is discontinuous, the kiln is known as intermittent kiln.









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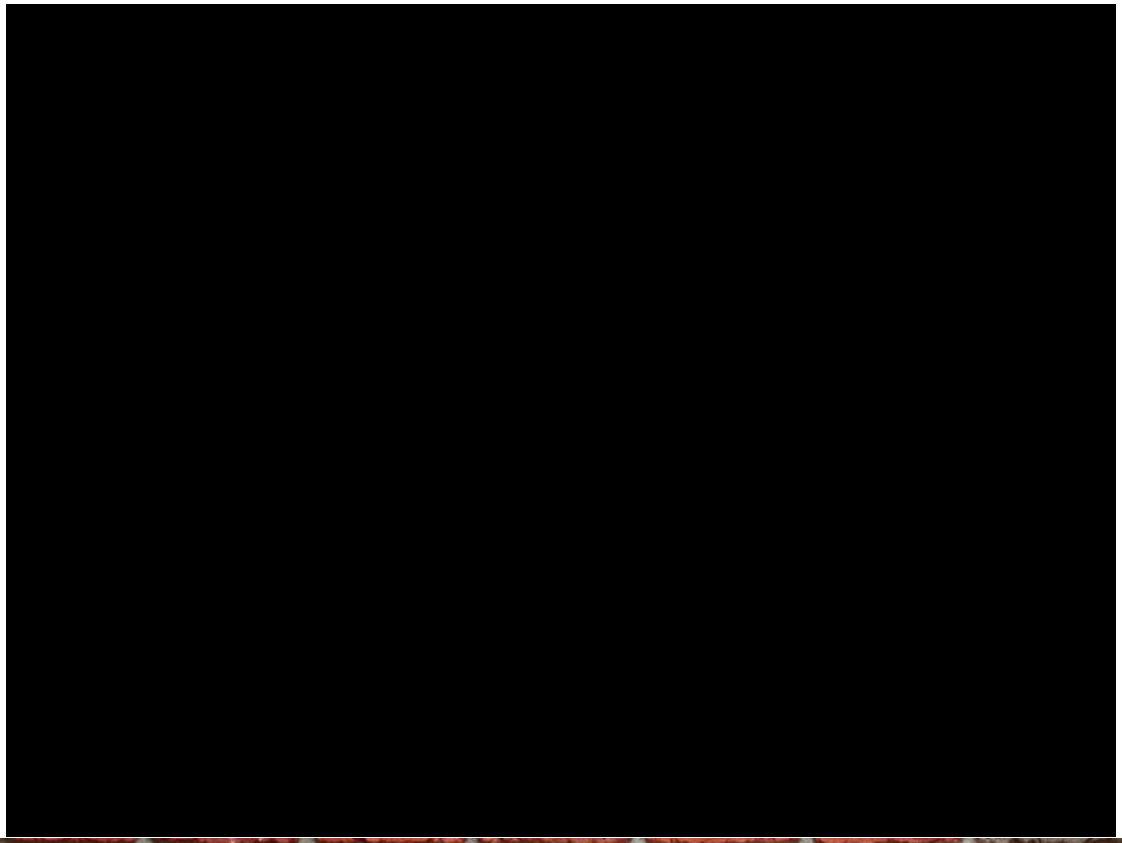
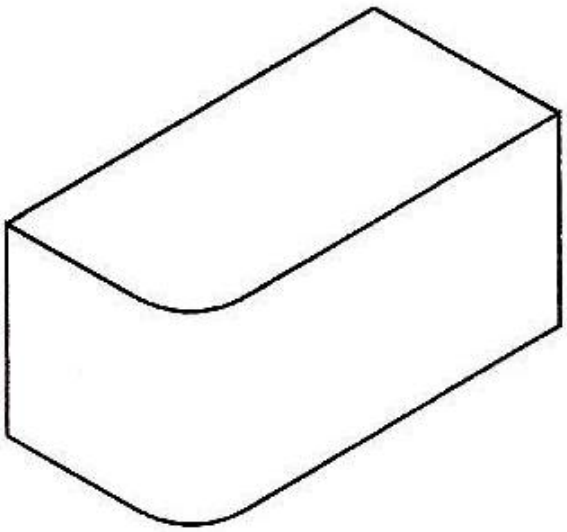
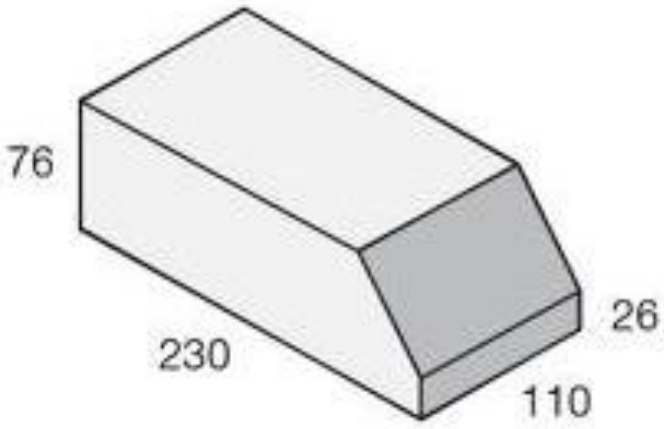


FORMS OF BRICKS

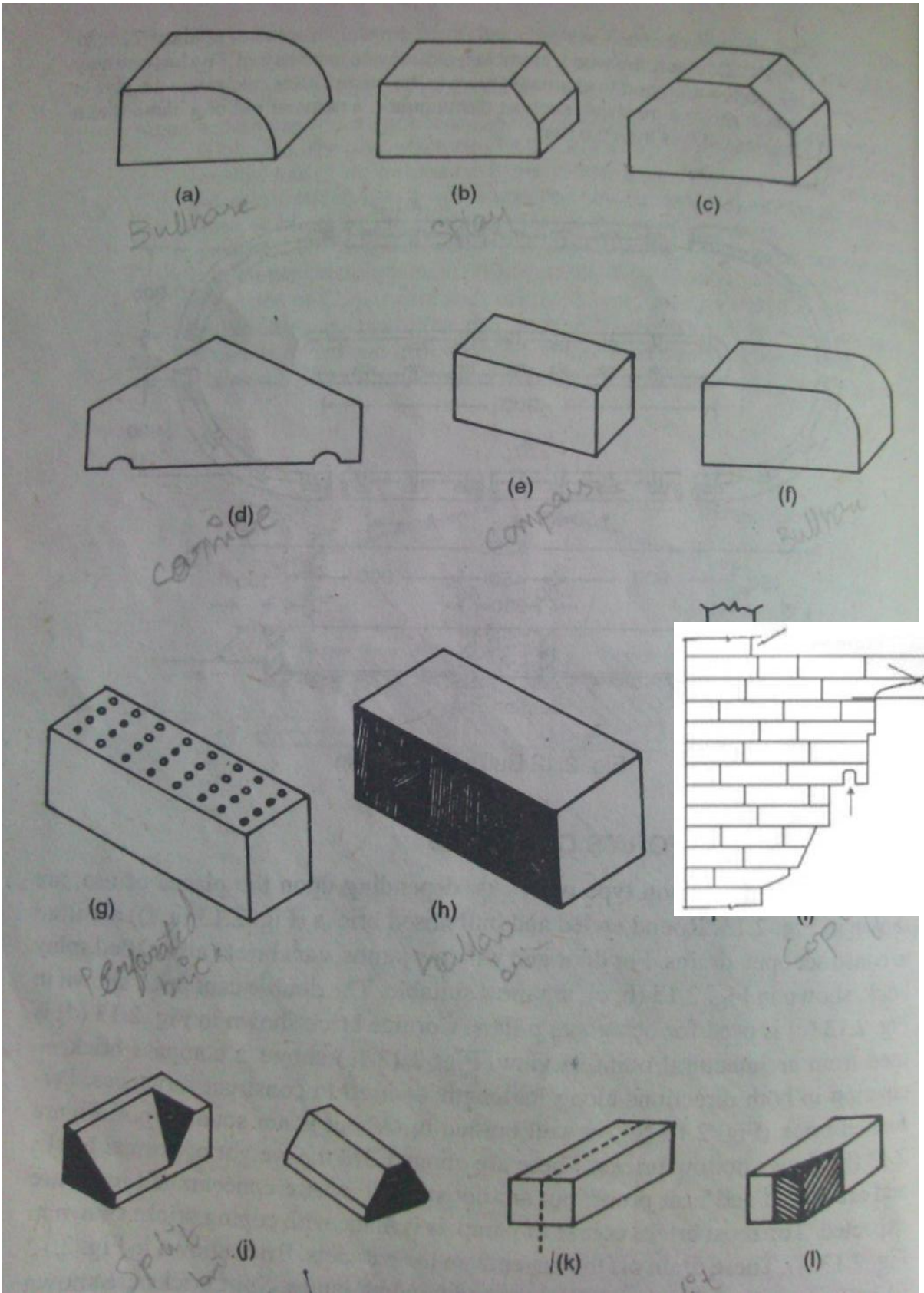


Bullnose brick



Splay brick

FORMS OF BRICKS



TESTING OF BRICKS

About fifty pieces of bricks are taken at random from different parts of the stack to perform various tests.

DIMENTION TEST : ***20 pieces out of selected*** pieces are taken and are laid flat as shown in Fig.

The tolerances on the sizes of bricks are fixed by giving maximum and minimum dimensions, not on individual bricks but on batches of 20 bricks chosen at random. It follows from this method of measurement that batches are likely to contain, bricks outside the prescribed limit of tolerance. Such lots should be rejected to avoid complaints about the variation.

TESTING OF BRICKS

COMPRESSIVE STRENGTH TEST

Six bricks are taken for the compressive strength test although it may be found that an individual brick varies by 20% or more.

For testing bricks for compressive strength from a sample the two bed faces of bricks are ground to provide smooth, even and parallel faces. The bricks are then immersed in water at room temperature for 24 hours. These are then taken out of water and surplus water on the surfaces is wiped off with cotton or a moist cloth. The frog of the brick is flushed level with cement mortar and the brick is stored under damp jute bags for 24 hours followed by its immersion in water at room temperature for three days. The specimen is placed in the compression testing machine with flat faces horizontal and mortar filled face being upwards.

Load is applied at a uniform rate of 14 N/m2 per minute till failure. The maximum load at failure divided by the average area of bed face gives the compressive strength.

$$\text{Compressive strength } (\text{N/mm}^2) = \frac{\text{Maximum load at failure (N)}}{\text{Average area of bed faces } (\text{mm}^2)}$$

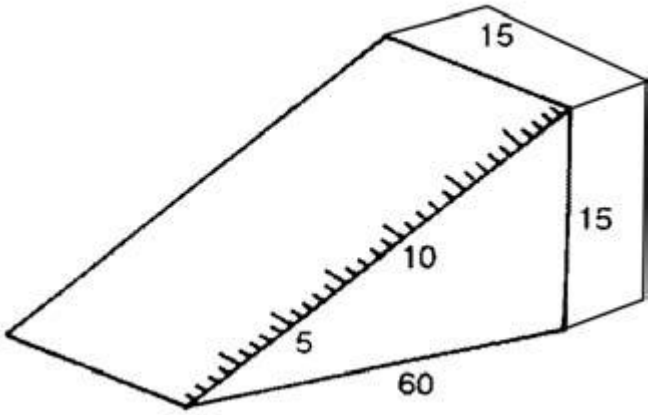
TESTING OF BRICKS

WARPAGE TEST

Warpage of the brick is measured with the help of a flat steel or glass surface and measuring ruler graduated in 0.5 mm divisions or wedge of steel 60 × 15 × 15 mm .For warpage test, the sample consists of 10 bricks from a lot.

Concave Warpage *:* The flat surface of the brick is placed along the surface to be measured selecting the location that gives the greatest deviation from straightness. The greatest distance
of brick surface from the edge of straightness is measured by a steel ruler or wedge.

Convex Warpage : *The brick is place on the plane surface with the convex surface in contact* with the flat surface and the distances of four corners of brick are measured from the flat surface. The largest distance is reported as warpage.



EFFLORESCENCE TEST

The ends of the brick are kept in a 150 mm diameter porcelain or glass dish containing 25 mm depth of water at room temperature (20°–30°C) till the entire water is absorbed or evaporated. The water is again filled to 25 mm depth in the dish and allowed to be absorbed by the brick or evaporated. Presence of efflorescence is classified as below.

1. **Nil** — When the deposit of efflorescence is imperceptible.
2. **Slight** — When the deposit of efflorescence does not cover more than 10 per cent of the exposed area of the brick.
3. **Moderate** — When the deposit of efflorescence is more than 10 per cent but less than 50% of the exposed area of the brick.
4. **Heavy** — When the deposit of efflorescence is more than 50 per cent but the deposits do not powder or flake away the brick surface.
5. **Serious** — When the deposits are heavy and powder or flake away the brick surface.

STORING OF BRICKS

Proper packaging, delivery, handling and storage of bricks help to prevent breakage, cracking, chipping, spalling and other damages. Bricks should be stored on a flat surface and should avoid direct contact with the ground. They should be placed in a manner that facilitates easy handling and allows adequate air circulation around the bricks.

Bricks should not be stacked higher than 2 pallets.

They should be hoisted in pallets or transported using a pallet jack.

Bricks stacked on 3 pallets

Bricks stacked on 2 pallets

Transporting bricks with a pallet jack

Hoisting bricks in pallets

There are a range of sustainable building materials that are both Earth friendly and elegant at the same time. Mud brick and poured Earth construction techniques are just a few of the options available for earth friendly construction.

Select a building of your choice from the given list and explain the various construction techniques and special features of the building with respect to brick as a construction material.

1) Kantana Institute.
2) A House For All Seasons.
3) Sra pou vocational school.
4) Centre for development studies.
5) Bricktopia.
6) Brick Pattern House.
7) South Asian Human Rights Documentation Centre.
8) The Brick Kiln House.
9) Loyola chapel Trivandrum