BRICKS

Bricks are one of the oldest and most popular building materials. The reasons for bricks being very popular and widely used construction material are,

- Bricks are cheap
- Bricks are durable
- Bricks are easy to handle and work with

Bricks can be defined as,

"Bricks are blocks of tampered clay molded to suitable shapes and sizes while it is still in plastic condition, dried in the sun and burnt, if desired so as to make them more strong, hard and durable."

Bricks are normally rectangular in shape and size is set so as to make it easy for workers to handle it. Bricks are usually available made up of three different materials,

- Burnt clay (Most common type in Pakistan)
- Mixture of sand and lime
- Portland cement concrete

The bricks made up of the last two types are usually called blocks and are available in sizes of following proportions,

Length of brick = 2 × width of brick + thickness of mortar

Height of brick = width of brick

Commonly available size is 19 × 9 × 9 cm and 19 × 9 × 4 cm.

The bricks made up of clay usually have the size, 9" × 4½" × 3". Weight of such brick is around 3.0 kg. An indent called frog, 1–2 cm deep. The size of frog should be 10 × 4 × 1 cm. The purpose of providing frog is to form a key for holding the mortar and therefore, the bricks are laid with frogs on top.

1 CLASSIFICATION OF BRICKS:

There are several categories to classify bricks. All those categories have been explained below.

1.1 ON FIELD PRACTICE:

Based upon the physical and mechanical properties the bricks are classified into four types such as, first class, second class, third class and fourth class.

a. First Class Bricks:

- These are thoroughly burnt and are of deep red, cherry or copper color.

- The surface should be smooth and rectangular, with parallel, sharp and straight edges and square corners.
- These should be free from flaws, cracks and stones.
- These should have uniform texture.
- No impression should be left on the brick when a scratch is made by a finger nail.
- The fractured surface of the brick should not show lumps of lime.
- A metallic or ringing sound should come when two bricks are struck against each other.
- Water absorption should be 12–15% of its dry weight when immersed in cold water for 24 hours.
- The crushing strength of the brick should not be less than 10 N/mm^2. This limit varies with different Government organizations around the country.

Uses: First class bricks are recommended for pointing, exposed face work in masonry structures, flooring and reinforced brick work.

b. Second Class Bricks:

These bricks are supposed to have the same requirements as the first class ones except that

- Small cracks and distortions are permitted.
- A little higher water absorption of about 16–20% of its dry weight is allowed.
- The crushing strength should not be less than 7.0 N/mm^2.

Uses: Second class bricks are recommended for all important or unimportant hidden masonry works and centering of reinforced brick and reinforced cement concrete (RCC) structures.

c. Third Class Bricks:

- These bricks are under burnt.
- They are soft and light-colored.
- They produce a dull sound when struck against each other.
- Water absorption is about 25 per cent of dry weight.

Uses: It is used for building temporary structures.

d. Fourth Class Bricks:

- These bricks are over burnt.
- Badly distorted in size and shape.
- Brittle in nature.

Uses: The ballast of such bricks is used for foundation and floors in lime concrete and road material.

1.2 On The Basis Of Finish:

On the basis of finish the bricks have been classified into the following two types,

a. Sand Faced Bricks:

This type has textured surface manufactured by sprinkling sand on the inner surfaces of the mould.

b. Rustic Bricks:

This type has mechanically textured finish, varying in pattern.

1.3 On The Basis Of Burning:

On the basis of burning the bricks have been classified into the following three types,

a. Pale Bricks:

These are under burnt bricks obtained from outer portion of the kiln.

b. Body Bricks:

These are well burnt bricks occupying central portion of the kiln.

c. Arch Bricks:

These are over burnt also known as clinker bricks obtained from inner portion of the kiln.

1.4 On The Basis Of Types:

On the basis of types the bricks have been classified into the following four types,

a. 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.

b. Perforated Bricks:

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

c. Hollow Bricks:

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

d. Cellular Bricks:

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

2 CHARACTERISTICS OF GOOD BRICKS:

The characteristics of a good brick are,

- **Size and Shape:** The bricks should have uniform size and plane, rectangular surfaces with parallel sides and sharp straight edges.
- **Color:** The brick should have a uniform deep red or cherry color as indicative of uniformity in chemical composition and thoroughness in the burning of the brick.
- **Texture and Compactness:** The surfaces should not be too smooth to cause slipping of mortar. The brick should have pre compact and uniform texture. A fractured surface should not show fissures, holes grits or lumps of lime.
- **Hardness and Soundness:** The brick should be so hard 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:** Water Absorption should not exceed 20 per cent of its dry weight when kept immersed in water for 24 hours.
- **Crushing Strength:** Crushing strength should not be less than 10 N/mm^2.
- **Brick Earth:** Brick earth should be free from stones, kankars, organic matter etc.

3 INGREDIENTS OF GOOD BRICK EARTH:

For the preparation of bricks, clay or other suitable earth is molded to the desired shape after subjecting it to several processes. After drying, it should not shrink and no crack should develop. Different ingredients present in the good quality brick earth have been shown in the figure below with their percentages.

Silica	50–60%	
Alumina	20–30%	
Lime	10%	
Magnesia	< 1%	Less than 20%
Ferric oxide	< 7%	
Alkalis	< 10%	
Carbon dioxide		Very small percentage
Sulphur trioxide		
Water		

4 FUNCTIONS OF VARIOUS INGREDIENTS:

The functions of different substances present in the brick earth have been explained below,

4.1 SILICA:

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

4.2 ALUMINA:

Alumina absorbs water and renders the clay plastic. If alumina is present in excess of the specified quantity, it produces cracks in brick on drying.

4.3 LIME:

Normally lime is added less than 10%. The benefits are,

- Reduces the shrinkage on drying.
- Causes silica in clay to melt on burning and thus helps to bind it.
- In carbonated form, lime lowers the fusion point.
- Excess of lime causes the brick to melt and the brick lose its shape.
- Red bricks are obtained on burning at considerably high temperature (more than 800°C) and buff-burning bricks are made by increasing the lime content.

4.4 MANGNESIA:

Mangnesia is rarely exceeding 1%, affects the color and makes the brick yellow, in burning; it causes the clay to soften at slower rate than in most case is lime and reduces warping.

4.5 IRON:

Iron oxide constituting less than 7 % of clay, imparts the following properties:

- Gives red color on burning when excess of oxygen is available and dark brown or even black color when oxygen available is insufficient; however, excess of ferric oxide makes the brick dark blue.
- Improves impermeability and durability.
- Tends to lower the fusion point of the clay, especially if present as ferrous oxide.
- Gives strength and hardness.

5 HARMFUL SUBSTANCES IN BRICK EARTH:

The harmful substances present in the brick earth have been explained below,

5.1 LIME:

When a desirable amount of lime is present in the clay, it results in good bricks, but if in excess, it changes the color of the brick from red to yellow. When lime is present in

lumps, it absorbs moisture, swells and causes disintegration of the bricks. Therefore, lime should be present in finely divided state and lumps, if any, should be removed in the beginning itself.

5.2 PEBBLES AND GRAVELS:

Pebbles and Gravels do not allow the clay to be mixed thoroughly and spoil the appearance of the brick. Bricks with pebbles and gravels may crack while working.

5.3 IRON PYRITES:

This tends to oxidize and decompose the brick during burning. The brick may split into pieces. Pyrites change the color of bricks.

5.4 ALKALIS:

These form less than 10 per cent of the raw clay, are of great value as fluxes, especially when combined with silicates of alumina. These are mainly in the form of soda or potash. However, when present in excess, alkali makes the clay unsuitable for bricks. They melt the clay on burning and make the bricks unsymmetrical. When bricks come in contact with moisture, water is absorbed and the alkalis crystallize. On drying, the moisture evaporates, leaving behind grey or white powder deposits on the brick which spoil the appearance.

5.5 ORGANIC MATTER:

On burning green bricks, the organic matter gets charred and leave pores making the bricks porous; the water absorption is increased and the strength is reduced.

5.6 CARBONACEOUS MATERIALS:

Present in the form of bituminous matter or carbon greatly affects the color of raw clay. Unless proper precaution is taken to effect complete removal of such matter by oxidation, the brick is likely to have a black core.

5.7 SULPHUR:

Sulphur is usually found in clay as the sulphate of calcium, magnesium, sodium, potassium or iron, or as iron sulphide. Generally, the proportion is small. If, however, there is carbon in the clay and insufficient time is given during burning for proper oxidation of carbon and sulphur, the latter will cause the formation of a spongy, swollen structure in the brick and the brick will be discolored by white blotches.

5.8 WATER:

A large proportion of free water generally causes clay to shrink considerably during drying, whereas combined water causes shrinkage during burning. The use of water

containing small quantities of magnesium or calcium carbonates, together with a sulphurous fuel often causes similar effects as those by sulphur.

6 MANUFACTURING OF BRICKS:

6.1 PREPARATION OF BRICK-EARTH

Following steps are involved in preparing Brick-earth.

a. Digging

If the area from where soil is to be taken is grassy or has other vegetation then the top layer (about 20 cm deep) is excavated and thrown away as it contains roots of vegetation and other organic matter. The excavated lumps of soil are broken. It is ensured that the soil is free from gravel, coarse sand, lime and kankar particles, vegetable matter etc.

b. Weathering

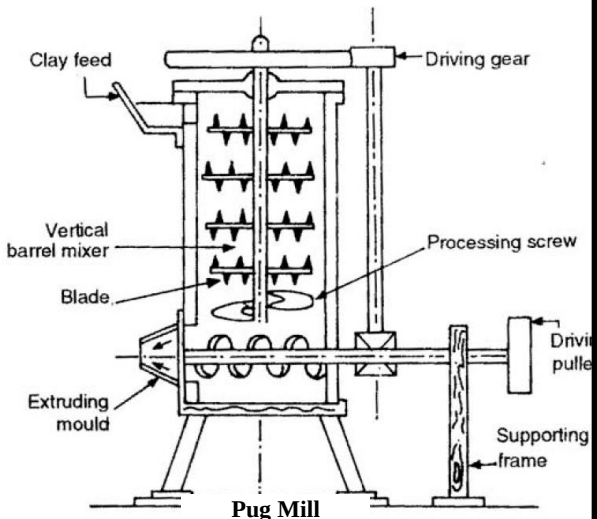
Excavated soil, after the lumps have been broken, is mixed with a little water and is left in heaps to weather for a period varying from a few weeks to as long as it can be left. This improves its plasticity and strength. To keep the soil wet water may be sprayed on the heap from time to time and the heap turned over.

c. Blending

The earth is then thoroughly broken and mixed with sandy soil if needed. The whole mass is thoroughly mixed up and reasonable amount of water is added if needed.

d. Tempering

Blended soil is kneaded under the feet of men or cattle after desired quantities of water have been added to it. The whole mass becomes homogeneous and plastic. It is then left covered with mats and allowed to dry gradually in layers about 30 cm thick for not less than 36 hours, till it is just soft enough for moulding, pug mill is used for tempering earth needed for the manufacture of bricks either on large scale or for use on superior works like arches etc.



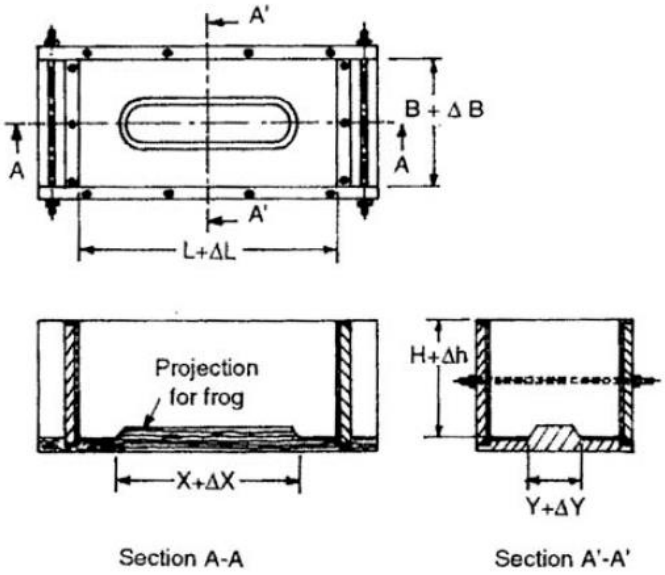
Pug Mill

e. Molds

Moulds are rectangular boxes of wood or steel without top bottom and the longer sides projecting a few centimeters to act as handles. The edges of the wooden molds should be protected with strips of brass or steel screwed on them.

Steel molds keep their shapes and last longer than the wooden molds and are used for heavy works.

Inside dimensions of the molds are kept a little larger than the size of burnt brick (generally about 1/10th of the size of brick each way). It is done to allow for the shrinkage of the moulded brick on drying and burning. The exact allowance to be made for shrinkage can be ascertained by field tests.



6.2 MOULDING QF BRICKS

Giving the required shape to the prepared brick earth is known as molding of brick. There are two different ways of molding.

a) Hand molding

b) Machine molding.

a. Hand molding:

Hand molding of bricks is extensively used and could be done either on ground or on table.

b. Ground molding:

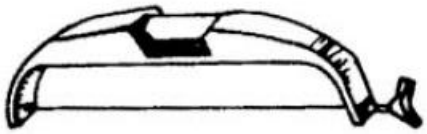
This method is adopted when a large and level area of land is available for the purpose. The area of land on which molding is to be done is leveled, plastered smooth and sprinkled over with sand.

i. To prevent the molded bricks from sticking to the molds either sand is sprinkled on the inner sides of the mould or the mould is dipped in water each time before molding is done. When sand is used to prevent the sticking of earth to molds the molded bricks are known as **sand molded** and if the mould is dipped in water each time before molding a brick then the bricks are known as **slop molded** bricks. Sand molded bricks have better finish and sharper edges.

ii. After either sprinkling sand on the inside of the mould or dipping the mould in water take a lump of well-prepared earth, the volume of which is a little more than that of the brick. This lump is shaped in hands to the size and shape of the brick.

iii. Now it is rolled in sand and with a jerk the lump is dashed into the mould in such a manner that the mould is completely filled with earth. The molder then gives blows with his fists and press in the corners and edges with the thumbs.

iv. The surplus soil is then scrapped off and the top surface is leveled. A metal plate with a sharp edge, known as strike is used for removing the surplus soil. Generally a thin wire stretched on a frame is used for this purpose.



Wire strike

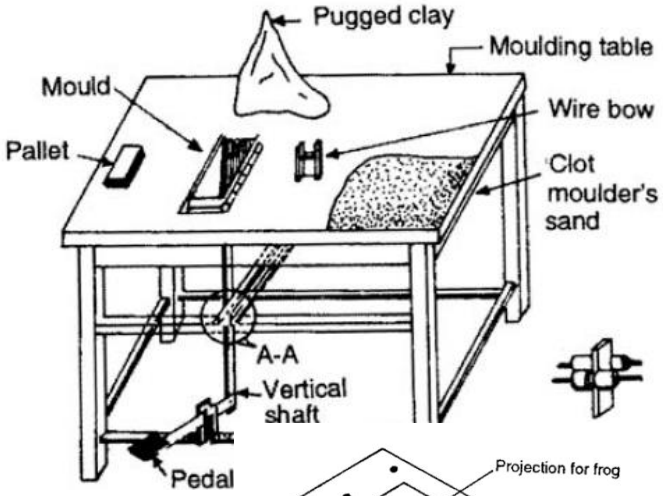
v. After the brick has been molded the mould is given a gentle stroke with something hard and then mould is lifted leaving the brick dry on the ground. The mould is placed nearby to mould another brick and the process is repeated.

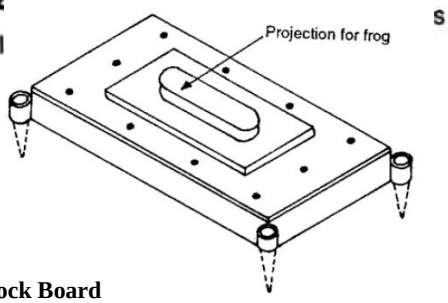
Bricks molded directly on the ground have their lower face rough and can have no frog.

To avoid it bricks are molded on a block of wood known as the molding block, having a projection 0.5 cm thick. A molder can mold between 500 to 1000 bricks per day.

c. Table Molding:

In it the molder carries out the molding of brick on a table. He does so while standing by the side of the table. He molds bricks on boards known as stock boards. Stock boards are of the same size as the molds and have a projection for the frog. Sand is sprinkled inside the mould and on the stock board. The mould is placed to fit the stock board and then filled with earth. Sufficient quantity of earth is dashed into the mould pressed hard and the surplus earth is removed with a strike or a thin wire. A Pallet is then placed on the mold. The mold containing the brick is then smartly lifted off the stock board and inverted so that the whole rests on the pallet. The mold is then given a gentle blow and lifted leaving the brick on the pallet. One more pallet is placed on the brick and it is carried to drying site between the two pallets. It is allowed to dry on side.

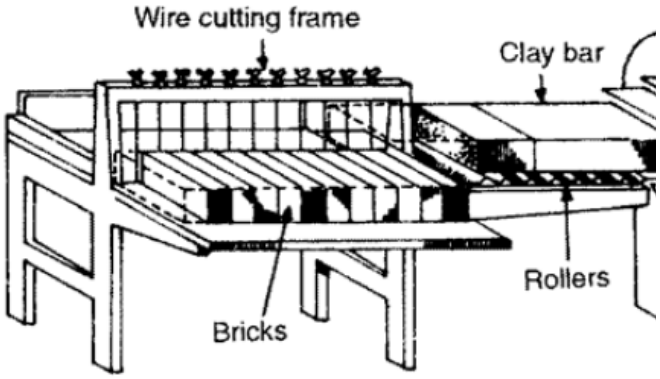


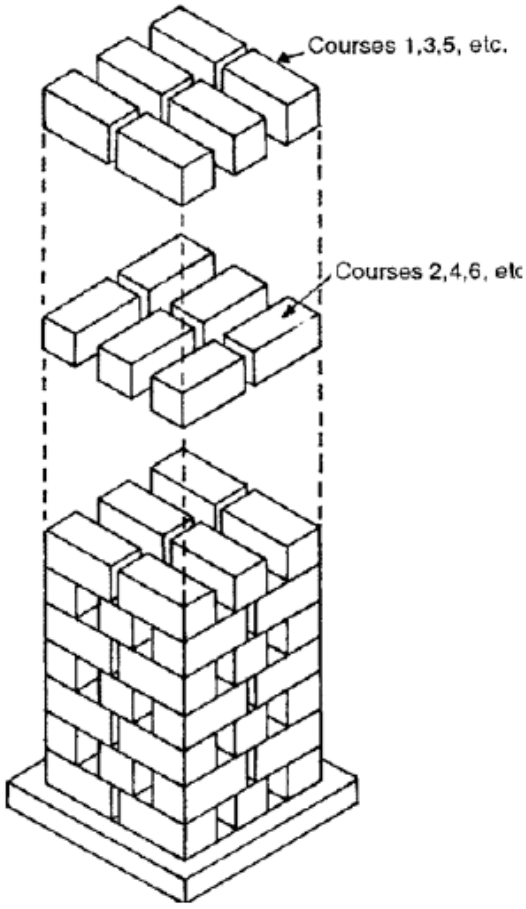


Stock Board

d. Machine molding:

There are a variety of molding machines and these machines are capable of manufacturing large number of bricks quickly. The bricks molded in machine have better / sharp edges / smooth surface, stronger than hand molded bricks etc.





6.3 DRYING OF BRICKS

Before burning it is essential that the bricks have dried and have become sufficiently hard to be handled and stacked in kilns without getting damaged.

Also if the bricks have not completely dried then they are likely to get cracked and distorted when burnt in the kiln.

The following points are kept in view to ensure successful completion of drying operation.

i. As soon as the molded bricks become dry enough so that they do not get damaged on handling they should be turned on edge and left for a day or two more to further harden. In the initial stage of drying, bricks should be protected from sever sun and winds as otherwise rapid drying of bricks might result in their developing cracks.

ii. They should then be stacked in such a way that each brick gets full circulation of air all around it. Best form of stack is of a breadth equal to two bricks laid longitudinally with interval between them. The alternate layers being along and across the stack and all placed on edges.

iii. The drying area should be higher than the surroundings so that it does not get flooded due to any occasional rain. It should have a gentle slope to facilitate drainage of rain water.

iv. A layer of sand should be spread at the drying area so as to keep it dry in wet weather.

v. To protect the drying, bricks from damage caused by occasional rains temporary bamboo frames and sirki should be provided. The sirkis should be weighed down with heavy planks to stop them from being blown away by winds. The height of stack may be of eight to ten layers of bricks.

A gap of about 1 m should be left between adjacent stacks so as to facilitate free movement of workers.

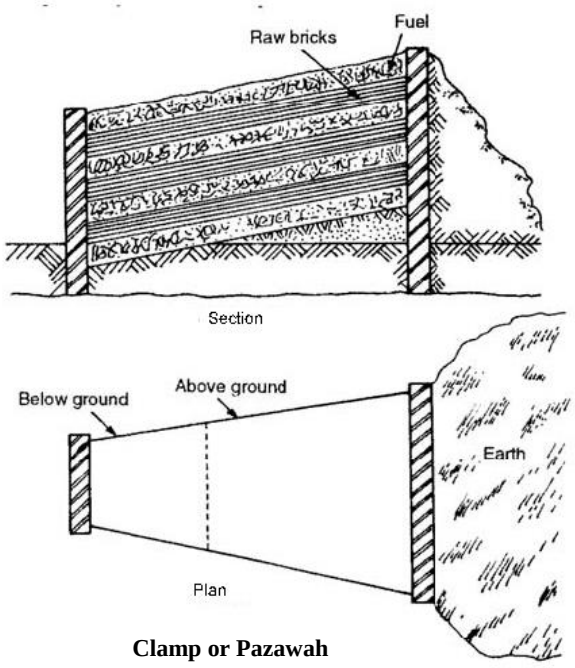
Length and height of all the stacks should be kept the same. Every stack should contain bricks in multiples of a thousand. This shall make it easy to count the number of bricks. Depending upon weather it takes three to eight days for bricks thoroughly dry.

6.4 BURNING OF BRICKS

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

Burning in Clamp or Pazawah:

A typical clamp is shown in Fig. 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 cow dung is given, which prevents the escape of heat. The production of bricks is 2–3 lac and the process is completed in six months. This process yields about 60 per cent first class bricks.

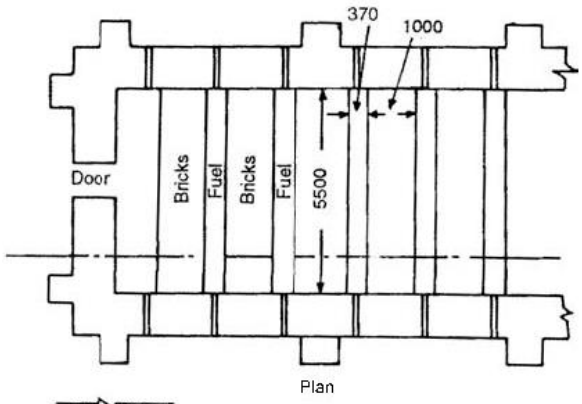


Clamp or Pazawah

Kiln Burning

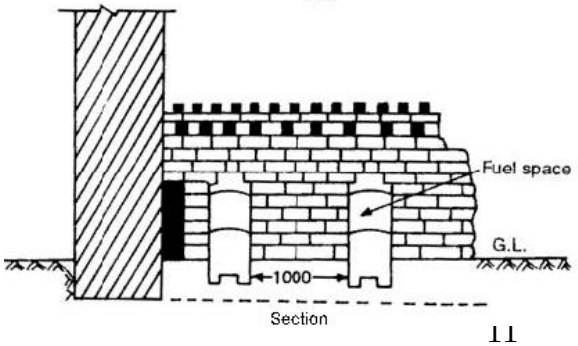
Intermittent Kiln:

The example of this type of an over ground, rectangular kiln is shown in Fig. After loading the kiln, it is fired, cooled and unloaded and then the next loading is done. Since the walls and sides get cooled during reloading and are to be heated again during next firing, there is wastage of fuel.



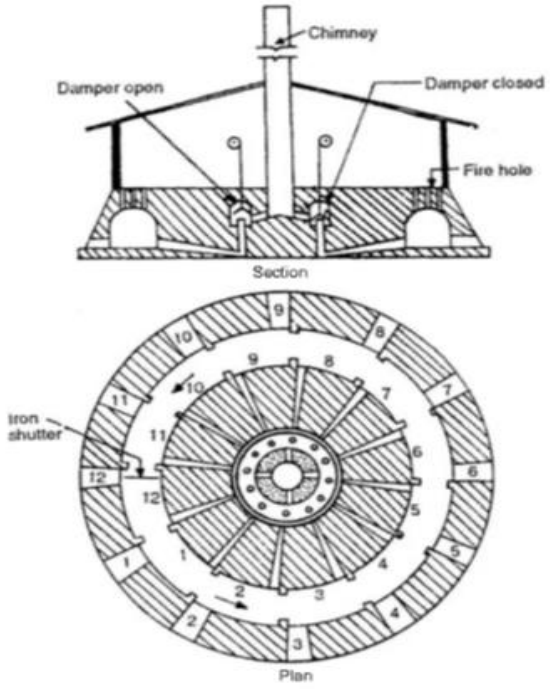
Continuous Kiln:

The examples of continuous kiln are Hoffman's kiln and Bulls trench kiln .In a continuous kiln, bricks are stacked in various chambers wherein the Bricks undergo different treatments at the same time. When the bricks in one of the chamber are

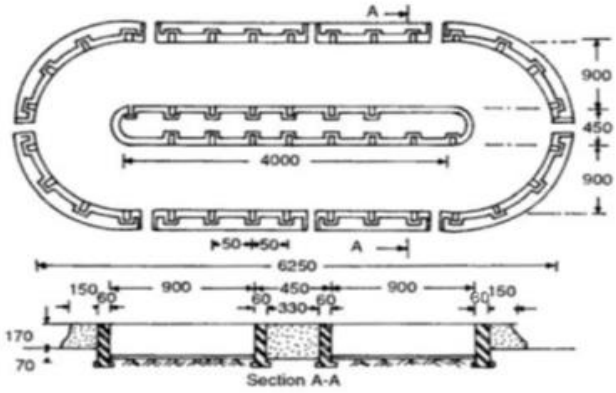


Intermittent Kiln

fired, the bricks in the next set of chambers are dried and preheated while bricks in the other set of chambers are loaded and in the last are cooled.



Hoffman's Continuous Kiln



Bull's Trench Kiln