DETERIORATION OF STONES

The stones with exposed faces are acted upon by various atmospheric and external agencies so as to cause their deterioration. The following are the causes of decay of stones.

a) Rain
b) Frost
c) Temperature Changes
d) Wind
e) Vegetable Growth
f) Living organisms
g) Chemical agents
h) Alternate wetness and drying
i) Nature of mortar
j) Impurities in atmosphere

PRESERVATION OF STONES

Preservation of stone is essential to prevent its decay. Different types of stones require different treatments. But in general stones should be made dry with the help of blow lamp and then a coating of paraffin, linseed oil, light paint, etc. is applied over the surface. This makes a protective coating over the stone. However, this treatment is periodic and not permanent. When treatment is done with the linseed oil, it is boiled and applied in three coats over the stone. Thereafter, a coat of dilute ammonia in warm water is applied. The structure to be preserved should be maintained by washing stones frequently with water and steam so that dirt and salts deposited are removed from time to time. However, the best way is to apply preservatives. Stones are washed with thin solution of silicate of soda or potash. Then, on drying a solution of $CaCl_2$ is applied over it. These two solutions called Szerelmy's liquid, combine to form silicate of lime which fills the pores in stones. The common salt formed in this process is washed afterwards. The silicate of lime forms an insoluble film which helps to protect the stones.

An ideal preservative has the following properties:

- It is harmless
- It is easily penetrated in stone surface
- It does not allow moisture to penetrate the stone surface
- It is economical
- Its application on stone surface is easy.
- It does not develop objectionable colour.

The following are the preservatives which are commonly adopted to preserve the stones i.e Coal tar, Paraffin, Solution of Baryta, Paint, Linseed oil, Solution of alum and soap.

BRICKS

One of the oldest building material brick continues to be a most popular and leading construction material because of being cheap, durable and easy to handle and work with. Clay bricks are used for building-up exterior and interior walls, partitions, piers, footings and other load bearing structures. A brick is rectangular in shape and of size that can be conveniently handled with one hand. Brick may be made of burnt clay or mixture of sand and lime or of Portland cement concrete. Clay bricks are commonly used since these are

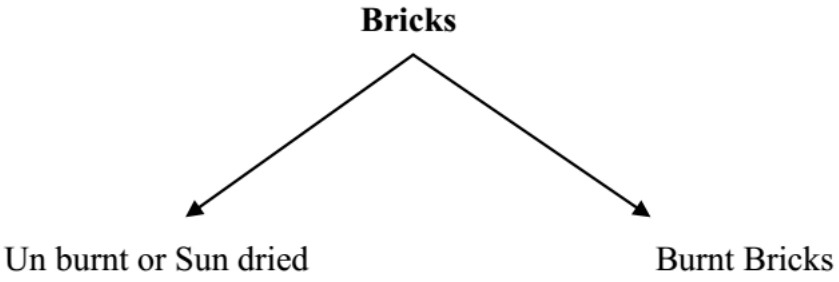
economical and easily available. The length, width and height of a brick are interrelated as below:

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

Size of a standard brick (also known as modular brick) should be 19 × 9 × 9 cm and 19 × 9 × 4 cm.

When placed in masonry the 19 × 9 × 9 cm brick with mortar becomes 20 × 10 × 10 cm. However, the bricks available in most part of the country still are 9" × "× 3" and are known as field bricks. Weight of such a brick is 3.0 kg. An indent called frog, 1–2 cm deep, as shown in Fig. 5, is provided for 9 cm high bricks. 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. Frog is not provided in 4 cm high bricks and extruded bricks.

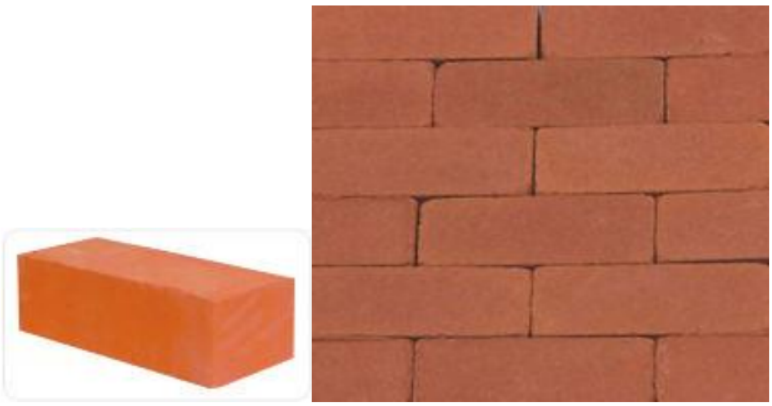
CLASSIFICATION OF BRICKS



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:



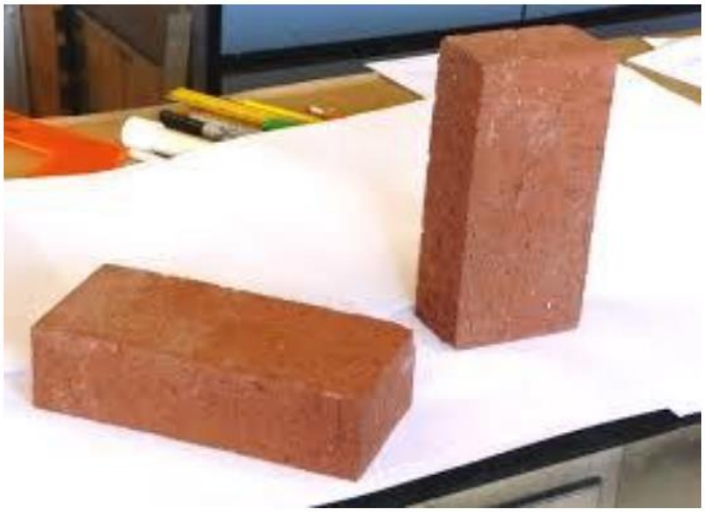
First class bricks

These bricks are burnt in kilns and are table molded of standard shape. The surfaces and edges of the bricks are sharp, square, smooth and straight. These bricks are used for superior work of permanent nature. These bricks should have uniform texture and should be free from flaws, cracks and stones. These bricks are thoroughly burnt and are deep red ,or copper colour. No impression should be seen on the brick when a scratch is made by a finger nail. The crushing strength of the brick should not be less than 10 $N/mm^{2.}$ .This limit varies with various government organizations around the country. The water absorption should be 12-15% of its dry weight when immersed in cold water for 24 hours. A ringing or metallic sound should come when two bricks are struck against each other.

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

Second Class Bricks:

These bricks are ground moulded and they are burnt in kilns. The surface of these bricks is somewhat rough and shape is also slightly irregular. 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. This second class bricks are supposed to have the same requirements as the first class ones except that



Second class bricks

1. Small cracks and distortions are permitted.
2. A little higher water absorption of about 16–20% of its dry weight is allowed.
3. 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.

Third Class Bricks:

Third class bricks

These third class bricks are under burnt, ground moulded and are burnt in clamps. They are soft and light-coloured producing a dull sound when struck against each other. These bricks are not hard and they have rough surfaces with irregular and distorted edges. Water absorption is about 25 per cent of dry weight.

Uses : It is used for building temporary structures and at places where rainfall is not heavy

Fourth Class Bricks:

These bricks are overburnt with irregular shape and badly distorted in shape and size and are brittle in nature. They are dark in colour.

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

Fourth class bricks

MANUFACTURING OF CLAY BRICKS

The following four distinct operations are involved in the process of manufacturing bricks:

1) Preparation of Clay
2) Molding
3) Drying
4) Burning

1. **Preparation of Clay:**

Preparation of clay takes place in the following order.

- ❖ Unsoiling
- ❖ Digging
- ❖ Cleaning
- ❖ Weathering
- ❖ Blending
- ❖ Tempering

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.

i) 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. The digging operation should be done before rains.

ii) Cleaning and 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. The soil should be turned over at least twice and it should be ensured that the entire soil is wet throughout the period of weathering. In order to keep it wet, water may be sprayed as often as necessary. The plasticity and strength of the clay are improved by exposing the clay to weather.

iii) 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. Addition of water to the soil at the dumps is necessary for the easy mixing and workability, but the addition of water should be controlled in such a way that it may not create a problem in moulding and drying. Excessive moisture content may effect the size and shape of the finished brick.

iv) Tempering:

Tempering consists of kneading the earth with feet so as to make the mass stiff and plastics(by plasticity, we mean 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 bricks on a large scale, the tempering is usually done in a pug mill and the operation is called pugging. The process of grinding clay with water and making it plastic is known as the pugging.

A typical pug mill capable of tempering sufficient earth for a daily output of about 15000 to 20000 bricks . A pug mill consists of a conical iron tub with cover at its top. It is fixed on a timber base which is made by fixing two wooden planks at right angles to each other. The bottom of tub is covered except for the hole to take out pugged earth. The diameter of pug mill at bottom is about 800mm and that at top is about one metre.

The provision is made in top cover to place clay inside the pug mill. A vertical shaft with horizontal arms is provided at the centre of iron tub. The small wedge-shaped knives of steel are fixed on horizontal arms. The long arms are fixed at the top of vertical shaft to attach a pair of bullocks. The ramp is provided to collect the pugged clay. The height of pug mill is about 2 m. Its depth below ground is about 600mm to 800mm to lessen the rise of the barrow run and to throw out the tempered clay conveniently.

In the beginning , the hole for pugged clay is closed and clay with water is placed in pug mill from the top. When the vertical shaft is rotated or turned by a pair of bullocks, the clay is thoroughly mixed up by the actions of horizontal arms and knives and a homogeneous mass is formed. The rotation of vertical shaft can also be achieved by using steam, diesel or electric power. When clay has been sufficiently pugged, the hole at the bottom of tub, is opened out and the pugged earth is taken out from ramp by barrow i.e., a small cart with two wheels for the next operation of moulding. The pug mill is then kept moving and feeding of clay from top and taking out of pugged clay from bottom are done simultaneously. If tempering is properly carried out, the good brick earth can then be rolled without breaking in small threads of 3mm diameter.

2) Moulding:

The clay which is prepared as above is then sent for the next operation of moulding. Following are the two ways of moulding:

- Hand moulding
- Machine moulding.

a) Hand moulding:

In hand moulding, the bricks are moulded by hand i.e., manually. It is adopted where manpower is cheap and is readily available for the manufacturing process of bricks on a small scale. The moulds are rectangular boxes which are open at top and bottom. They may be of wood or steel.

A typical wooden mould should be prepared from well seasoned wood. The longer sides are kept slightly projecting to serve as handles. The strips of brass or steel are sometimes fixed on the edges of wooden moulds to make them more durable. A typical steel mould is prepared from the combination of steel plates and channels. It may even be prepared from steel angles and plates. The thickness of steel mould is generally 6mm. They are used for manufacturing bricks on a large scale. The steel moulds are more durable than wooden moulds and they turn out bricks of uniform size. The bricks shrink during drying and burning.

The bricks prepared by hand moulding are of two types:

i) Ground Moulded Bricks

ii) Table Moulded Bricks

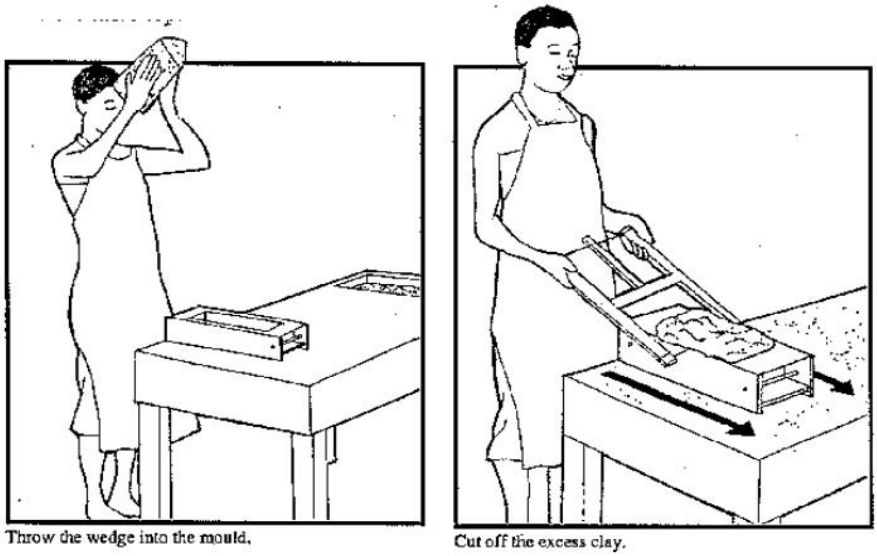
Ground Moulding:

This method is adopted when a large and level land is available. In this process, the ground is levelled and sand is sprinkled on it, to prevent the moulded bricks from sticking to the side of the mould. 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. The bricks prepared by dipping mould in water everytime are known as slop moulded bricks. The fine sand may be sprinkled on the inside surface of mould instead of dipping mould in water. Such bricks are known as the sand – moulded bricks and they have straight and sharp edges.

A brick moulder can mould about 750 bricks per day with working period of 8 hours. When such bricks become sufficiently dry, they are carried and placed in the drying sheds.

Table Moulding:

In this method the bricks are moulded on stock boards nailed on the moulding table. Stock boards have the projection for forming the frog. The process of filling clay in the mould is the same as in case of ground moulding. 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.



Throw the wedge into the mould.

Cut off the excess clay.

b) **Machine moulding:**

The moulding may also be achieved by machines. It proves to be economical when bricks in huge quantity are to be manufactured at the same spot in a short time. It is also helpful for moulding hard and strong clay. These machines are broadly classified in two categories:

a) Plastic clay machines
b) Dry clay machines

Plastic clay machines:

Such machines contain a rectangular opening of size equal to length and width of a brick. The 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. The arrangement is made in such a way that strips of thickness equal to that of the brick are obtained. As the bricks are cut by wire, they are also known as the wire cut bricks.

Dry clay machines: In these machines, the strong clay is first converted into powder form. A small quantity of water is then added to form a stiff plastic paste. Such paste is placed in mould and pressed by machine to form hard and well shaped bricks. These bricks are known as the pressed bricks and they do not practically require drying. They can be sent directly for the process of burning.

The wire cut and pressed bricks have regular shape, sharp edges and corners. They have smooth external surfaces. They are heavier and stronger than ordinary hand-moulded bricks. They carry distinct frogs and exhibit uniform dense texture.