Drying:

The damp bricks, if burnt, are likely to be cracked and distorted . Hence the moulded bricks are dried before they are taken for the next operation of burning. For drying, the bricks are laid longitudinally in stacks of width equal to two bricks. A stack consists of eight or ten tiers. The bricks are laid along and across the stock in alternate layers. All bricks are placed on edge. The bricks should be allowed to dry till they become leather hard or bone –dry with moisture content of about 2 percent or so.

The important facts to be remembered in connection with the drying of bricks are as follows:

i) Artificial Drying: The bricks are generally dried by natural process. But when bricks are to be rapidly dried on a large scale, the artificial drying may be adopted. In such a case, the moulded bricks are allowed to pass through special layers which are in the form of tunnels or hot channels or floors. Such dryers are heated with the help of special furnaces or by hot flue gases. The tunnel dryers are more economical than hot floor dryers and they may be either periodic or continuous. In the former case, the bricks are filled , dried and emptied in rotation. In the latter case, the loading of bricks is done at one end and they are taken out at the other end. The temperature is usually less than $120^{o}C$ and the process of drying of bricks takes place 1 to 3 days depending upon the temperature maintained in the dryer, quality of clay product etc.

ii) Circulation of air:

The bricks in stacks should be arranged in such a way that sufficient air space is left between them for free circulation of air.

iii) Drying yard: For the drying purpose, special drying yards should be prepared. It should be slightly on a higher level and it is desirable to cover it with sand. Such an arrangement would prevent the accumulation of rain water.

iv) Period of drying: The time required by moulded bricks to dry depends on prevailing weather conditions. Usually it takes about 3 to 10 days for bricks to become dry.

v) Screens: It is to be seen that bricks are not directly exposed to the wind or sun for drying. Suitable screens, if necessary, amy be provided to avoid such situations.

Burning:

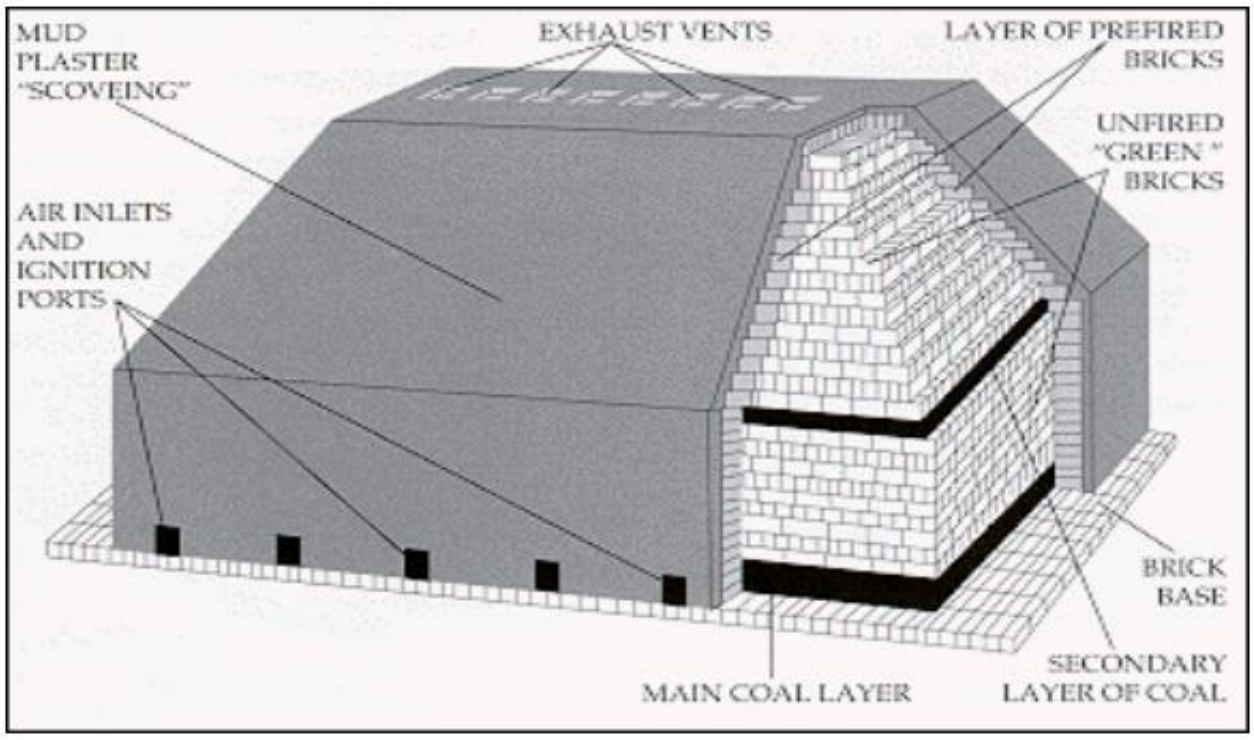
This is a very important operation in the manufacture of bricks. It imparts hardness and strength to the bricks and makes them dense and durable. The bricks should be burnt properly. If bricks are over burnt, they will be brittle and hence break easily. If they are under burnt, they will be soft and hence cannot carry loads. When the temperature of dull red heat, about 650^{o}C, is attained, the organic matter contained in the brick is oxidized and also the water of crystallization is driven away. But heating of bricks is done beyond this limit for the following purposes:

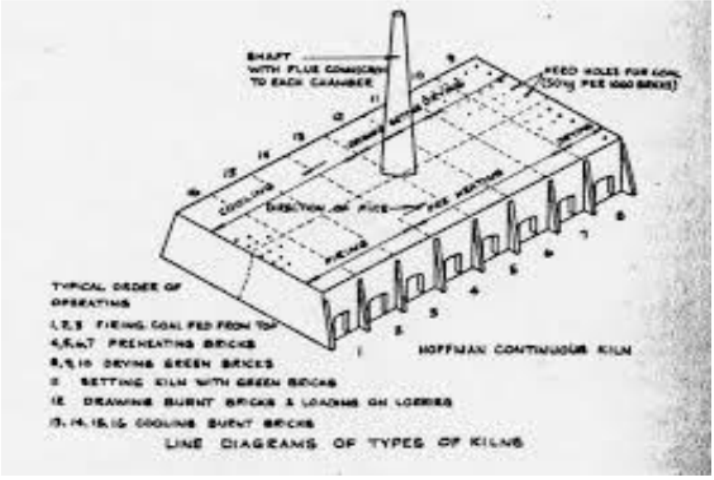
i) If bricks are cooled after attaining the temperature of about 650°C, the bricks formed will absorb moisture from the air and get rehydrated.

ii) The reactions between the mineral constituents of clay are achieved at higher temperature and these reactions are necessary to give new properties such as strength, hardness, less moisture absorption etc. to the bricks.

When the temperature of about 1100oC is reached, the particles of two important constituents of brick clay, namely alumina and sand, bind themselves together resulting in the increase of strength and density of bricks. Further heating is not desirable and if the temperature is raised beyond 1100°C, a great amount of fusible glassy mass is formed and the bricks are said to be vitrified. The bricks begin to loose their shape beyond a certain limit of verification.

The burning of bricks is done either in clamps or in kilns. The clamps are temporary structures and they are adopted to manufacture bricks on a small scale to serve a local demand or a specific purpose. The kilns are permanent structures and they are adopted to manufacture bricks on a large scale.





TESTS FOR BRICKS

A brick is generally subjected to the following tests to find out its suitability for the construction work.

i. Water absorption
ii. Shape and size
iii. Crushing strength
iv. Hardness
v. Presence of soluble salts
vi. Soundness
vii. Structure

□ Water Absorption:

A brick is taken and it is weighted dry. It is then immersed in water for a period of 16 hours. It is weighted again and the difference in weight indicates the amount of water absorbed by the brick. It should not, in any case exceeds 20 per cent of dry weight of dry brick.

Determination of Water Absorption of Brick ((IS: 3495-PART 2-1992)

Objective: For determination of water absorption of bricks

Reference Standards: IS : 3495 (Part-2)-1992,RA 2011

Equipment & Apparatus: Balance (0-10 kg)

Procedure:

1. The specimen is dried in a ventilated oven at a temperature of 105 to 115^{0}C; till it attains substantially constant mass. The specimen is cooled to room temperature and its weight is recorded (M_1)
2. The dried specimen is immersed completely in clean water at a room temperature of 27±2^{0}C for 24 hours.
3. The specimen is then removed and any traces of water are wiped out with a damp cloth and the specimen is weighed. The weighing is completed 3min after the specimen has removed from water(M_2)

Calculation:

Water absorption, percent by mass after 24 hours immersion in cold water is given by the following formula

$$\text{Water absorption} = \frac{M_2 - M_1}{M_1} \times 100$$

Reports:

The water absorption of brick shall be reported to the nearest one percent.

Safety & Precautions:

- Use hand gloves while removing containers from oven after switching off the oven.
- Thoroughly clean & dry the container before testing.
- Special care should be taken that no outer air enters when using the balance.
- To wear safety shoes & apron at the time of test.

Size, shape and color test: In this test randomly collected 20 bricks are staked along lengthwise, widthwise and height wise and then those are measured to know the variation of sizes as per standard. Bricks are closely viewed to check if its edges are sharp and straight and uniform in shape. A good quality brick should have bright and uniform color throughout.

Crushing strength/Compression strength:

The crushing strength of a brick is found out by placing it in a compression testing machine. It is pressed till it breaks. As per IS: 1077-1970, the minimum crushing or compressive strength of bricks is 3.50 N/mm^2. The bricks with crushing strength of 7 to 14 N/mm^2 are graded as A and those having above 14 N/mm^2 are graded as AA.

Determination of Compression strength of Brick (IS:3495-PART 1-1992)

Objective: For the determination of compressive strength of bricks

Reference Standard:IS: 3495 – P (1)-1992-Methods of tests of burnt clay building bricks (Determination of compressive strength)

Equipment & Apparatus: a) Compression Testing machine

b) Scale for measuring dimension of brick

Procedure:

1. Unevenness observed in the bed faces of bricks is removed to provide two smooth and parallel faces by grinding. It is immersed in water at room temperature for 24 h.
2. The specimen is then removed and any surplus moisture is drained out at room temperature. The frog and all voids in the bed face is filled with cement mortar (1 cement, clean coarse sand of grade 3 mm and down). It is stored under the damp jute bags for 24 h followed by immersion in clean water for 3 days.
3. The specimen is placed with flat faces horizontal, and mortar filled face facing upwards between two 3 ply plywood sheets each of 3 mm thickness and carefully centered between plates of testing machine.
4. Load is applied axially at a uniform rate of 14 N/mm^2 per minute till failure occurs. The maximum load at failure is noted down. The load at failure is considered the maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine.

5. 

Compression Testing Machine

Calculation:

Reports:

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

Five numbers of bricks should be tested and the average value is reported.

Safety & Precautions:

- Safety shoes should be used at the time of testing.
- Before testing, CTM machine should be properly checked.

Hardness test: In this test a scratch is made on brick surface with a hard thing. If that doesn't left any impression on brick then that is good quality brick.

Presence of soluble salts/ Efflorescence:

The soluble salts, if present in bricks, will cause efflorescence on the surface of bricks. For finding out the presence of soluble salts in a brick, it is immersed in water for 24 hours. It is then taken out and allowed to dry in shade. The absence of grey or white deposits on its

surface indicates absence of soluble salts. If the white deposits cover about 10 per cent surface, the efflorescence is said to be slight and it is considered as moderate, when the white deposits cover about 50 per cent of surface, the efflorescence becomes heavy and it is treated as serious, when such deposits are converted into powdery mass.

Efflorescence on plaster

Determination of Efflorescence of Bricks(IS: 3495-PART 3-1992)

Objective: For determination of efflorescence of bricks

Reference Standards: IS: 3495 – Part (3)-1992

Equipment & Apparatus: Oven (300^0c)

Procedure:

1. A shallow flat bottom dish containing sufficient distilled water to completely saturate the specimens is used for the test. The ends of the bricks are placed in the dish, the depth of immersion in water being 25 mm.
2. The whole arrangement is placed in a warm (between 20^0C and 30^0C) well ventilated room until all the water in the dish is absorbed by the specimens and the surplus water evaporates.
3. The dish containing the brick is covered with a suitable glass cylinder so that excessive evaporation from the dish may not occur.
4. When the water has been absorbed and brick appears to be dry, a similar quantity of water is placed in the dish and it is allowed to evaporate as before. Examine the bricks for efflorescence after the second evaporation and the results are reported.

Reports:

The liability to efflorescence shall be reported as 'Nil', 'Slight', 'Moderate', 'Heavy' or 'Serious' in accordance with the following definitions

(a) Nil : When there is no perceptible deposit of efflorescence

(b) Slight : When not more than 10 percent of the exposed area of brick is covered with a thin deposit of salts

(c) Moderate: When there is a heavier deposit than under 'Slight' and covering up to 50 percent of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.

(d) Heavy: When there is a heavy deposit of salts covering 50 percent or more of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.

(e) Serious: When there is a heavy deposit of salts accompanied by powdering and / or flaking of the exposed surfaces

Safety & Precautions:

- Use hand gloves while removing containers from oven after switching off the oven.
- Thoroughly clean & dry the container before testing.
- Use apron & safety shoes at the time of testing.

Soundness test: In this test two bricks are held by both hands and struck with one another. If the bricks give clear metallic ringing sound and don't break then those are good quality bricks.

Structure test: In this test a brick is broken or a broken brick is collected and closely observed. If there are any flows, cracks or holes present on that broken face then that isn't good quality brick.

Special purpose bricks: Fire-clays:

The fire-clay is refractory clay which is capable of resisting a high temperature without being melted or softened. It is used for making refractory materials. A refractory material is able to stand a high temperature without losing its shape. Thus the fire-clay is used in the manufacture of fire-bricks, crucibles, lining materials for furnaces, hollow tiles, etc.

The earth that is available from under the coal seams is generally found to be good fire-clay. The constituents of a good fire-clay are two- alumina and silica. The percentages of alumina vary from 25 to 35 and that of silica from 75 to 65. In any case, the impurities such as lime, magnesia, iron oxide and alkalies should not exceed 5 per cent.

Depending upon the fire resisting capacity , the fire-clays are classified into the following three categories:

i. High duty fire-clays
ii. Medium duty fire-clays
iii. Low duty fire clays.

The high duty fire clays can resist temperature range of 1482'c to 1648'c. The medium duty fire clays can resists temperature range of 1315'c to 1482'c and the low duty fire-clays can resist temperature upto 870'c only.

Fire-Bricks:

These bricks are made from fire clay. The process of manufacture is the same as that of ordinary clay bricks. The burning and cooling of fire bricks are done gradually. These bricks are usually white or yellowish white in color. The weight of the fire brick is about 30-35 N. The fire bricks can resist high temperature without softening or melting. Hence they are used for linings of interior surface or furnaces, chimneys, kilns, ovens, fire places etc. The compressive strength of this bricks varies from 200 to 220N/mm2. The percentage of absorption for these bricks varies from 5-10.

Following are the three varieties of fire bricks,

i. Acidic bricks
ii. Basic bricks
iii. Neutral bricks

Acidic bricks: these bricks are used for acidic lining. Following are the types of acidic bricks.

a. Ordinary fire bricks: these bricks are prepared from natural fire clay and they provide a good material for acidic refractory lining.
b. Silica bricks: these bricks contain a very high percentage of silica to the extent of about 95-97%. A small quantity of lime about 1-2% is added to work as binding material.

These bricks are moulded under pressure and burnt at high temperature. The silica bricks can stand a high temperature upto about 2000'c. The compressive strength of such bricks is about 15 N/mm^2

Basic bricks: These bricks are used for basic lining and basic refractory materials are used in the manufacture of such bricks. The magnesia bricks are preferred from lime and magnesia rocks. The dolomite may also be adopted for the manufacture of these bricks.

Neutral bricks: these bricks are used for neutral lining. They offer resistance to the corrosive action of slag and acid fumes. As compared to the basic bricks , the neutral bricks are more inert to the slag. Following are the types of neutral bricks.

- Coromite bricks: these bricks are prepared from a mixture of chrome, iron ore, ferrous oxide, bauxite and silica. Such bricks are unaffected by acidic or basic actions.
- High-alumina bricks: these brick contain a high percentage of alumina and they are found to be more inert to the slag.

Concrete blocks:

i. Raw materials: the materials required for the production of the concrete blocks are aggregates, cement and water. The aggregates of various types have been used with varying degree of success and they include crushed stones, gravel, volcanic cinders, foamed slag, furnace clinkers etc. The aggregates are selected by considering the weight, texture are composition of the unit designed. The strength, texture and economy of the concrete block depend upon the careful grading of the aggregate. If locally available aggregate is suitable it will help in achieving the economy.

Concrete blocks wall

The cement used is ordinary Portland cement. The water required is the normal potable water.

Manufacturing: the fully automatic plants are available for the manufacture of high strength concrete blocks. These automatic machines produce superior quality Concrete blocks. But they involve a large capital investment. The manually operated machine are also available

and they can be installed at project site itself which further reduce the transportation cost of the concrete blocks from the place of the production to the place of actual use.

Concrete blocks

The process involved in the manufacturing of the concrete blocks is as follows:

i. Selection and proportion of ingredients: The main criterion for the selection of the ingredients is the desired strength of the block. The greater the proportion of coarse aggregate, the greater will be the strength of the quantity of cement used.

ii. Mixing of ingredients: the blending of aggregates, cement, and water should be done very carefully. The mixing should be preferably take place in the mechanical mixer. For hand mixing , the extreme care should be taken to see that the cement and aggregates are first mixed thoroughly in dry state and the water is then added gradually.

iii. Placing and vibration: the mixed concrete is fed into the mould box upto the top level and it is ensured that the box is evenly filled. The vibration of concrete is done till it has uniformly settled in the mould box.

iv. Curing: the block is watered after about one day of casting and it is continued for a minimum of 7 days and preferably till 28 days. The longer the curing period, the better will be the block.

Advantages: the use of concrete blocks is as masonry unit can be observed on many construction sites because of the following advantages;

a. It increase the carpet area of the building because of small width of concrete block as compared to the brick masonry wall.
b. It provides better thermal insulation, enhanced fire resistance and sound absorption.
c. It results in the saving of precious agricultural land which is used for the manufacture of bricks.
d. The blocks can be prepared in such a manner that the vertical joints can be staggered automatically and thus the skilled supervision is reduced.
e. The construction of concrete block masonry is easier, faster and stronger than the brick masonry.
f. The perfect shape and size of the concrete block makes the work of a mason much simpler.
g. There is saving in construction of mortar because the numbers of joints are reduced.
h. The utility can be further increased by producing the Reinforced Concrete Block (RCB) masonry units. The blocks are provided two holes for placing suitable reinforcing bars and the structures with RCB units could safely resist wind and earthquakes, if so designed. The traditional beams and columns could be completely eliminated and the structure with RCB units can be given a better appearance.

Uses: In view of the advantages mentioned above, the concrete block masonry technique of construction can be adopted on a large scale for mass housing and various civil engineering projects.