Bricks

3. Definition : A brick is an artificial kind of stone made of clay whose chief characteristics are a plasticity when wet and stone like hardness after being heated to high termperatute.

3.2 Factors that Affect the Quality of Bricks : The following are the factors on which the quality of bricks depends :

1. Chemical properties of the clay used.
2. Preparation of the clay.
3. Process of drying.
4. Different degress of buning.

3.3 Constituents of Brick Clay and Their Functions : A good brick-clay should be such a mixture of pure clay and sand that when prepared with water, it can easily be moulded and dried without cracking or warping. It should also contian alumina, (aluminum oxide) lime. iron oxside add magnesia (magnesium oxide). Chemical analysis of a good brick-clay should give the following chemical

Silica	55%
Alumina	30%
Iron oxide	8%
Magnesia	5%
Lime	1%
Organic matters	1%
	100%

Silica : Silica exists in all clays in a state of chemical combination with alumina forming silicate of alumina and

some times exists in a free state when it is called flint or sand. The presence of sand prevents cracking, shrinking, and warping. The higher the proportion of sand, the more shapely and uniform in texture shall be the brick. But too much of sand makes the brick brittle and weak.

Alumina (Aluminum Oxide) : The, is the principal constituent of brick clay. It imparts plasticity to clay which is very essential for the prupose of moulding. It also imparts density. But the clay containing too much alumina should not be used decease bricks will crack and warp buring drying and becomes very hard under the influence of heat.

Iron Oxide : The presence of iron oxide in clay enhances the impermeable and durable qualities. Iron and lime in small quantities give creamy colour to bircks. the colour of bircks is very much dependent upon the conents of iron and the colour ranges from light yellow to orange and red. The colour gradually depens to red and then purple as the iron content goes up 8%. By adjusting the burning temperature, red colour due to iron oxide or back colour due to presence of manganese can be produced. Magnesia in presence of iron makes the brick yellow.

Magnesia (Magnesium Oxide) : Presence of magnesia in small quantity decseases shrinkage and gives yellow tint.

Lime : It reduces shrinkage of bricks during drying and enables the silica to melt in burning and thus binds the particles of brick together. In excess, however, it will cause the brick to fuse too readily and the shape will be lost. Lime should be present in a very finely divided state. Because, if present in the form of lumps it is very injurious to bricks, because on buring it becomes quick lime and absorbs moisture causing disintegration.

Alkalies and Organic Matter : A small quantity of organic mater will assist burning bricks. Excess is bad, becuse if it

is not completely burnt, the bricks will be porous. Small quantity of alkalies will lower the fusion point of clay.

3.4 Harmful constituents of Brick-Clay :

Iron Pyrites : Presence of pyrites cause crystallization and disintegration of bricks on burning.

Alkalies : They are mainly the chlorides and sulfates of calcium, magnesium, sodium and potassium. They produce a dark greenish hue on the surface of bricks on drying. They cause the bricks to fuse, twist, and warp during. Alkalies in bricks absorb moisture from and on drying cause efflorescence.

Stone Particles : Small particles of stones do not allow the clay to be mixed thoroughly and uniformly. These are harmful to the uniformity of brick-textuer. These make bricks porous and weak.

Vegetation and Organic Matter : They make the bricks porous and weak because vegetations and organic matter get burnt during the burning of bricks leaving small pores in them.

Lime : Lime if present in excess causes the brick to fuse too readily and the shape is lost. Lime in the form of limestone and kankar nodules is very harmful and cause serious troubles to bricks. Because due to high heating. limestone ($CaCo_3$), is converted into lime (Cao), and carbon-di.oxide (CO_2). On contact with water, lime gets hydrated and swels and cuases the bricks to split and crumble to pieces. Limestone in the form of kankar nodules should not be present because it deteriorates the quality of a good brick.

3.5 Manufacturing of Bricks : The following are the different steps in manufacturing bricks.

Selection of Brick- Clay : Brick-clay should be free from harmful constituents. The sedimentary deposits of clay are

generally quite suitable for the manufacture of bricks. It is necessary that a few sample bricks should be made first and the suitability of the clay is judged from the product. The proportion of different constituents of clay could then be adjusted. To manufacture bricks on a large scale and analysis of the clay constituents is to be made to determine their best proportions.

Preparation of Brick-Clay : First selection is made where from the brick-clay is to be excavated and this earth is exavated before the rains and spread out or the gound for sometimes. This process is termed as weathering and has an important effect on the plasticity and strengh of the clays. The clay should be kept moist during the period it is weathered. About 100 cu. ft of clay is required for manufacturing of 1000 nos. of standard bricks. The quality of brick-clay is to be improved (if there is any deficit of important constituent inqredients) by adding sand lime, alumina and magnesia. This process is known as blending.

The clay is then cut slashed and well worked with spade and is trodden which makes it soft. This process is known as tempering. Water is gradually added when tempering is in progress. The clay is well tempered by kneading it under feet of men and cattle into a stiff condition and thereby the clay is made homogeneous having uniform consistency. so that it may possess the required plasticity for moulding for large scale manufacturing of bricks.A pug mill is generally used to temper the clay shown in fig. 8.1 This consists of a conical vessel of wrought iron, 5 ft. 6 inch. high, partially (2 ft. 6 inch.) burried underground. It is provided with a central revolving shaft to which are attached horizontal blades. To these horizontal blades, small vertical wedge-shaped steel knives are fixed. Feeding of clay and water is done through the top. The shaft is rotated eigher by bullocks

or by mechanical power. When tempering is complete, the clay is forced out of an aperture at the base of the mill.

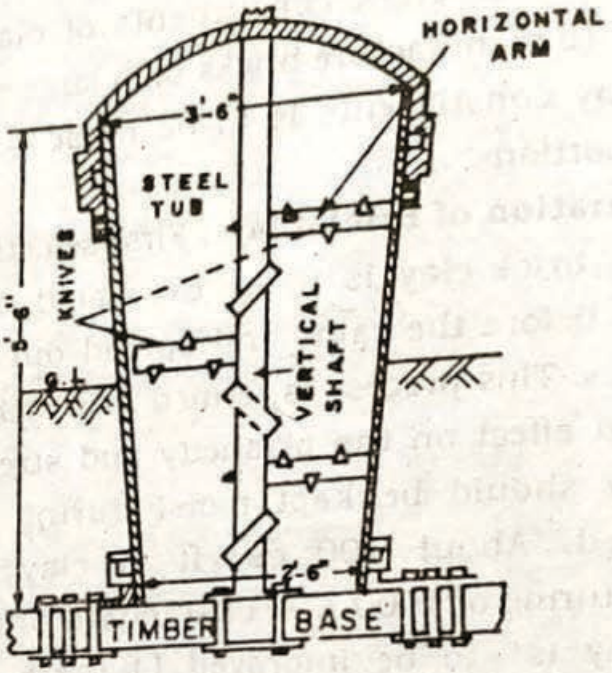
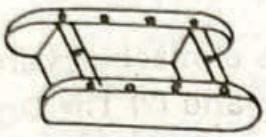


FIG. 3.1 PUG MILL

Brick Moulding : Having prepared the brick-clay as described above the next step is brick moulding. Moulds are rectangular boxes with top or bottom made of any varitey of hard wood, some times lined with iron or brass where accurate mouling is needed. The edges are protected with thin strip of iron to prevent wearing of the mould. Moulds afe sometime made of iron or brass. The mould is generally made for one brick its size being determined by the dimensions of brick required after buring. It is an usual practice to make the internal dimensions of the mould about 1/10 larger than the size of the burnt bricks to allow for shrinkage on buring. Typical brick-moulds are shown in Fig. 3.2 Generally identification marks (Frogs and Impression) are left on the face of the brick during the process of moulding to indicate the name of the manufacture of bricks. This is done by fitting a fillet or projection on the

projection on the corresponding face of the mould, usually on the lower surfac.



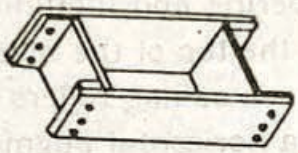


Fig. 3.2

There are two methods of moulding : (1) Hand Moulding and (2) Machine Moulding.

Hand Mouling : It is divided into two methods: (A) Ground Moulding. and (B) Table Moulding. In ground moulding the bricks are made on the gound usually in wooden moulds while in case of table moulding, they are made on a table usually with metal moulds. Table moulded bricks are superior to ground moulded bricks because of the regularity of the level and shape and also because sharp corners are obtained in table moulded bricks.

The mould is placed either on the ground made smooth and even or on a table. the tempered brick-clay is rolled up into shape slightly longer and thicket than the required brick. The rolled up clay is lifted over head with both hands and dashed with force into the mould and preseed by hand very carefully and thoroughly so as to fill the mould completly. The excess earth on the top of the mould is removed by a straight edge of wood or steel, known as stike. The usual dimension of a wood or stirke is "12 x 2" x $\frac{1}{8}$" and that of a steel strike "12 x 2" x $\frac{1}{8}$" A thin piece of wood. known as pallet board, little larger than the size of the mould. is placed on the top of the mould and the mould with the brick inside is lifted up and put upside down. The mould is then lifted leaving the wet brick on the pallet.

Before the mould is filled with clay abvoe, it is frequently dipped during use in water to prevent the clay

sticking to the mould. This is called sloup moulding Another method to secure the some object is to sprinkle fine sand or ahes over and into the mould. This is called sand mouding. Sand mouldling is considered to produce cleaner and sharper bricks.

Machine Moulding : Generally two types of machines are used namely : (1) The Plastic Clay Machine; and (?) The Dry Clay Machine. The plastic clay machine combines the process of crushing. tempering and moulding. The raw-clay is tipped into a hopper at the top of the machine.

The clay passes betwen crushing rollers and the crushed clay then passes through a horizontal pugmill. The tempered clay moves on to a mouding box and is forced from the box by reciprocating piston moved by a rack and pinion movement. alternately from either end of the box through two roller dies on to a smooth and greased platform in a continues rectangular bar. The bar as comes over the platform is cut into bricks by wires stretched across a frame shown in Fig. 3.3. The distance between the consecutive wires corresponds to the length of the bricks. The bricks are called wire-cut bricks as they are cut by wires. In this method, uniform size and density of bricks are secured.

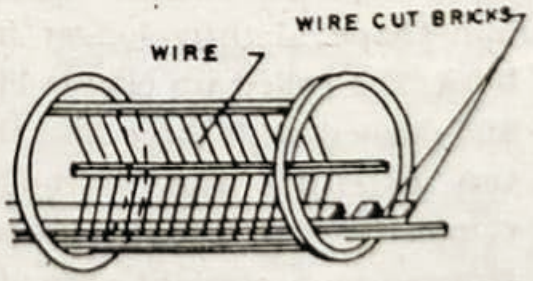


fig. 3.3

In the dry clay machine , stony clay is first ground to powder and mixed with a small proportion of water so as to form stiff plastic paste. This paste is fed through a power driven press where it is first formed into a rough clot and then shaped accurately. The bricks made by this process are very hard and compact.

Brick Drying: Before burning it is necessary to dry the bricks so that they are sufficiently hard to be handled and stocked in the burning kiln without any injury. The moulded bricks are dried by being placed on their edges for sometimes and then piled in open order in long row and stacks. The length and breadth of the stacks are generaly kept equal . This sould be carried on a slightly raisesd platform and thee surroundings should be carried on a slightly raised platform and the surroundings should be sanded to keep it dry in wet weather. To protect the bricks from the rain , they should be covered with some sort of thached roof. In Bangladesh brick- moulding is generally suspended during the monsoons.Brick-drying generally takes 5 to 12 days depending upon the local climatic conditions. In case of machine made bricks. drying is performed by circulating hot air or gases around the bricks. Great care should be taken in this system of drying because rapid drying may develop cracks in the bricks.

Brick Brurning : When drying is complete, the bricks are burnt for the followng purposes :

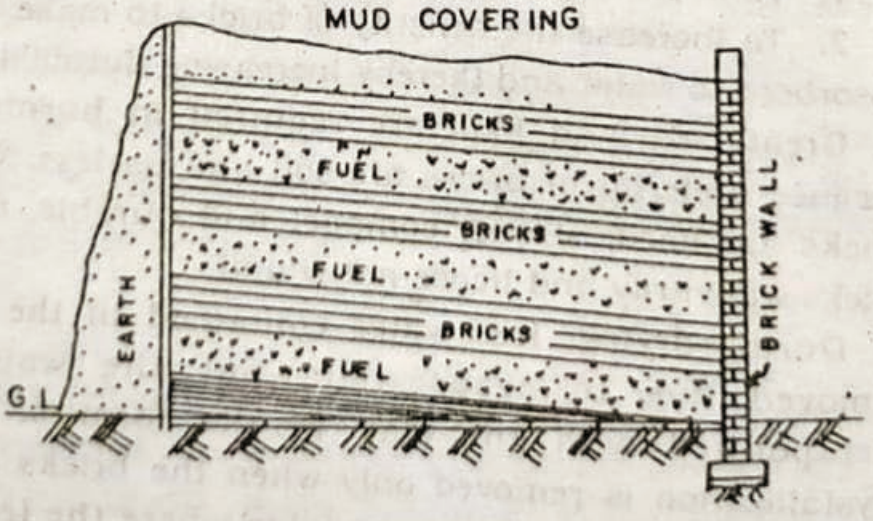
1. To impart hardness and strength to bricks.
2. To increase the denstity of bricks to make them less absorbent to water and thereby increasing durability.

Great care and skill are required in burning bricks because underburnt bricks are soft and useless. Well burnt bricks are hard, strong, compact and durable. Overburnt bricks will vitrify and hence not sound.

During drying, free water contained in the clay gets removed due to evaporation. but the water which incorporated with the clay in the form of water of crystallization is removed only when the bricks are burnt. Bricks are burnt in clamps or kilns where the temperature is raised to about 2100°F. At a temperature of about 1200°F, the organic matter present in the bricks is oxidized and disappears. When the temperature raised to about 2100°F,

certain chemical changes take place in its constituent minerals. giving new properties to the bricks. Particles of alumina and sand bind themselves together and that increases the density and strength of the bricks. Fusible glass in small quantity is produced by burnign of alumina and sand grains. But when heated beyond 2100°F, the fusible galss is formed in a much greater quantity and the bricks are said to be vitrified. Vitrification softens the bricks are said to be vitrified. Vitrification softens the bricks and they begin to loose their shape. Therefore, vitrification must be controlled so as to be just sufficient to impart the required density and strength. Bricks are burnt in clamps (Pazawha) or in kilns.

Clamp or Pazawah Burning : In clamps. bricks and fuels (grass, cowdung, wood-chips, rice-husks, jute-sticks. etc) are placed in alternate layers, shown in Fig. 3.4 and the whole male mass is plastered over with mud on the external suface.



SLOPING FLOOR OVER ONE BRICK FLAT

Fig. 3.4

The clamps are formed on the sloping ground measuring about 30' x 40'. The height is generally 8' to 12". In the first course, a layer of fuel is laid about 2".6" thick. Bricks are laid in alternate layers. The upper surface is kept sloping at an angle of about 30° in the direction of its length. The clamp is fired from below. During burning the violent outburst of flames is noticed and earth is thrown on to suppress it. When firęing is completed, the clamp is left to burn itself out thoroughly and completely. The bruning of bricks by this method is very slow. In a large of bricks can be burnt in about in about months. In this method, bricks are not uniformly burnt. Nowadays, this method has become obsolete and is used in rural areas where the quantity required is small and the quality also not of a high standard.

Kiln Burning : Kiln burning is preferred when bricks are required to be manufactured in large quantities. The kiln consists of a regular walled strucutre with proper arrangements for heating and the bricks are arranged in regular stacks. A good kiln should supply the maximum number of well burnt high class brick with less consumption of fuels (powdered coals). There are various types of kilns. the most common ones that are generally used in our country have been shown in Fig 3.5 and Fig 3.6.

Hoffman's Kiln : It is circular in plan and consists of an annular chamber by brick partitions with small opening into twelve or more compartment each of which is connected by a flue to a central chimney. Each compartment is also provided with a door-opening outward for loading and unloading bricks. When the compartments are in use, the doorway is closed by dry bricks and sand, and the joints are closed by mud filling. Holes are provided on the top of each compartment, and through these holes, fueal (powdered coal) is dropped.

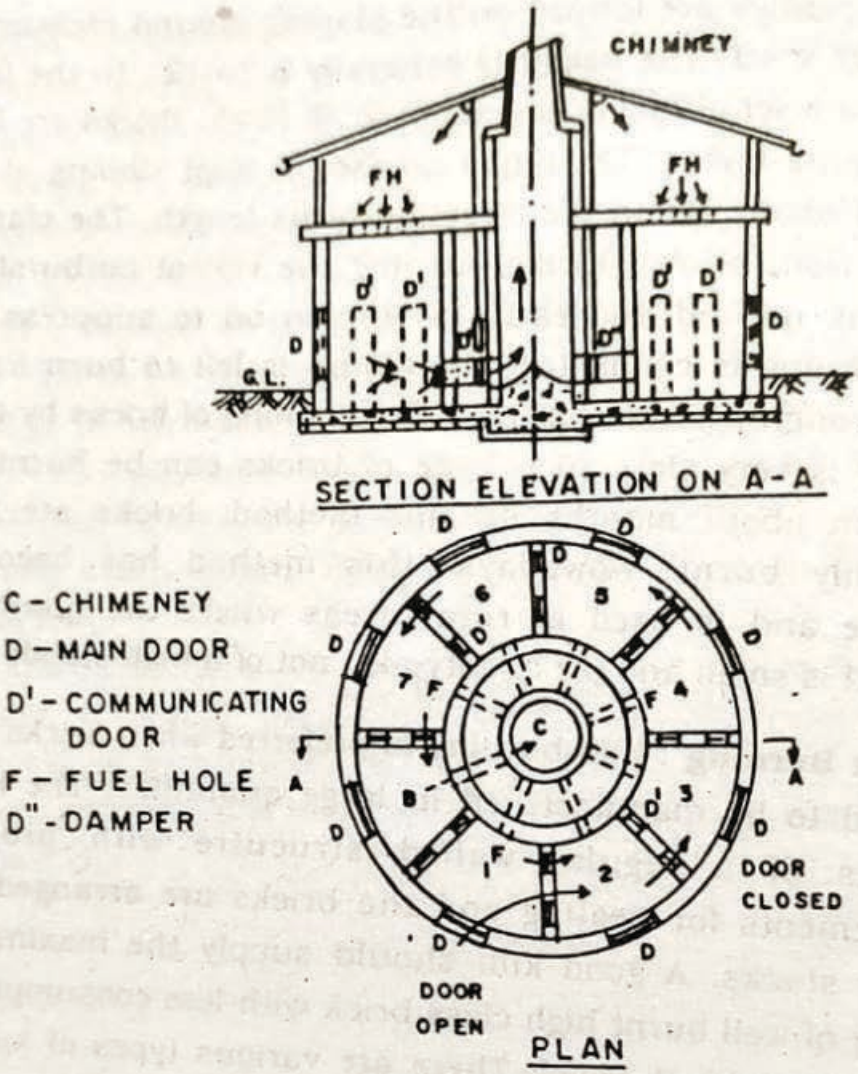


Fig. 3.5

At any particular time, each compartment of the kiln has a specific function to perform. In Fig. 3.5, compartment no. 1 is being filled up with unburnt bricks, compartmetn no. 2 contains burnt bricks which have cooled and are being unloaded, compartments nos. 3 and 4 contain bricks alrerdy burnt that are being cooled down, compartment nos. 5 and 6 contain bricks which are being supplied with fuels and compartment nos. 7 and 8 contain bricks which are being dried and preheated. Due to continuty in operation form the loading of the new bricks. this type of kiln is also termed as continuous kiln. The kiln, shown in Fig. 3.5 has got 8

compartmets. Depending upon the output desired, continues kiln may have 12, 16 or 20 compartment's.

Generally cool air enters through the open door of the compartment nos. 1 and 2, passes through the cooling compartment nos. 3 and 4 them enters into a heated condition in the burning compartment nos. 5 and 6 and finally the hot flue gases enter compartment nos, 7 to 8.

In a moderately sized kiln, each compartment, if made about 36 ft. long, 15 ft. mean width an 8 ft. high, will hold 25,000 bricks and 8x25,000=2,00,000 bricks may, therefore, be burnt in 12 days. Such a kiln will, therefore, burn approximately 60 lakhs of bricks annually.

ADVANTAGES AND DISADVANTAGES OF HOFFMAN'S KILN :

Advantages : (1) Economy of fuel : (2) Uniform burning of bricks, (3) Regulation of heat, (4) Preheating of unburnt bricks (5) Higher precentage of good bricks (6) Regularity of supply (7) No smoke as the combustion of the fuel is

Disadvantages : Only one that is the high initial cost of construction.

Trench or Tunnel Kiln : This type of kiln is continuous in operation, consists of a tunnel of generally 200 ft. long 18 to 24 ft. wide and 6 to 8 ft. deep, rectangular, circular or oval in plan. Of course, the length of the kiln depends upon the site available and the number of bricks to be manufactured. The most common shape of the kiln is an oval one with semicircular ends to save space, but in this case irregularity of buring bricks result as firing appreaches or leaves the semicircular ends. A typical oval shaped kiln with semicircular ends is shown in Fig. 3.6. Uniformity in burning is generally results in a circular section and the second best in the rectangular section.

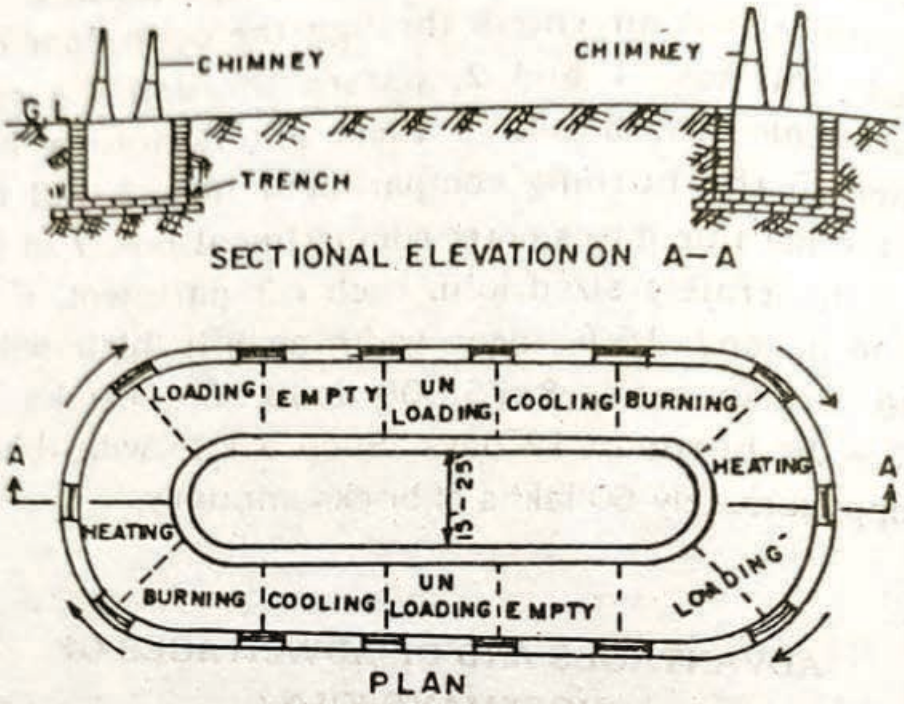


Fig : 3.6

It is made in a trench excavated below ground and lined with masonry walls. A number of opening are built around the outer walls. A number of openings are built around the outer wall of the kiln and movable iron chimneys are placed over the opening (generally 2'6" x 1' x 7") at about 12 ft. apart and the coal pits lie between them. These chimney openings are connected to the trench by two arched opening for draught. Sometimes, permanent chimneys are built over these openings but for economy, movable chimneys on four wheels can be used by easily movable chimneys on four wheels can be used by easily moving them along the kiln. In some cases, chimney openings are provided in the inner wall as well but in others, chimneys are placed over the arranged bricks in the kiln and in the case no hole is to be povided in the walls. Dampers or iron plates are placed by the side of these openings. The space beween two dampers in the trench is called a section. Each section of a trench 18 ft. wide contains 10,000 bricks which

require 58 cu ft. of coal of burn. Roughly, 6 maunds (692 lbs) of coal are required per 1000 bricks. The fig. 3.6 shows an oval trench kiln in which loading drying, burning, cooling and unloading take place in two stages. Two chimneys and two batches of workers are required for its operation. The arrows on the plan indicated the direction of movement of chimneys. One section is loaded first, and then covered with earth on top to prevent the escape of heat. When one section is being burnt, its hot gases pass on to the next section to warm up the bricks already stacked in the second section before passing out through the chimneys. When first section is burnt and the fire has advanced to the next, all the flue holes of the first are closed and it is allowed to cool down gradually. When fire has advanced through a number of sections from one side, the first section cools sufficiently and is unloaded and reloaded with dry raw bricks which in thier turn are warmed up first with the hot gases of the last section and than burnt up by the advancing fire going round the kiln. Thus, the kiln works continuoulsy admiting loadig drying, burning, cooling and unloading to go on simulataneously in different sections. The average output of this type of kiln is as follows;

1st class bricks 60%
2nst clss bricks 15 %
3rd class bricks 10%
Picked Jhama 5%
Jhama bats 5%
Bricks bats 5%

The smallest size kiln of 20 chambers of sections 18' x 12' with one chimney will turn out about 10,000 bricks daily. A large size kiln of 24 to 40 chambers worked by two chimneys will be much economical to operate and also cheaper in construciton.

A trench kiln generally takes 36 to 40 hours for burning and 10 to 12 days for cooling.

In Bangladesh, most of the brick manufactures prefer this type of brick burning because of the following reasons : (1) Economy in construction: (2) Net affected by wind and moderate rain as it is constructed below ground level and covered with earth on top: (3) Short period of burning : (4) Better quality of bricks.

3.6 Characteristics of Good Bricks :

1. Bricks should be uniform in colour , size and shape.
2. They should be sound and compact.
3. They should be free from cracks and other flaws such as air bubbles; stone nodules,etc.
4. They should not absorb more than 1/5 of their own wt.of water when immerged in water for 24hours (15 to 20% dry wt.).
5. The compressive strength of bricks should be in the range of 5,000to 8,000 psi.
6. The percentage of soluble salts (sulphates of calcium, magnesium, sodium and potassium) should not exceed 2.5% in burnt bricks, because the presence of excess soluble salts causes efflorescence.
7. They should be neither overburnt or underburnt.
8. They weight should be generally 6 lbs per brick and the weight per cu ft should not be less than 125 lbs.
9. They should have low thermal conductivity as it is desirable than the buildings built of them should be cool in summer and warm in winter.
10. They should be non-Inflammable and incombustibe.
11. Bricks should not change in volume when wetted.

3.7 Field Tests of Bricks: The following are the test that are generally performed in the field to determine the quality of good bricks:

1. Take a brick and try to make mark on the surface by nil. If you can make it, it is not, a good brick, if not. it is very hard and compact.

2. Take a brick and strike it with a hammer. If it gives clear ringing or metallic sound, it is a good brick, if not a bad one.
3. Take two bricks and form a tee (T) and drop from a height of 6 ft on a more or less solid surface. If they break they are not good bricks. If they remain unbroken, they are good bricks.

3.8 Size of Bricks: In Bangladesh, according to P.W.D. specification, each brick should measure $9\frac{1}{4}''$ $9\frac{1}{2}'' \times 2\frac{3}{4}''$ This is the standard size of bricks in our country. There are other sized bricks also. But this size is most economical. Because when bricks are put in any construction with mortar the size becomes 10 "x5"x3" (approximately). The size of walls which are constructed by bricks in our country are 3", 5", 10", 15", 20", 25" and 30" So this size of bricks can be used safely without any breakage. Hence, this standard size. is most economical in engineering constructions in our $9\frac{1}{2}'' 4\frac{1}{2}'' \cdot \frac{3}{4}''$ country.

3.9 Classification of Bricks: The following is the classification of bricks by P:W.D. in our country.

1. **First Class Bricks:** They should be of uniform size and colour, thoroughly and evenly burnt. They should ring clearly when struck. With a hammer or another brick. They should be well shaped with even surfaces and without cracks, rainspots or flaws of any kind. They should not absorb more than one sixth of their weight of water when wet in water for 24 hours.
2. **Second Class Bricks:** These bricks must possess the hardness and colour of first class bricks but are slightly irregular in shape, size or rough on the surface.

3. **Third Class Bricks:** These are bricks which are not sufficiently well-burnt sufficiently and of uniform shape and size for use in un-important constructions.
4. **First Class Bats:** These are broken bricks of the same quality as first and second class bricks.
5. **Second Class Bats:** These are broken bricks of the same quality as third class bricks.
6. **Picked Jhama Bricks:** These bricks are uniformly vitrified throughout, but must be of good shape, haevy and of selected quality. They must not be spongy.
7. **Jhama Bricks:** These are well- burnt bricks but not quite so well shaped as picked jhama bricks. They must not be spongy and must be free from cinders and projecting lumes and of fairly good shape.
8. **Jhama Bats:** These are broken bricks of the classes picked jhama and jhama bricks.

3.10 Special Bricks: Bricks are usually made rectangular but they are also made in various special forms to meet the different situation where they are used also to suit to the taste of the users. Such bricks are called purpose-made bricks and are more costly than ordinary bricks. These are:

(1) Perforated bricks used in building walls: (2) Hollow bricks used in hollow walls in building: (3) Checkered bricks, used in bricks masonry: (4) Stable bricks (with grooved pannels): (5) Plinth bricks. (6) Jamb bricks-bricks chamfered and rounded to the desired shape at one corner: (7) Klinker (paving brick) for internal flooring. In addition to these, there are other varities of special bricks. They are mainly used for decorative and ornamental purposes.

The Mirpur Ceramic works in Dhaka manufactures various types of special bricks. A few special bricks are shown in Fig. 3.7

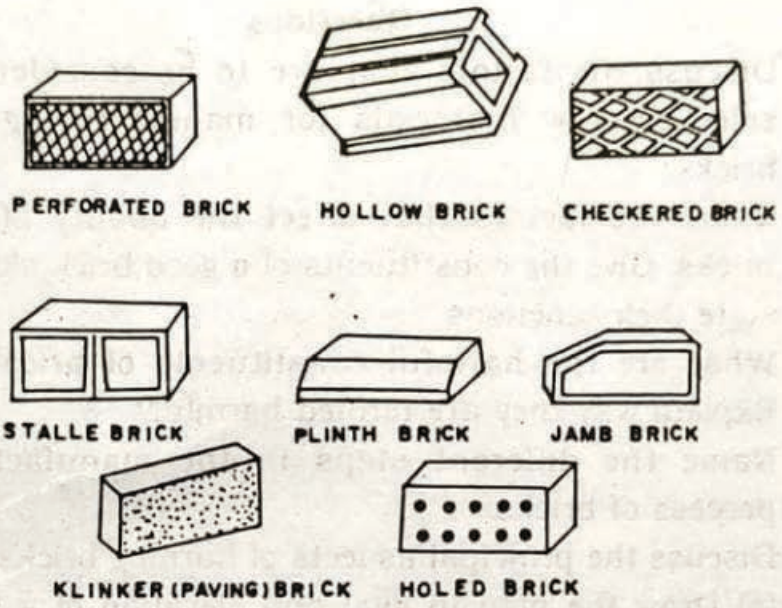


Fig. 3.7

3.11 Uses of Bricks:

1. Construction of walls of any size.
2. Construction of floors.
3. Construction of arches and cornices.
4. Making khoa (broken bricks of requird size) to use as an aggregate in concrete.
5. Manufacture of surki (powdered bricks) to be used in lime plaster and lime concrete..

3.13 Brick Works: The following are the different types of brick works:

1. First Class Brick-work: This consists of first class bricks in lime or cement morter. All the material required should be of first class quality.
2. Second Class Brick-work: This consist of second class bricks laid in lime or cement-mortar.
3. Third Class Brick-work: This consists of third class bricks in mud mortar.

For 100 cft. of brickworks 1200 nos. bricks and 45 cft. of mortar are required 830 bricks will make 100 cft. of khoa for concrete.

Questions

1. Discuss the factors that are to be considered in selecting raw materials for manufacturing good bricks.
2. Name the factors that affect the quality of good bricks. Give the constituents of a good brick clay and state their functions.
3. What are the harmful constituents of brick-clay? Explain why they are termed harmful?
4. Name the different steps in the manufacturing process of bricks.
5. Discuss the principal aspects of burning bricks.
6. (a) Draw the plan in oval and elevation of a treach kiln. Explain also its working principle.

(b) If a daily production of 3 lacs of bricks is required, what should be size of the kiln? What will be the amount of coal dust that will be required per day?

7. What is the standard size of bricks in our country? Do you think that the existing size is economical? Justify your answer.
8. Give the charcteristics of good bricks. What are the test that are carried out in the field to determine the quality of good bricks?
9. Supply the classification of bricks with proper specification.
10. Write explanatory notes on the following:

(a) Pug Mill, (b) Machine moulding (c) Brick drying (d) Pazawah (e) Hoffman's kiln (f) Brick works.

11. What are the function of special bricks? Give neat sketches of the different types of special bricks that are commonly used in Bangladesh.