CHAPTER II

PRODUCTION PROCESS – AN OVERVIEW

2.1 INTRODUCTION

This chapter is devoted to present details relating to production process, type and nature of raw material used, and the variation of Bricks manufactured in general.

2.2 BACKGROUND OF NAMAKKAL DISTRICT

Namakkal is one of the 30 Districts in Tamil Nadu. Which is situated adjacent to Salem District. Since the Namakkal District is a part of the Salem District, the historical background of Salem and Namakkal remains the same. After the struggle between the Cheras, Cholas and Pandiyans, the Hoysalas came to power and had controlled till the 14th century followed by Vijayanagar kings till 1565 AD. Then the Madurai Nayaks came to power in 1623 AD and Two of the poligans of Tirumalai Nayak namely, Ramachandra Nayak and Gatti Maudails ruled the Salem area. The Namakkal fort is reported to have been built by Ramchandra Nayak. After about 1635 AD, the area came successively under the rule of Muslim Sultans of Bijipur and Golkonda, Mysore kings, the
Marattas, and then during 1150 AD Hyder Ali came to power. During this period, it was a history of power struggle between Hyder Ali and later Tippu, with the British. Tamil is the main language spoken in this district.

2.2.1 GEOGRAPHICAL LOCATION

Namakkal District, a newly created district with effect from January 1997 was bifurcated from the composite Salem District and is known for poultry farming and lorry body building. This district is bounded by Salem on the North, Karur on the South, Perambalur and Salem on the East and Erode on the West. The district falls under North-western Agro climatic Zone (except Tiruchengode Taluk which falls under Western Zone). Kolli Hills and a few isolated hills and ridges fall under hilly zones. The administrative headquarters of this district is located at Namakkal town.

The District lies between 11° 09’ and 11° 65’ north latitude and 78° 23’ and 79 45’ east longitude. Cauvery River is flowing in the District, which will be dry during the summer season. Namakkal District consists of four Taluks, namely Namakkal, Rasipuram, Paramathi velur and Tiruchengode. The total geographical area of the district is 4376.57sq.km. The Namakkal District is divided into 15 Blocks. The details of the name of the taluk and area have been shown in the following Table.2.1
### TABLE 2.1

**Taluk Wise Geographical Area**

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Name of Taluk</th>
<th>Area in Sq.Km</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Namakkal</td>
<td>1784.09</td>
</tr>
<tr>
<td>2</td>
<td>Rasipuram</td>
<td>903.18</td>
</tr>
<tr>
<td>3</td>
<td>Paramathi velur</td>
<td>729.09</td>
</tr>
<tr>
<td>4</td>
<td>Tiruchengode</td>
<td>960.21</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>4376.57</strong></td>
</tr>
</tbody>
</table>

Source: Directorate of Environment, Govt of Tamil Nadu, 2009.

**DISTRICT MAP OF NAMAKKAL**
Namakkal is noted for Truck Body Building Activity. Truck Body Building is being carried out in Namakkal since 1956. Namakkal is known for Body Building for Truck, Trailer, Tanker and Rig Unit. Customers from Other States also get the truck body building work done in Namakkal. Body builted trucks and Rig Units are being exported to foreign countries from Namakkal. About 25000 persons are employed directly and indirectly in truck body building activity in the District. About 300 units in Namakkal and 100 Units in Tiruchengode are engaged in this activity.

2.2.2 POPULATION
An official Census 2011 released by Directorate of Census Operations in Tamil Nadu states that the district has male and female were 866,740 and 854,439 respectively. There was change of 15.25 percent in the population compared to population as per 2001. In the previous census of India 2001, Namakkal District recorded increase of 12.91 percent to its population compared to 1991. The initial provisional data suggest a density of 506 in 2011 compared to 439 of 2001. Average literacy rate of Namakkal in 2011 was 74.92 compared to 67.41 of 2001. If things are looked out at gender wise, male and female literacy were 83.09% and 66.68% respectively. For 2001 census, the figures stood at 77.56% and 57.00% in the District. Total literates in Namakkal District were 1,184,344 of which male and female were 659,232 and 525,112 respectively. With regards to sex ratio in Namakkal, it stood at 986 per 1000 male compared to 2001 census figure of 966. The average national sex ratio in India is 940 as per latest reports of Census 2011.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Taluk Name</th>
<th>Total / Rural / Urban</th>
<th>Total Households</th>
<th>Total Population</th>
<th>Male Population</th>
<th>Female Population</th>
<th>Sex Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Namakkal</td>
<td>Total</td>
<td>121424</td>
<td>459296</td>
<td>232447</td>
<td>226849</td>
<td>976</td>
</tr>
<tr>
<td>2</td>
<td>Rasipuram</td>
<td>Total</td>
<td>82471</td>
<td>317571</td>
<td>161944</td>
<td>155627</td>
<td>961</td>
</tr>
<tr>
<td></td>
<td>Tiruchengode</td>
<td>Total</td>
<td>139501</td>
<td>529686</td>
<td>271238</td>
<td>258448</td>
<td>953</td>
</tr>
<tr>
<td>---</td>
<td>--------------</td>
<td>-------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>-----</td>
</tr>
<tr>
<td>4</td>
<td>Paramathi-Velur</td>
<td>Total</td>
<td>50982</td>
<td>186909</td>
<td>93922</td>
<td>92987</td>
<td>990</td>
</tr>
</tbody>
</table>

Source: Census of India 2011

### 2.2.3 CLIMATE

The weather is pleasant during December and January but during other months it is hot and humid, a sub-tropical climate. The temperature ranges from 20 to 42 degree Celsius. The normal rainfall of the district is 776 mm. The District is predominantly dry due to low rainfall. Cauvery and its tributaries namely Aiyaru, Karaipottan and Thirumanimuthu flow through the District. River Cauvery flows south and southwest hugging the border of the district with Erode and Karur Districts. The scope for grounding conventional minor irrigational structures is limited owing to the over exploitation of the groundwater sources. The main sources of irrigation are well and canal and the net area irrigated in the district is 64,408 hectare.

### 2.2.4 SOIL
The soils of the district can be classified under six categories, viz. red loam, lateritic soil (Kolli Hills), black soil, sandy coastal alluvial (Kabilarmalai), red sandy soil (Puduchatram) and clay loam (Sendamangalam, Vennandur, Erumapatti). The hilly region of Kolli Hills, with an area of 371.03 sq km and altitude of 1300 meter above the sea level, offers scope for cultivation of horticultural crops like pineapple, Herbal and Medicinal plants. Coffee is also being cultivated in Kolli Hills to a limited extent. Animal husbandry activities are the mainstay of the population. This district is popularly known for Transport and Egg because about 60 percent of the egg production of Tamil Nadu is from Namakkal district which is being marketed to other states and exported to the Middle East countries. In the areas adjoining the Kabilarmalai block where river Cauvery passes by, sugarcane is cultivated while the majority of the other areas are entirely dependent on rainfall for agricultural operations. Groundnut, millets, pulses, oil seeds, spices, fruits, vegetables, tapioca, and cotton are the major crops grown in the district.

### 2.2.5 ADMINISTRATIVE SETUP

The district has been divided into two revenue divisions, and four taluk (Namakkal, Paramathi velur, Rasipuram and Tiruchengode) and 15 blocks. The district comprises of five municipalities and 454 villages and it’s headquarter ‘Namakkal’ is well connected to important cities like Madurai, Chennai and Bangalore. This district has a well developed railway lines about 55 km from Salem and Rail connectivity passing through Namakkal District is in progress.
2.2.6 INDUSTRIALISATION

Handloom and power loom weaving are predominant in the District, particularly in Tiruchengode and Rasipuram region. Nearly 272 sago factories are located in and around Rasipuram taluk. Rasipuram Taluk is also famous for Ghee production. The District finds a place of importance in the map of India because of its Lorry Body building industry. More than 150 Lorry Building workshops with a number of subsidiary industries of auto body works are operating in the District. Besides, there are 61 registered Brick industries and a couple of unregistered small units operated by families called “Country bricks”.

2.2.7 AGRICULTURE AND IRRIGATION

The main occupation in the district is agriculture. The cultivation generally depends on monsoon rains, wells and tanks. Nearly 90 per cent of the cultivated areas are under food crops. The principal crops of this District are paddy, sorghum (cholam), cumbu and finger millet (ragi), panivaragu, kuthanally, amal millet (varagu) and Italian millet (thinai). Among pulses, the major crops are redgram, blackgram, greengram and horsegram. Among oil seeds, groundnut, castor and gingelly occupy important places. Of the commercial crops, sugarcane, cotton, turmeric, plantain and tapioca are important crops. Tapioca is used for the manufacture of sago. There are lots of sago factories functioning in this District.
The Kolimalais range of hills occupies the eastern portion of the district and forms a compact blocks lying, like the Shevaroys in Salem District, roughly parallel to the direction of the monsoon winds. The elevation of these hills varies from 1000m to 1500m above the sealevel, and the plateau which is roughly 16kms by 13kms to come it extent occupies an area of about 190sq.kms. The Reserved Forests on this plateau are Ariyurshola, Karavalli Extn. (Kolli hills block-I) Puliansholai extn. Shelur exten.Valavaradhinadu block-I, Valavandinadu Block-II, Shelur Nadu Block-I and Devanurnadu Block-II were recently declared as Reserved Forest, besides ten other blocks, covering an area of about 1600hs, are under various stages of the forest settlement. The boundary between Rasipuram and Namakkal Taluks, which is also the boundary between Rasipuram and Namakkal ranges, passes across the Kollimalais dividing it into two portions. The northern portion, consisting of the northern, north-western and north eastern slopes of the Kollimalais comprise some of the reserves of Rasipuram Range while the Southern portions contain most of the reserves of Namakkal Range extending over the western, southern and eastern slopes. The Kollimalais form the catchment area of two streams, the Periacombai and Ayyar which irrigate the crops in some villages in Musiri taluk of Tiruchirappalli District and localities near Thammampatti in Athur taluk of Salem District in the gap between the Kollimalais and Pachamalais respectively.

2.2.9 Brick Industries in Namakkal
Namakkal is one among the industrial district in Tamilnadu where number of organized and unorganized sector industries operating, in which Brick industries are one of the unorganized sector which supply millions of bricks for construction industries in and around the district. Generally the brick production requires many natural resources such as clay soil, fuel and required labour. Certain resources available in plenty and certain others are scarcely available. Since the availability of resource is one of the determinant factors for establishing any productive venture, brick units have no exception. The reason for establishment of plenty of brick units in Namakkal district is the abundance of required resources available everywhere in Namakkal district. The detail of brick units located in Namakkal district is given below

**Brick units In Namakkal District**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Taluk</th>
<th>No.of Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Namakkal</td>
<td>18</td>
</tr>
<tr>
<td>2</td>
<td>Rasipuram</td>
<td>02</td>
</tr>
<tr>
<td>3</td>
<td>Tiruchengode</td>
<td>33</td>
</tr>
<tr>
<td>4</td>
<td>Paramathi Velur</td>
<td>08</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>61</strong></td>
</tr>
</tbody>
</table>


In this District Brick manufacturers produce various kinds of bricks viz, country brick, chamber brick, Hollow Blok brick and flay ash brick. Brick Manufacturing requires
special type of clays. The clay should not disintegrate in the water and it should have some degree of plasticity. Further it must be dried safely without cracking and should not shrink too much while firing. In Namakkal district brick kilns are situated on either sides of river Kaveri which offers greatest scope for the efficient functioning of brick industry.

Brick manufacturing is carried on in this district from the month of October to the mid of July. During this period the availability of labourers and climatic condition is favorable for drying of bricks due to the absence of rainfall in Namakkal at that time.

In this district, all taluks are having brick industries and good quality of clay and sand suitable for brick making. The suitable clay is obtained by the brick owners from land, ponds and the lake. In Namakkal District, bricks are produced in the following area such as Sendamangalam, Erumaipati, Kabilarmalai, Kalappnayakanpati, Belukuruchi, Moolachi, Kokarayanpettai, Vellapati, Iraya Mangalam and Paramathi.

The soil in the district is mostly of the red variety especially sandy type of soil prevails and near the mountain gravelly soil is generally seen. The important resource namely clay which required for brick production is abundantly available in Namakkal District. This is substantiated by the census report that loamy clay soil with high sand content is one of the primary ingredients for brick production. This is abundantly
available in Namakkal district. The clay in the area is having the plasticity which is suitable for the production of bricks.

The other positive factors for the location of brick units in the district are the abundant supply of unemployed agricultural labourers, transport facility and marketing location of the industry at nearest district. Therefore, the brick making is one among the profession employment which results in the increase of income generation to many people in this district.

2.3 BRICKS – AN OVERVIEW

Brick has been used in building construction since civilization of mankind. It is one of the least expensive and most important materials made from clay used in a variety of architectural buildings, structural and industrial applications. It is probably one of the most durable materials that can be withstanding aggressive environment much better than other building materials. The bricks cannot be replaced by concrete and steel in major structural systems. Hence it has been used and will continue to be used in structural forms such as arches, jack arches, reinforced brick works, walls, pillars and slabs. There are substitutes for many products used in the construction industry. Wood is replaced by steel, cement is used in the place of lime and Mosaic tiles are used instead of cement in the case of flooring and the like. But brick as a primary material has not been changed. Though cement blocks are used in the place of brick, the importance of brick has not been changed much. Cement blocks mostly are used only for a specific purpose namely
for the construction of compound wall. So brick is still an important component in the construction activity.

Brick manufacturing becomes important in the context of providing shelter which is an important basic human need next to food and clothing. Besides shelter, bricks are used in the development of infrastructure such as construction of dams, canals, work sheds etc., which are needed for improvement in the levels of living.

2.3.1 HISTORICAL PERSPECTIVE OF BRICKS

The history of brick goes back to the earliest days of civilized man and it is said that bricks were made more than 10,000 years ago. Although such great antiquity cannot be established Archaeologists working at the site of the Chaldees, the city of Abraham in the valley of the Euphrates, have accurately determined that the burned and unburned bricks in the lower levels of the great ziggurat or temple were made more than 5000 years ago\textsuperscript{30}.

Brick making was first carried on in the sunny, relatively rain-free areas of the Middle East where timber was lacking, such as Mesopotamia, Palestine and Egypt. The first bricks in use was as early as 4000 B.C. were made of clay strengthened with straw. Brick making flourished during the period of Elizabeth era and were made in the American colonies from 1612 onwards\textsuperscript{31}.

\textsuperscript{30} Encyclopedia Britannica, Vol.4, 971. P. 169.

\textsuperscript{31} New Standard Encyclopedia, vol.3, 1983, P. 433
Bricks were produced in sundried form in Egypt about 6000 years ago and the burning, enameling and glazing of bricks were later discovered in Babylon. In fact, the ancient river valleys and alluvial plains saw the beginnings of brick architecture and brick was chief building materials of the Indus Valley civilization at Mohemn-Je-daro and Harappa\(^{32}\).

Archaeological excavations have unearthed a brick that authorities dated as 9000 to 10000 years old and this brick was discovered at the site of an ancient settlement beneath the city of Jericho. The Bible contains the earliest written record of the production of bricks, which were made by the Israelites under their Egyptian taskmasters. The Bible also records that burnt brick was used in building the Tower of Babel (Genesis 11). The Greek historian Herodotus, in the 5\(^{th}\) century B.C. stated that burnt brick was used in building the wall of the city in Babylon\(^{33}\).

Bricks in the early Egyptian dynasties were formed of alluvial silt. The Roman subsequently developed a characteristic flat, kiln burnt brick, using sand or clay. Brick survive from pre-dynastic Egypt (before – 3400 B.C.). Fired bricks were used in Mesopotamia early times and also by the Romans\(^{34}\).

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\(^{32}\) Indian Architect Builder, Vol.1, No.4, Nov. 1987, P.77


\(^{34}\) The New Illustrated Everyman’s Encyclopedia Vol.2, 1978, P.227
The Romans made wide use of sun dried bricks and burnt bricks, they used sun –
dried clay bricks until the time of Augustus (63 B.C. – 14 A.D) but after that timer they
generally used bricks burnt in kilns. During the period of Roman Empire, the Romans
spread the art of the brick making throughout Europe. In Britain, brick making was
discontinued when Roman occupation ended in 410\textsuperscript{35}.

From Western Asia the art of brick making appears to have spread westward
Egypt and the Mediterranean and eastward to India and China. From Egypt brick making
spread throughout the eastern Mediterranean to Rome whose legionnaire carried the
art throughout the Roman Empire\textsuperscript{36}.

A Mud brick (dried in the sun) was one of the first building materials. It is
conceivable that on the Nile, Euphrates, or Trigris rivers, following floods, the deposited
mud or silt cracked and formed cakes that could be shaped into rude building units to
build huts for protection from the weather. In the ancient city in Mesopotamia (Iraq),
the first true arch of Sun baked brick was made about 4000 B.C. The arch itself has not
survived, but a description of it includes the first known reference to mortara other than
mud. Abitumen slime was used to hind the bricks together\textsuperscript{37}.

\textsuperscript{35} Encyclopedia America, Vol. 4, 1976. Pp. 519-520
\textsuperscript{36} Ibid
\textsuperscript{37} Chambers Encyclopedia, Vol. II, 1973, P. 537
Hollow bricks, which at first were little more than square pipes, began to be produced, and were made on a fairly large scale in France by the middle of the 19th century. Hollow bricks can be bigger than standard bricks without being too heavy to handle, and they are cheaper than the latter. After 1945, the patterns of Hollow and perforated bricks were based increasingly on a conscious effort to achieve the best possible balance of properties (thermal insulation, strength, ease of laying etc.) and hence the most efficient and economical brickwork. In Britain, similar developments had only just begun by 1960, and standard bricks had been cheaper than in most other countries. In China bricks were used to build several parts of great wall, which dates from 3rd century B.C.

2.4 PRODUCTION PROCESS

The bricks are obtained by moulding clay in rectangular blocks of uniform size and then by drying and burning these blocks. As bricks are of uniform size, they can be properly arranged and further, as they are light in weight, no lifting appliance is required for them. The bricks do not require dressing and the art of laying bricks is so simple that the brickwork can be carried out with the help of unskilled labourers. Thus, at places where stones are not easily available, but if there is plenty of clay suitable for the manufacture of bricks, the bricks replace stones. The common brick is one of the oldest building materials and it is extensively used at present as a leading material of construction because of its durability, strength, reliability, low cost, easy availability, etc.
The bricks have been used all over the world in every class and kind of building. If the total bricks produced till today are to be counted, the figure would indeed be astronomical. At present, India has the production capacity to manufacture over 10000 crore bricks through about 45000 local kilns in the unorganized sector. It is understood that about 65 per cent of the bricks in the world goes into dwellings and the balance into commercial, industrial and institutional buildings.

The bricks have established as an age old material right from the thatched house to the multi-storied buildings. They were initially handmade and used as load bearing material for various structures. With the passage of time and advent of cement and steel, the frames only are filled up with the burnt clay bricks. The production of burnt clay bricks on a scientific and modern basis including proper mining of clays can lead to the availability of quality bricks.

In India, the process of brick making has not changed since many centuries except some minor refinements. There has been hardly any effort in our country to improve the brick-making process for enhancing the quality of the bricks. The main reason for this attitude is that the production of bricks has been largely confined to the unorganized small sector. Some of the large mechanized brick plants came up in the past. But they seem to have gone sick for some reason or the other. The result is that the construction industry in our country is largely dependent on the small sector which
is unable to deliver high quality bricks in view of rising fuel cost, outdated technology and lower efficiency of production.

2.4.1 COMPOSITION OF GOOD BRICK EARTH

Following are the constituents of good brick earth

1. **Alumina**

   It is the chief constituent of every kind of clay. A good brick earth should contain about 20% to 30% of alumina. This constituent imparts plasticity to the earth so that it can be molded. If alumina is present in excess, with inadequate quantity of sand, the raw bricks shrink and warp during drying and burning and become too hard when burnt.

2. **Silica**

   It exists in clay either as free or combined, as free sand. It is mechanically mixed with clay and in combined form and it exists in chemical composition with alumina. A good brick earth should contain about 50% to 60% of silica. The presence of this constituent prevents cracking, shrinking and warping of raw bricks. It thus imparts uniform shape to the bricks. The durability of bricks depends on the proper proportion of silica in brick earth. The excess of silica destroys the cohesion between particles and the brick becomes brittle.

3. **Lime**
A small quantity of lime not exceeding 5 per cent is desirable in good brick earth. It should be present in a very finely powdered state because even small particles of the size of a pin-head cause flaking of the bricks. The lime prevents shrinkage of raw bricks. The sand alone is infusible. But it slightly fuses at kiln temperature in the presence of lime. Such fused sand works as a hard cementing material for brick particles. The excess of lime causes the brick to melt and hence its shape is lost. The lumps of lime are converted into quick lime after burning and this quick lime slakes and expands in a presence of moisture. Such an action results in splitting of bricks into pieces.

4. Oxide of Iron

A small quantity of oxide of iron to the extent of about 5 to 6 per cent is desirable in good brick earth. It helps as the time to fuse sand. It also imparts red colour to the bricks. The excess of oxide of iron makes the bricks dark blue or blackish. If, on the other hand, the quantity of iron oxide is comparatively less, the bricks will be yellowish in colour.

5. Magnesia

A small quantity of magnesia in brick earth imparts yellow tint to the bricks and decreases shrinkage but excess of magnesia leads to the decay of bricks.

2.4.2 Classification of Brick Earth

The brick is classified in the following three categories...
1. Loamy, mild or sandy clay

2. Marls, chalky or calcareous clay

3. Plastic, strong or pure clay.

1. **Loamy, mild or sandy clay**

   This type of earth consists of considerable amount of free silica in addition to alumina. The presence of sand helps in preventing cracking, shrinking and warping of bricks. The addition of lime in such clay helps to fuse sand and thereby to increase hardness of bricks. A typical analysis of such clay is as follows

   **TABLE 2.2**

   **Loamy, Mild or Sandy Clay**

<table>
<thead>
<tr>
<th>Components</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alumina</td>
<td>27</td>
</tr>
<tr>
<td>Silica</td>
<td>66</td>
</tr>
<tr>
<td>Lime and Magnesia</td>
<td>1</td>
</tr>
<tr>
<td>Oxide of iron</td>
<td>1</td>
</tr>
<tr>
<td>Organic matter</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
2. Marls, Chalky or Calcareous Clay

This clay consists of considerable amount of chalk in addition to alumina and silica. Such clay generally makes good bricks. In order to avoid undesirable effects of excess lime, the sand is sometimes added to such clay. A typical analysis of such clay is as follows

<table>
<thead>
<tr>
<th>Components</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alumina</td>
<td>10</td>
</tr>
<tr>
<td>Silica</td>
<td>35</td>
</tr>
<tr>
<td>Lime and Magnesia</td>
<td>48</td>
</tr>
<tr>
<td>Oxide of iron</td>
<td>3</td>
</tr>
</tbody>
</table>
2. Plastic, Strong or Pure Clay

This clay consists of alumina and silica and it is sometimes referred to as strong clay or fat clay. The raw bricks will crack, shrink and warp during drying, if pure clay alone is used in making of bricks. Hence such clay is corrected by the addition of sand and ash. The sand prevents shrinkage and the ash provides time to act as flux. A typical analysis of such clay is as follows

<table>
<thead>
<tr>
<th>Alkalis</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

### TABLE 2.4

**Plastic, Strong or Pure Clay**

<table>
<thead>
<tr>
<th>Components</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alumina</td>
<td>34</td>
</tr>
<tr>
<td>Silica</td>
<td>50</td>
</tr>
<tr>
<td>Lime and Magnesia</td>
<td>6</td>
</tr>
<tr>
<td>Oxide of iron</td>
<td>8</td>
</tr>
<tr>
<td>Alkalis</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>


The best guide in the selection of brick clay would be the preparation of sample bricks from such clay. The sample bricks should be burnt in a simple kiln, and their behaviour in drying and burning should be carefully noted. The sample bricks should be exposed to the sun and wind and their various properties should be tested to determine their utility. If result is satisfactory, such clay should be adopted to manufacture bricks.
on a large scale. Otherwise, necessary ingredients may be added to such clay to make it fit for brick making.

2.4.3 PROCESS OF PRODUCTION OF BRICKS

The four distinct operations are involved in the production of Bricks such as Preparation of clay, Moulding, Drying and Burning.

1. Preparation of clay

Involves Unsoiling, Digging, Cleaning, Weathering, Blending and Tempering

i) Unsoiling

The top layer of soil, about 200 mm in depth, is taken out and thrown away. The clay in top soil is full of impurities and hence it is to be rejected for the purpose of preparing bricks.\(^{38}\)

ii) Digging

The clay is then dug out from the ground. It is spread on the leveled ground, just a little deeper than the general level of ground. The height of heaps of clay is about 600 mm to 1200 mm.\(^{39}\)

\(^{38}\) Rangwala. S.c “Engineering materials” II edition, p.70
iii) Cleaning

The clay, as obtained in the process of digging, should be cleaned of stones, pebbles, vegetable matter, etc. If these particles are in excess, the clay is to be washed and screened. Such a process naturally will prove to be troublesome and expensive. The lumps of clay should be converted into powder form in the earth crushing roller.  

iv) Weathering

The clay is then exposed to atmosphere for softening or mellowing. The period of exposure varies from few weeks to full season. For a large project, the clay is dug out just before the monsoon and it is allowed to weather through the monsoon.

v) Blending

The clay is made loose and any ingredient to be added to it, is spread out at its top. The blending indicates intimate or harmonious mixing. It is carried out by taking small portion of clay every time and by turning it up and down in vertical direction. The blending makes clay fit for the next stage of tempering.

vi) Tempering

In the process of tempering, the clay is brought to a proper degree of hardness and it is made fit for the next operation of moulding. The water in required quantity is

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39. Ibid., pp 74-75.
added to clay and the whole mass is kneaded or pressed under the test of men or cattle. The tempering should be done exhaustively to obtain homogeneous mass of clay of uniform character.

If tempering is properly carried out, the good brick earth can then be rolled without breaking in small threads of 3 mm diameter.\textsuperscript{42}

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\textsuperscript{43}

i) Hand Moulding

ii) Machine Moulding

i) Hand Moulding

In hand moulding, the bricks are molded 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.

\textsuperscript{42} Rangwala. S.c “Engineering materials” II edition, pp.74-75
\textsuperscript{43} Reveltavlofk Dancy, “Construction materials”p50.
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 6 mm. 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. Hence the moulds are to be made larger than the size of fully burnt bricks. The moulds are therefore made longer by about 8 to 12 per cent in all directions. The exact percentage of increase in dimensions of mould is determined by actual experiment on clay to be used for preparing bricks.

The bricks prepared by hand moulding are of two types

a) Ground-moulded bricks

b) Table-moulded bricks

a) Ground-moulded bricks

The ground is first made level and fine sand is sprinkled over it. The mould is dipped in water and placed over the ground. The lump of tempered clay is taken and it is dashed in the mould. The clay is pressed or forced in the mould in such a way that it
fills all the corners of mould. The extra or surplus clay is removed either by wooden strike or metal strike or frame with wire. A strike is a piece of wood or metal with a sharp edge. It is to be dipped in water every time. The mould is then lifted up and raw brick is left on the ground. The mould is dipped in water and it is placed just near the previous brick to prepare another brick. The process is repeated till the ground is covered with raw bricks.

A brick molder 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.

The bricks prepared by dipping mould in water every time are known as the slop-molded bricks. The fine sand or ash may be sprinkled on the inside surface of mould instead of dipping mould in water. Such bricks are known as the sand-molded bricks and they have sharp and straight edges.

The lower faces of ground molded bricks are rough and it is not possible to place frog on such bricks. A frog is a mark of depth about 10mm to 20mm which is placed on raw brick drying moulding. It serves two purposes

(i) It indicates the trade name of the manufacturer.

(ii) In brickwork, the bricks are laid with frog uppermost. It thus affords a key for mortar when the next brick is placed over it.
The ground-molded bricks of better quality and with frogs on their surface are made by using a pair of pallet boards and a wooden block. A pallet is a piece of thin wood. The block is bigger than mould and it has a projection of about 6mm height on its surface. The dimensions of projection correspond to the internal dimensions of mould. The design of impression or frog is made on this block. This wooden block is also known as the moulding block or stock board.

The mould is placed to fit in the projection of wooden block and clay is then dashed inside the mould. A pallet is placed on the top and the whole thing is then turned upside down. The mould is taken out and another pallet is placed over the raw brick and it is conveyed to the drying sheds. The bricks are placed to stand on their longer sides in drying sheds and pallet boards are brought back for using them again. As the bricks are laid on edge, they occupy less space and they dry quicker and better.

(b) Table-molded bricks: The process of moulding these bricks is just similar as above. But in this case, the molder stands near a table of size about 2m x 1m. The clay, mould, water pots, stock board, strikes and pallet boards are placed on this table. The bricks are molded on the table and sent for the further process of drying.
However the efficiency of molder decreases gradually because of standing at the same place for long duration. The cost of brick moulding also increases when table moulding is adopted.\textsuperscript{44}

\textbf{(ii) Machine Moulding}

The moulding may also be undertaken 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 into two categories.

(a) Plastic clay machines

(b) Dry clay machines

\textbf{(a) Plastic clay machines}

Plastic clay machines contain a rectangular opening of size equal to length and width of a brick. The plugged 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.

\textbf{b) Dry Clay Machines}

\textsuperscript{44} Malchells Elementary, “Civil engineering Materials” p.13
In the dry clay machines, the strong clay is first converted into powder form. A small quantity of water is then added to form 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-molded bricks. They carry distinct and exhibit uniform dense texture.\(^{45}\)

3) Drying

The damp bricks, if burnt, are likely to be cracked and distorted. Hence the molded 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 one 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.

(i) Artificial drying

\(^{45}\) Kay., W “Building construction”, Vol. p.1
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 molded bricks are allowed to pass through special dryers who are in the form of tunnels or hot channels or floors. Such dryers are heated with the help of special furnaces or by hot fuel 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°C and the process of drying of bricks taken about 1 to 3 days depending upon the temperature maintained in the dryer, quality of clay used, 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, may be provided to avoid such situations

4. 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\(^\circ\)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\(^\circ\)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 1100\(^\circ\)C 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 lose 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 large scale.

2.4.4 IMPORTANCE OF KILNS USED FOR PRODUCTION OF BRICKS

A kiln is a large oven which is used to burn bricks. The kilns which are used in the manufacture of bricks are of the following two types.

(i) Intermittent kilns
(ii) Continuous kilns

(i) Intermittent kilns

These kilns are intermittent in operation which means that they are loaded, fired, cooled and unloaded. Such kilns may be either rectangular or circular in plan. They may be over ground or underground. They are classified in two ways.

(a) Intermittent up-draught kilns
(b) Intermittent down-draught kilns
(a) *Intermittent up-draught kilns*

These kilns are in the form of rectangular structures with thick outside walls. The wide doors are provided at each end for loading and unloading of kilns. The flues are channels or passages which are provided to carry flames or hot gases through the body of kiln. A temporary roof may be installed of any light, material. Such roof gives protection to the raw bricks from rain while they are being placed in position. This roof is to be removed when the kiln is fired.

1. The raw bricks are laid in rows of thickness equal to 2 to 3 bricks and of height equal to 6 to 8 bricks. A space of about 2 bricks is left between adjacent rows. This space is utilized for placing fuel.

2. The fuels are filled with brushwood which takes up a fire easily. The interior portion is then filled with fuel of bigger size.

3. An arch like opening is formed by projecting 4 to 5 rows of bricks. The projection of each row is about 30 mm to 40 mm.

4. The loading of kiln with raw bricks is then carried out. The top course is finished with flat bricks. Other courses are formed by placing bricks on edge.

5. The end doors are built up with dry bricks and are covered with mud or clay.
(6) The kiln is then fired. The fire can be regulated by opening or closing the iron sheet doors of the fire holes and by controlling the supply of fuel. The progress of burning at any instant can be seen through these holes. For the first three days, the firing is kept slow by proper manipulation of flues. The strong fire is maintained for a period of 48 to 60 hours. The draught rises in the upward direction from bottom of kiln and brings about the burning of bricks.

(7) The kiln is allowed to cool down gradually for at least seven days and the bricks are then taken out.

(8) The procedure is then repeated for the next burning of bricks.

The bricks manufactured by the intermittent up-draught kilns are better than those prepared by clamps. But such kilns have the following disadvantages:

(i) The quality of burnt bricks is not uniform. The bricks near bottom are over burnt and those near top are under burnt.

(ii) The supply of bricks is not continuous.

(iii) There is wastage of fuel heat as kiln is to be cooled down every time after burning.

(b) Intermittent down-draught kilns

These kilns are rectangular or circular in shape. They are provided with permanent walls and closed tight roof. The floor of the kiln has openings which are connected to a common chimney stack through flues. The working of this kiln is more or
less similar to the up-draught kiln. But it is so arranged in this kiln that hot gases are carried through vertical flues up to the level of roof and they are then released. These hot gases move downward by the chimney draught and in doing so, they burn the bricks.

(ii) Continuous Kilns

These kilns are continuous in operation. This means that loading, firing, cooling and unloading are carried out simultaneously in these kilns. There are various types of the continuous kilns. Following three varieties of continuous kilns are in use.

(a) Bull’s trench kiln

(b) Hoffman’s kiln

(c) Tunnel kiln

(a) Bull’s trench kiln

This kiln may be of rectangular, circular or oval shape in plan. As the name suggests, the kiln is constructed partly projecting above ground. The outer and inner walls are to be constructed of bricks. The openings are generally provided in the outer walls to act as flue holes. The dampers are in the form of iron plates and they are used
to divide the kilns in suitable sections. This is the most widely used kiln in India and it gives continuous supply of bricks.

The bricks are arranged in sections. They are arranged in such a way that flues are formed. The fuel is placed in flues and it is ignited through flue holes after covering top surface with earth and ashes to prevent the escape of heat. The flue holes are provided in sufficient number on top to insert fuel when burning is in progress. Usually the two movable iron chimneys are employed to form draught. These chimneys are placed in advance of section being fired. The hot gases leaving the chimneys warm up the bricks in next section. Each section requires about one day to burn.

When a section has been burnt, the flue holes are closed and it is allowed to cool down gradually. The fire is advanced to the next section and the chimneys are moved forward.

The Bull’s trench kiln is working continuously as all the operations—loading, burning, cooling and unloading are carried out simultaneously. The two pairs of chimneys and two gangs of workers will be required to operate this kiln.

(b) Hoffman’s kiln

This kiln is constructed over ground and hence it is sometimes known as the flame kiln. Its shape is circular in plan and it is divided into a number of compartments
or chambers. As a permanent roof is provided, the kiln can even function during rainy season. Each chamber is provided with the following

1. A main door for loading and unloading of bricks.
2. Communicating doors which would act as flues in open condition.
3. A radial flue connected with a central chimney, and
4. Fuel holes with covers to drop fuel.

The main doors are closed by dry bricks and covered with mud, when required. For communicating doors and radial flues, the dampers are provided to shut or open them. In the normal condition, only one radial flue is connected to the chimney to establish a draught.

In this type of kiln, each chamber performs various functions in succession, namely, loading, drying, burning, cooling and unloading.

The cool air enters through chambers 1 and 12 as their main doors are open. After crossing the cooling chambers 8 to 11, it enters the burning section in a heated condition, it then moves to chambers 2 to 5 to dry and pre-heat the raw bricks. The damper of chamber 2 is in open condition and hence it escapes into atmosphere through chimney. The initial cost of installing this kiln is high, but it possesses the following advantages
(1) The bricks are burnt uniformly, equally and evenly. Hence the high percentage of good quality bricks can be produced.

(2) It is possible to regulate head inside the chambers through fuel holes.

(3) The supply of bricks is continuous and regular because of the fact that the top of kiln is closed and it can be made to work during the entire year.

(4) There is considerable saving in fuel due to pre-heating of raw bricks by flue gas. Thus the hot gases are fully utilized in drying and pre-heating the raw bricks.

(5) There is no air pollution in the locality because the exhaust gases do not contain black smoke or coal dust particles.

The capacity of the kiln will depend upon the dimensions of chambers. If each chamber is of about 11m length, 4.50 m average width and 2.50 m height, it will contain about 25000 bricks. Hence, if it is so arranged that one chamber is unloaded daily, such a kiln will manufacture about 25000 bricks daily or about 8 to 9 million bricks annually. The quantity of coal dust required for burning one lakh bricks is about 120 to 150 kn.

It may be noted that in case of Bull’s trench kiln and Hoffman’s kiln, the chambers are zoned in accordance with the brick-processing stages, namely, loading, drying, preheating, burning, cooling and unloading. The source of fire and other zones are moving continuously along the channel of kiln while the bricks in process remain stationary.

(c) Tunnel kiln
This type of kiln is in the form of tunnel which may be straight, circular or oval in plan. It contains a stationary zone of fire. The raw bricks are placed on trolleys which are then moved from one end to the other end of tunnel. The raw bricks get dried and pre-heated as they approach zone of fire. In zone of fire, the bricks are burnt to the required degree and they are then pushed forward for cooling.

When bricks are sufficiently cooled, they are unloaded. This kiln proves to be economical when bricks are to be manufactured on a large scale. As temperature is under control, uniform bricks of better quality are produced.

2.5 QUALITIES OF GOOD BRICKS

The good bricks which are to be used for the construction of important structures should possess the following qualities

(1) The bricks should be table-moulded, well-burnt in kilns, copper-coloured, free from cracks and with sharp and square edges. The colour should be uniform and bright.

(2) The bricks should be uniform in shape and should be of standard size.

(3) The bricks should give a clear metallic ringing sound when struck with each other.

(4) The bricks when broken or fractured should show a bright homogeneous and uniform compact structure free from voids.
(5) The brick should not absorb water more than 20 per cent by weight for first class bricks and 22 per cent by weight for second class bricks, when soaked in cold water for a period of 24 hours.

(6) The bricks should be sufficiently hard. No impression should be left on brick surface, when it is scratched with finger nail.

(7) The bricks should not break into pieces when dropped flat on hard ground from a height of about one metre.

(8) The bricks should have low thermal conductivity and they should be sound-proof.

(9) The bricks, when soaked in water for 24 hours, should not show deposits of white salts when allowed to dry in shade.

(10) No brick should have the crushing strength below 5.50 N/mm².

2.6 STRENGTH OF BRICKS

Following factors affect the strength of bricks

(1) Composition of brick earth;

(2) Preparation of clay and blending of ingredients;

(3) Nature of moulding adopted;

(4) Care taken in drying and stacking of raw or green bricks

(5) Type of kiln used including type of fuel and its feeding;

(6) Burning and cooling processes; and
(7) Care taken in unloading

It is thus obvious that not only the bricks of different brick fields will have different strengths, but in the same brick field, the bricks of the same batch may have different strengths. The average crushing strength and tensile strength of hand moulded bricks are 60000 kN/m² and 2000 kN/m² respectively. The shearing strength of bricks is about one-tenth of the crushing strength. In practice however the bricks are not subjected to the tensile stresses. It may be noted that the strength of brickwork mainly depends on the type of mortar used and not so much on the individual strength of the bricks.

2.7 TESTING OF BRICKS IN THE CONSTRUCTION WORK

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

(1) Absorption
(2) Crushing strength
(3) Hardness
(4) Presence of soluble salts
(5) Shape and size
(6) Soundness
(7) Structure

1) Absorption

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

2) Crushing 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 BIS 1077-1957, 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.

3) Hardness

In this test, a scratch is made on brick surface with the help of a finger nail. If no impression is left on the surface, the brick is treated to be sufficiently hard.

4) Presence of soluble salts

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. If grey or white deposits are found on more than 50 per cent of surface, the efflorescence becomes heavy and it is treated as serious, when such deposits are converted into powdery mass.

5) **Shape and Size**

In this test, a brick is closely inspected. It should be of standard size and its shape should be truly rectangular with sharp edges. For this purpose, 20 bricks of standard size (190 mm x 90 mm x 90 mm) are selected at random and they are stacked lengthwise, along the width and along the height. For good quality bricks, the results should be within the following permissible limits

- **Length**: 3680 mm to 3920 mm
- **Width**: 1740 mm to 1860 mm
- **Height**: 1740 mm to 860 mm

6) **Soundness**

In this test, the two bricks are taken and they are struck with each other. The bricks should not break and a clear ringing sound should be produced.

7) **Structure**
A brick is broken and its structure is examined. It should be homogeneous, compact and free from any defects such as holes, lumps, etc.

2.8 CLASSIFICATION OF BRICKS

The bricks can broadly be divided into two categories as follows[46]

(1) Unburnt or sun-dried bricks and

(2) Burnt bricks

The unburnt or sun-dried bricks are dried with the help of heat received from sun after the process of moulding. The bricks can only be used in the construction of temporary and cheap structures. Such bricks should not be used at places exposed to heavy rains. The bricks used in construction works are burnt bricks and they are qualities into the following four categories

(1) First class bricks

(2) Second class bricks

(3) Third class bricks

(4) Fourth class bricks

1) First class bricks

These bricks are table-moulded and of standard 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 which are mentioned earlier. These bricks are used for superior work of permanent nature.

2) 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 cost of plaster.

3) Third class bricks

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

4) Fourth class bricks

These are over burnt bricks with irregular shape and dark colour. These bricks are used as aggregate for concrete in foundations, floors, 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.

2.9 SIZE AND WEIGHT OF BRICKS
The bricks are prepared in various sizes. The custom in the locality is the governing factor for deciding the size of a brick. Such bricks which are not standardized are known as the traditional bricks.

If bricks are large, it is difficult to burn them properly and they become into heavy to be placed with a single hand. On the other hand, if bricks are small, more quantity of mortar is required.

For India, a brick of standard size 190 mm x 90 mm x 90 mm is recommended by the BIS. With mortar thickness, the size of such a brick becomes 200 mm x 100 mm x 100 mm and it is known as the normal size of the modular brick. Thus the nominal size of brick includes the mortar thickness. It is found that the weight of 1 M$^3$ of brick earth is about 18 kN. Hence the average weight of a brick will be about 30 to 35 N.

2.10 SHAPE OF BRICKS

The ordinary bricks are rectangular solids. But sometimes the bricks are given different shapes to make them suitable for particular type of construction. Following are such few shapes of bricks.

1) Bullnose brick

A brick moulded with a rounded angle is termed as a bullnose. It is used for a rounded quoin. A connection which is formed when a wall takes a turn is known as a quoin. The centre of the curved portion is situated on the long centre-line of brick.
2) **Channel bricks**

These bricks are moulded to the shape of a gutter or a channel and they are very often glazed. These bricks are used to function as drains.

3) **Coping bricks**

These bricks are made to suit the thickness of walls on which coping is to be provided. Such bricks take various forms such as chamfered, half-round or saddle-back.

4) **Cownose bricks**

A brick method with a double bullnose on end is known as cownose.

5) **Curved Sector bricks**

These bricks are in the form of curved sector and they are used in the construction of circular brick masonry pillars, brick chimneys, etc.

6) **Hollow bricks**

These are known as the cellular or cavity bricks. Such bricks have wall thickness of about 20 mm to 25 mm. They are prepared from special homogeneous clay. They are light in weight about one-third the weight of the ordinary brick of the same size. These bricks can be laid almost about four times as fast as the ordinary bricks and thus the use of such bricks leads to speedy construction. They also reduce the transmission of heat, sound and damp. They are used in the construction of brick partitioning.
7) **Paving bricks**

These bricks are prepared from clay containing a higher percentage of iron. The excess iron vitrifies the bricks of a low temperature. Such bricks resist better the abrasive action of traffic. The paving bricks must be plain or chequered.

These bricks are extensively used for garden walks, street pavements, stable floors, etc. These bricks also render the floor less slippery.

8) **Perforated bricks**

These bricks contain cylindrical holes throughout their thickness. These bricks are light in weight and they require less quantity of clay for their preparation. The drying and burning of these bricks are also easy.

If perforated bricks of large size are used, it will result in the increase of output of mason. It has been observed that for tropical countries like India, the bricks with perforations of about 30 to 45 per cent of the total area of the corresponding face of the brick would offer adequate thermal insulation property.
The perforated bricks are used in the construction of brick panels for lightweight structures and multi-storied framed structures.

The perforations may be circular, square, rectangular or any other regular shape in cross-section. The distance between the side of brick and edge of perforation should not be less than 15 mm. The distance between the edges of successive perforations should preferably be not less than 10 mm. The water absorption after immersion for 24 hours in water should not exceed 15 per cent by weight. The compressive strength of perforated bricks should not be less than 7 N / mm² on gross area.

9) Purpose-made bricks

In order to achieve certain purpose, these bricks are made. The supply of bricks are made for jambs of doors and windows. The arch bricks are made of wedge shape to keep mortar joint of uniform thickness.

The ornamental bricks are prepared for corbels,, cornices, etc. The engineering bricks having considerable strength, 50 to 80 N/mm² and water absorption about 4 to 6 per cent, can be prepared from specially selected earth for use in constructions where high durability, compression strength and adequate resistance to sudden shocks are required.
These bricks are usually more costly than the ordinary bricks. But they grant safe, clean and quick construction. Hence their cost is justified by their excellent performance in situations for which they are purposely prepared.

10) 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 manufactures of fire-bricks, crucibles, lining materials for furnaces, hollow tiles, etc.

The earth that is available from under the coal seems is generally found to be good fired-clay. The constituents of a good fire clay are two alumina and silica. The percentage of alumina varies from 25 to 35 and that of silica from 75 to 65. In any case, the impurities such as lime, magnesia, iron oxide and alkalis should not exceed 5 per cent. Depending upon the fire resisting capacity, the fire clays are classified into the following three categories

(1) High duty fire-clays
(2) Medium duty fire-clays
(3) 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 resist temperature range of 1315°C to 1482°C; and the low duty fire-clays can resist temperature up to 870°C only.

11) 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 colour. The weight of a fire brick is about 30 to 35 N. The fire-bricks can resist for linings of interior surfaces of furnace, chimneys, kilns, ovens, fireplaces, etc. The compressive strength of these bricks varies from 200 to 220 N/mm². The percentage of absorption for these bricks varies from 5 to 10. Following are the three varieties of fire-bricks

a. Acidic bricks

b. Basic bricks

c. Neutral bricks

(a) Acidic bricks

These bricks are used for acidic thing. Following are the types of acidic bricks.

(i) Ordinary fire-bricks
These bricks are prepared from natural fire-clay and they provide a good material for acidic refractory lining.

(ii) Silica bricks

These bricks contain a very high percentage of silica to the extent of about 95 to 97 per cent. A small quantity of lime, about 1 to 2 per cent, 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 up to about 2000°C. The comparative strength of such bricks is about 15 N/mm².

(b) 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 prepared from lime and magnesia rocks. The dolomite may also be adopted for the manufacture of these bricks.

(c) Neutral bricks

These bricks are used for neutral lining. They offer resistance to the corrosive action of slags and acid fumes. As compared to the basic bricks, the neutral bricks are more inert to the slags.

SUMMARY