1.1. Introduction

Brick making is as ancient as human civilization itself. Great architectural wonders and the immortal monuments built in the antique past had been built with bricks besides stones and mortar. Ever since man realized the housing as basic need, he started using bricks in various forms like green bricks, sun dried bricks and the fired bricks. Today from the humble dwellings to the modern skyscrapers and labyrinthine structures, brick forms the most important building material. Like the earth withstanding the passage of unimaginable astronomical years, the bricks also, made of earth’s clay and soil do withstand even the worst disastrous onslaughts of nature for quite a long time. Myths abound with information about the usage of bricks even in the building of Babel Tower by the King Solomen.

Today, one cannot imagine a construction at the exclusion of bricks and such is the importance that bricks have assumed as a building material.

In any country, construction accounts for about 60 per cent of the plan outlays all over the world. Out of this, bricks account for more than forty per cent. Brick manufacturing has become important in the context of providing shelter which is an important basic human need next to food and clothing. Besides shelter, bricks are being used in the development of infrastructure such as construction of dams, canals and business houses which are needed for improvement in the levels of living of the people everywhere.

In the commercial market, brick is still a leading wall cladding material. Brick making is a traditional unorganized industry, generally confined to rural
and semi urban areas. It is one of the largest employment generating industries, employing millions of workers.

Brick, being one of the oldest building materials is extensively used at present as a main input in construction because of its durability, strength, reliability, low cost and easy availability. Brick industry, which is essentially a labour intensive industry, provides employment opportunity to a vast work force of around several millions of people in India.\(^1\)

The brick industry is rural oriented. It provides direct employment to crores of poor families and indirect employment to several lakh of people. Brick does have the largest share of the opaque materials market for commercial building and it continues to be used as a siding material in the housing industry.

Bricks play a vital role in the modern day construction. Being an important building material, bricks are widely used by the human race. As large scale construction of high rise housing and business complexes gained momentum, modern architecture and usage of various building materials such as bricks become inevitable.\(^2\)

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\(^1\) Report of the Second State Conference of Tamil Nadu Bricks and Tiles Manufacturers Association held at Tirunelveli on 24\(^{th}\) June 2004.

1.2. Origin of the word ‘Brick’

The word ‘brick’ was originated from late middle English: from Middle Low German, Middle Dutch ‘bricke’, probably reinforced by Old French ‘brique’, of unknown origin or ‘briquette’, which means a block of compressed coal dust or peat used as fuel-origin late 19th century: French diminutive of brique brick.³

The antiquity of bricks can be pushed back to the ancient times. In Sanskrit it was known as ‘Aishtakam’.

1.3. Evolution and Growth of Brick Industry

Brick is perhaps the only manmade material that has defied time gracefully even it was invented 5000 years ago. Manufacture of clay bricks is perhaps the oldest industry in the history of mankind. It is reported that hand-dried, sun-dried mud bricks were made and used during the pre-pottery Neolithic period as far as back as 10000B.C.⁴

It is believed that the first brick was probably made in the Middle East, between the Tigris and Euphrates rivers (what is now Iraq) lacking stones which their contemporaries in other regions used for permanent structures. Early builders here relied on the abundant natural materials to make their sun-baked bricks. These, however, were of limited use because they lacked durability and could not be used outdoors; exposure to the elements caused them to disintegrate. The Babylonians, who later dominated Mesopotamia, were the first to fire bricks, from which many of their tower-temples were constructed.


⁴ http://www.brickindia.com/
From the Middle East the art of brick making spread west to what is now Egypt and east to Persia and India. Although the Greeks, having a plentiful supply of stone, did not use much brick, but surprisingly still, evidence of brick kilns and structures remain throughout the Roman Empire. With the decline and fall of Rome, brick making in Europe soon diminished. It did not resume until the 1200s, when the Dutch made bricks that they seem to have exported to England. In America, people began to use bricks during the 16th century. It was the Dutch, who were considered expert craftsmen in this field.

The holy Bible mentions the problems the Israelites faced in making mud bricks for Pharaoh.

Prior to the mid-1800s, people made bricks in small batches, relying on relatively inefficient firing methods. One of the most widely used was an open clamp, in which bricks were placed on a fire beneath a layer of dirt and used bricks. As the fire died down over the course of several weeks, the bricks fired. Such methods gradually became obsolete after 1865, when the Hoffmann kiln was invented in Germany. Better suited to the manufacture of large number of bricks, this kiln contained a series of compartments through which stacked bricks were transferred for pre-heating, burning, and cooling.

Brick making improvements have continued in the twentieth century which made remarkable improvements in rendering brick shape such as absolutely uniform, in lessening weight, and in speeding up the firing process.  

The bricks are known to man since the dawn of human activity in India. The remains of brick monuments helped towards a proper understanding and appreciation of the life and spirit of ancient Indian people and at the same time, it has also contributed to bring up new suggestions regarding the origin of Indian civilization.\textsuperscript{6}

Sumerian structures were built of Plano-convex mud bricks, not fixed with mortar or cement. As Plano-convex bricks (being rounded) are somewhat unstable in behaviour, Sumerian bricklayers would lay a row of bricks to the rest of every few rows. They would fill the gaps with bitumen, straw, marsh reeds and weeds.

The ancient Egyptians and the Indus Valley Civilization also used mud bricks extensively, as can be seen in the ruins of Buhen, Mohen-jo-daro and Harappa, for example, in the Indus Valley Civilization particularly, all bricks corresponded to sizes in a perfect ratio of 4:2:1, and made use of the decimal system. The ratio for brick dimensions 4:2:1, even today is considered optimal for effective bonding even today.

The Romans made use of fired bricks, and the Roman legions, which operated mobile kilns, introduced bricks to many parts of the Empire. Roman bricks are often stamped with the mark of the legion that supervised its

production. The use of bricks in Southern and western Germany, for example, can be traced back to traditions already described by the Roman architect Virtuvius.⁷

Established in England by the Romans, brick making was later reintroduced in the 13th century becoming widespread in domestic building only in the 19th century. Brick sizes were first regulated in 1729.⁸

The origin and development of brick can be well attested by the archaeology. The following are the some of important brick measurements of various sites in India:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Period</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pre-Harappa</td>
<td>30 x 20 x 10 cm</td>
</tr>
<tr>
<td>2.</td>
<td>Harappa</td>
<td>50 to 25 x 25 to 12.5 x 12.5 to 6.35 cm</td>
</tr>
<tr>
<td>3.</td>
<td>Post-Harappa</td>
<td>33 to 27.9 x 15.2 to 12.7 x 12.7 to 8.9 cm</td>
</tr>
<tr>
<td>4.</td>
<td>Early Historical</td>
<td>60 to 20 x 31.75 to 16 x 10 to 5 cm</td>
</tr>
<tr>
<td>5.</td>
<td>Late Historical</td>
<td>60 to 11 x 28.6 to 8 x 12 to 4 cm</td>
</tr>
</tbody>
</table>

Source: Souvenir of the Diamond Jubilee of the Brick and Tile Manufacturers’ Association, Chennai, 2005

The earliest availability of bricks in archaeological context goes back to the Pre-Historic times when first man started to live as a community. The earliest availability of bricks was obtained from the Pre-Harappan levels, the sites like Kili Gul Mohammad, Kot Diji. (3600 B.C. to 2700 B.C.). During the Harappan level both Mud brick and burnt bricks were profusely used for their construction. Harappa, Mohenjadharo, Dholavira, Rakhigari, Kalibangan were few sites which had the examples of Brick structures.

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In central India mud bricks were used during the Chalcolithic times. Bricks were used during the Mauryan period to the Mughal period. During the Gupta period, moulded burnt bricks were used and during the medieval period Lahori brick were used.9

1.4. Brick Industry-The Global Scenario

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. Hence, an attempt is being made by the researcher to study at a glance the global scenario of the brick industry at a glance.

1.4.1. United States of America

In the recent past, with jubilant economy, housing sector flourished in America facilitating residences to the new settlers and the natives on a large scale. According to American New Housing Report of Census Bureau, Regional Products and Consumption by Census Region were as follows:

<table>
<thead>
<tr>
<th>Area</th>
<th>Production (in Percentage)</th>
<th>Consumption (in Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New England</td>
<td>0.7</td>
<td>1.3</td>
</tr>
<tr>
<td>Middle Atlantic</td>
<td>5.1</td>
<td>6.4</td>
</tr>
<tr>
<td>East North Central America</td>
<td>8.2</td>
<td>15.6</td>
</tr>
<tr>
<td>West North Central America</td>
<td>4.4</td>
<td>3.9</td>
</tr>
<tr>
<td>East South Central America</td>
<td>19.7</td>
<td>15.5</td>
</tr>
<tr>
<td>West South Central America</td>
<td>19.5</td>
<td>20.5</td>
</tr>
<tr>
<td>South Atlantic</td>
<td>38.7</td>
<td>33.7</td>
</tr>
<tr>
<td>Mountain</td>
<td>3.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Pacific</td>
<td>0.2</td>
<td>0.6</td>
</tr>
</tbody>
</table>


While sixty years ago, there were several thousand brick manufacturers with nearly three thousand plants; today there are 83 manufacturers in the U.S. operating 204 plants. According to Industrial Outlook, the use of brick as a siding material for single family homes dropped from twenty six per cent in 1984 to 17 per cent in 1989.  

1.4.2. West Virginia

The earliest West Virginia brick plant was built near New Cumberland in 1832 and bricks and fired clay were shipped to Pittsburgh and various other parts along the Ohio State. In 1862, gas was struck nearby and soon it was being used for firing brick.

1.4.3. Some Asian Countries

1.4.3.1. China

China is banning brick and tiles made in smoky coal-fired kilns, ending a two thousand year old tradition in an effort to cut smog and save farmland mined for clay. The style of brick making in China dates back to the Second Century B.C. Construction of rural brick kilns over the past decade consumed more than 7,50,000 acres of farmland.

In China, brick was used to build several parts of the Great Wall which dates from third century B.C. The Great Wall of China (210 B.C.) was built with both, burnt and sun-dried bricks.

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1.4.3.2. Bangladesh

There are 23 thousand brick making units in Bangladesh producing 3,000 million bricks every year and employing 1,30,000 labour per annum.

1.4.3.3. Indonesia

There are more than 45000 brick making units in Indonesia producing over 4,100 million bricks every year and employing 1,25,000 labourers per annum.

1.4.3.4. Nepal

There are 442 brick making units in Nepal producing 627 million bricks every year and employing 50,000 labourers per annum.

1.4.3.5. Pakistan

There are more than 3,000 brick making units in Pakistan producing 11,000 million bricks per annum and employing eleven thousand labourers per year.

1.4.4. Jerimo and Jericho of Middle East Countries

The presence of mud bricks in the excavation at Jerimo and Jericho of Middle East Countries is dated back to 7000 or 8000 years Before Christ.

1.4.5. Toronto

In Toronto, it has been made mandatory to build houses with bricks especially after the disastrous fires of the 19th and the early 20th Centuries.
1.4.6. Egypt

Mud bricks dried in the sun are still being made in Egypt today. Bricks in the early Egyptian dynasty were formed of alluvial slit. Bricks survive from Pre-dynastic Egypt (before- 3400 B.C.)\textsuperscript{11}

1.4.7. North West Cambodia

The past ten years have been rather successful ones for the brick industry due to booming economic conditions of the 1990s after two decades of civil war. The Government and development specialists support the setting up of brick industry throughout Asia.

1.4.8. Rome

Romans developed a characteristic flat, kiln burnt bricks using sand or clay. They made wide use of sun dried bricks until the time of Augustus (63 B.C. – 14 A.D.) but after that time they generally used bricks burnt in kilns. During the Roman Empire, the Romans spread the art of brick making which was discontinued when Roman occupation ended in 410.\textsuperscript{12}

1.4.9. France

Hollow bricks which at first were little more than square pipes began to be produced not long after 1800 and were made on a fairly large scale in France by the middle of the 19\textsuperscript{th} century.\textsuperscript{13}

\textsuperscript{12} Encyclopedia Americana, Vol.4, 1976, p.519, 520.
1.4.10. Australia

Today, the brick industry is worth around $2.8 million to the Australian economy and directly employs about 25000 people nationally and the same number indirectly as contractors, resellers and in supply industries.

1.4.11. England

The great fire of London in 1666 was really a blessing in disguise which changed London from being a city of wood to one of brick. A number of country farm houses still exits in Great Britain and profess to be the monuments of the excellent hand-made bricks.

1.5. Brick Industry in India

India is the second largest producer of bricks after China. The estimated brick production during 2000-2001 was close to 140 billion. The Indian brick industry is unorganized with small production units. More than one lakh units have clustered in rural and semi-urban areas in the country.

In India, the brick industry is one of the important labour intensive industries which provides employment to both skilled and unskilled rural people. There are about 30000 brick kiln units in India employing over five million landless labourers.\(^\text{14}\)

On the national level, All India Brick and Tile Manufacturers Federation, New Delhi, looks after the interests of the industry in general and its member units in particular. Brick fields are normally set up on leased-out lands near clay

sources. Owing to their temporary, low technology and polluting nature, and total absence of professional management (including quality control), these units do not enjoy much respect in the eyes of people and consequently, bricks are not thought of as an ‘industrial’ product by the common man. Only in South India (and at a few places in the North also), where roof tile plants are common, similar technology is used for making wire-cut bricks, which command reasonable consumer respect. Barring a few mechanized/semi-mechanized units in North and South India, all other units employ piece-rate contract labour to carry out the brick manufacturing process.

Although International Standards: 1977-1992 dictates 7.5” x 3.5” x 3.5” and 7.5”x 3.5”x 1.5” as the two recommended sizes for modular bricks, almost none of the manufacturers adopt either of these sizes. 9”x 41/4”x 3” size bricks are called standard ‘full size’ bricks, while smaller size are known as ‘cut size’. 9”x 6”x 4” size bricks, which are of recent origin, are called ‘double’ bricks. Double bricks are popular in Mumbai, Pune, Nashik, Aurangabad. 10” x 5”x 3” size is common in North India.

A few burning issues of the brick industry in India are total dependence on skilled moulders, clay shortage and rising fuel cost, opposition from environmentalists and social workers and absence of appropriate technology\textsuperscript{15}

Considering India as a whole, about 100 bricks are consumed per year per person, an estimated 100 billion bricks consumed by the present population of about 990 crores -the consumption factor is 100. This varies with the development

\textsuperscript{15}http://www.brickindia.com/
stage of a region, from 125 to 150 for a fast developing area to over 200 for mega cities.

1.5.1. Brick Industry in various States of India

In *Maharashtra* State, the present average production of brick fields is about 10 lakh per season per unit. There are about 11,500 units in the State. The size of open clamps varied between 25,000 numbers and 10 lakh numbers. The Government of Maharashtra has recently exempted entrepreneurs belonging to Kumhar caste from payment of Royalty and Cess.

There are 25,000 brick kilns in *Haryana* each on an average employing capacity upto 150 persons. In that State, the brick business is not doing well. There has not been much demand for bricks from the government construction sector also. The closure of government Departments has had a cascading effect.

In *Malabar Coastal Region (Kerala and Karnataka)*, the total number of production of bricks amounted to 57 crore per year. The demand for bricks in Malabar Coast is mush lesser than supply of bricks. Government of Karnataka and Kerala are putting a lot of restrictions on the use of sedimentary soil from rice fields for brick and tile making. It leads to shortage of raw materials in these States.

Brick industry is considered to be the biggest single employer in the State of *West Bengal*. According to an estimate, brick industry of West Bengal creates
50 jobs against an investment of Rs. One lakh compared to seven jobs in other Small Scale Industries and only two jobs in large scale industry.¹⁶

Brick industry in Gujarat is a small scale rural based industry providing employment to the maximum landless agricultural labourers of the weaker section of the society. By this way, the brick industry is supporting the 20 Point Programme of Government of India.

In Allahabad, farming is the main occupation. In the 1960s, the rich loam of the area attracted brick miners and the brick productive land was gobbled to feed the incessant demands of the construction industry. With their land leased to the brick industry, the local community was hard-pressed to find an occupation in the villages and began migrating.¹⁷

There are more than 2000 brick kilns in Punjab employing about 2.5 lakh workers. The migrant workers constituted a very high proportion of the workers working in brick industry in Punjab.¹⁸

Remains of altars called Syena (bird shape fire alter) has been found at Kausambi, of Uttar Pradesh of second century B.C. where the bricks are inscribed.


In Kerala, there are different types of bricks produced. They are hand moulded, wire cut, sand, lime, semi wire cut bricks and cement sand bricks. Production of other types of bricks is insignificant both in volume and employment generation when compared to the hand moulded bricks. Bricks are more homogeneous, cheaper, more easily available and easily put up than stones for building construction. In Kerala, brick industry employs 1.5 lakh workers and it requires serious attention by the government due to lack of credit facilities and adequate capital.19

1.6. Brick Industry in Tamil Nadu

Bricks were used in Tamil Nadu and its earliest reference comes from the Pallava King Mahendravarman-I (580-630 AD) in his ‘Mandagapatu’ inscription mentioning names of the earlier construction materials, which include brick also. This inscription clearly state that be Mahendravarman-I’s, time bricks were mainly used by his predecessors. But during his time, stone structures were abundantly used besides bricks.

In Kaveripattinam, the exposed structure like kiln – burnt bricks, brick built facade of water reservoir afford testimony to the remarkable stage attained by the Tamil people in structural engineering. The bricks found in the Wharf are the largest size found in South India measuring 24” x 12” x 3”, they are heavy and saffron red in colour. Made of soft and well levitated clay, they are examples of highly perfected craft, which has enabled those bricks to remain unaffected in saltiest back waters for more than 2000 years.

The bricks used in the Buddhist monastery of Kaveripattinam exhibit decorative detail and skillful workmanship. Bricks with various mouldings as well as chamfered or beveled edges have been used to suit the various positions in which they were placed. Bricks with curve and other complicated profiles were evidently shaped in fresh clay before they were placed in the kiln.

At Arikamedu (a famous Roman site near Pondicherry), two brick built tanks used as cisterns or vats for dying the muslin cloth were unearthed.

Besides, excavation conducted at site like Uraiyl, Tirukampuliyur, Kanchipuram, Palayarai (secondary capital of the great Chola’s) have come out with brick structures.

Recently, the excavation conducted at Saluvankuppam (near Mamallapuram district – Kanchipuram), a brick temple of Sangam period dedicated to Lord ‘Karthikeya’ (Murughan) was excavated by Archaeological Survey of India, Chennai Circle where the usage of bricks along with dressed stone is noteworthy.20

1.6.1. Predominant building materials in Tamil Nadu

The percentage distribution of houses under different materials of wall, floor and roof are given under Census Report on Housing and Housing Amenities, 2001 by Government of Tamil Nadu.

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1.6.1.1. Predominant materials of wall in houses in Tamil Nadu

Many of the houses in the rural areas are built with flimsy materials such as mud and stone which are generally referred as kutcha materials, while most of the houses in the cities are and towns are built with pucca materials such as burnt bricks and cement concrete.

Majority of the houses in the rural and urban areas of Tamil Nadu are built with burnt brick as the predominant construction material of wall, the second dominant material of wall is occupied by mud and unburnt bricks.

Of the different types of wall materials with which the houses have been classified, the materials in the rural areas which have been used in reasonably good number of houses are stone, grass, leaves, reeds or bamboo, plastic and polythene. The other wall materials like wood, cement concrete, galvanised iron (G1), asbestos sheets or other metal sheets are used by fewer houses, constituting a very small ratio in the rural areas. Thus, in the rural areas, kutcha wall materials as well as burnt bricks are used as wall material.

Of all districts in Tamil Nadu, the rural areas of Ariyalur district occupies the majority per cent of usage of mud and unburnt brick, which accounts for about 58.53 per cent to total and the urban areas of Kanniyakumari district occupies the majority percentage of usage of mud and unburnt brick, which accounts for about 39.99 per cent to total.

Of all districts in Tamil Nadu, the rural areas of Theni district occupies the majority per cent of usage of burnt brick, which accounts for about 52.75 per cent to total and the urban areas of Sivaganga district occupies the majority per cent of usage of burnt brick, which accounts for about 73.99 percent to total.
1.6.1.2. Predominant material of roof in houses in Tamil Nadu

The most commonly used roofing materials are grass, leaves, reeds, thatch, wood, mud, bricks, bamboo, tiles, slate or shingle, corrugated iron, zinc or other metal sheets, asbestos sheets, stone and lime, stone and concrete RBC/RCC.

The highest per cent to total of roofing material is occupied by concrete and next comes grass, thatch, bamboo, wood and mud. Bricks are found to be used in sizeable ratio for roofing in both rural and urban housing only on three districts namely Tirunelveli district (11.48 per cent to total and 13.61 per cent to total), Virudhunagar district (10.32 per cent to total and 12.03 per cent to total) and Thoothukudi district (7.01 per cent to total and 11.18 per cent to total).

1.6.1.3. Predominant material of floor in houses in Tamil Nadu

The floor materials are classified under six broad categories besides a residual category- ‘others and materials not stated’. ‘Cement’ and ‘Mud’ are the two prominent materials used for the floor in the houses both in rural and urban areas of the State. Although ‘mosaic / tiles’ is gradually picking up in usage, particularly in urban areas, it ranks only third in its importance. Even in the urban areas, there is a craze for using them in recent years.

Even though, cement and mud occupy the prime position as a predominant floor material, bricks are also used in a considerable amount. Bricks are found to be used in sizeable ratio for flooring in rural houses only in two districts, namely Tirunelveli (16.63 per cent to total), Virudhunagar (5.71 per cent to total).

Bricks are found to constitute the highest ratio among the urban areas of Tirunelveli district (21.61 per cent to total), and second highest ratio of this
material in urban areas is registered in Virudhunagar district (7.62 per cent to total).

1.7. Classification of Bricks

The bricks can be categorized on the basis of its burnt level, its shape and on the basis of its usage of fire clay:

1.7.1. On the Basis of Burnt Level

On the basis of the burnt level, bricks are classified into Unburnt or Sun-dried bricks and Burnt bricks.

1.7.1.1. Unburnt or Sun-dried bricks

The Unburnt or sun-dried bricks are dried with the help of heat received from sun after the process of moulding. These bricks can be used in the construction of temporary and cheap structures. Such bricks should not be used at places exposed to heavy rains.

1.7.1.2. Burnt bricks

The bricks commonly used in construction works are burnt bricks and they are classified into first class bricks, second class bricks, third class bricks and fourth class bricks.

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. These bricks are used for superior work of permanent nature.
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.

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.

Fourth class bricks

These are overburnt bricks with irregular shape and dark colour. These bricks are used as aggregate for concrete in foundations, floors, and roads because of the fact that the overburnt bricks have a compact structure.

1.7.2. On the basis of shape

The ordinary bricks are rectangular solids. But sometimes the bricks are given different shapes to make them suitable for particular type of construction. A few shapes of bricks are Bull nose bricks, Cow nose bricks, Curved sector bricks, Hollow bricks, Paving bricks, Perforated bricks and Purpose-made bricks.

1.7.2.1. Bull nose bricks

A brick moulded with rounded angle is termed as bull nose. 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.

1.7.2.2. Cow nose bricks

A brick moulded with a double bull nose on end is known as cow nose brick.

1.7.2.3. Curved sector bricks

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

1.7.2.4. Hollow bricks

These are also known as the cellular or cavity bricks. Such bricks have wall thickness of about 20 millimeter to 25 millimeter. They are prepared from special homogeneous clay. They are light in weight about one-third of the weight of the ordinary brick of the same size. They also reduce the transmission of heat, sound and moisture.

1.7.2.5. Paving bricks

These bricks are prepared from clay containing a higher percentage of iron. The excess iron vitrifies the bricks at a low temperature. Such bricks may be plain or checked. These bricks are extensively used for garden walks, street pavements and stable floors. These bricks also render the floor less slippery.

1.7.2.6. 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. These bricks are used in the construction of brick panels for lightweight structures and multi storeyed framed structures. The perforations may be circular, square, rectangular or any other regular shape in cross-section.

1.7.2.7. Purpose-made bricks

In order to achieve certain purpose, these bricks are made. The splay or cant bricks are made for jambs of doors and windows. The arch bricks are made of wedge shape to keep mortar joint of uniform thickness. These bricks are usually more costly than the ordinary bricks.

1.7.3. On the basis of its usage of fire clay

These bricks are made from fire-clay. The processes of manufacture of these bricks are the same as that of ordinary clay bricks. The burning and cooling of fire –bricks are done gradually. The three varieties of fire-bricks are acidic bricks, basic bricks and neutral bricks.

1.7.3.1. Acidic bricks

These bricks are used for acidic lining. These bricks are prepared from natural fire-clay and they provide a good material for acidic refractory lining. These bricks contain a very high percentage of silica to the extent of about 1 to 2 per cent, is added to work as binding material.

1.7.3.2. Basic bricks

These bricks are used for basic lining and basic refractory materials are used in the manufacture of such bricks. The magnesia bricks are prepared from lime and magnesia rocks. The dolomite may also be adopted for the manufacture of these bricks.
1.7.3.3. **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.

1.8. **Substitutes for Bricks**

The Indian construction industry has felt the need to search for an appropriate alternative to the bricks mainly for the reasons such as high wastage during transportation, high water absorption of bricks, inconsistency in size of bricks, increasing cost of kiln fuel, and unavailability of skilled labour.

It is possible to produce at present a variety of bricks from the materials other than clay and the bricks so produced can be grouped as concrete blocks, fly-ash bricks and sand-lime or calcium silicate bricks.

1.8.1. **Concrete Blocks**

The materials required for the production of the concrete blocks are cement, and water. The fully automatic plants are of high strength concrete blocks. These automatic machines produce superior quality concrete blocks. But they involve a large capital investment. The manually operated machines are also available and they can be installed at project site itself which further reduce the transportation cost of the concrete blocks from the place of production to the place of actual use.

1.8.2. **Fly-ash Bricks**

Fly-ash bricks are competitive to conventional bricks and provide enormous indirect benefits. The brick units can gain a lot by gainful utilisation of
ash resulting in conservation of natural resources as well as environment. The various technologies for the manufacture of fly-ash bricks are fly-ash sand lime bricks, fly-ash lime gypsum bricks and fly-ash clay bricks.

1.8.3. Sand-Lime or Calcium Silicate Bricks

The autoclaved calcium silicate bricks were invented by Van Derburgh in England as far back as 1866. However such bricks were produced on a commercial scale only in 1898. The raw materials are required for preparation of sand lime bricks are sand, lime, water and pigment.

These bricks have not yet become popular in India except in Kerala State where some structures are constructed by using these bricks. These large scale productions of this type of building material have not been possible in our country due to the non-availability of high capacity press.

1.9. 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-colored, 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 bricks should have the crushing strength below 5.50 N/mm².

1.10. Chapter Scheme

The present study is reported in the following seven chapters:

Chapter I – Introduction - covers a brief introduction about brick works, position of brick works at global level, in India, in Tamil Nadu, qualities of bricks and other technical details related to bricks and types of bricks are presented in this chapter. The chapter scheme is also presented.

Chapter II – Review of Literature - presents reviews of earlier studies and works relating to the brick industry.

Chapter III – Research Design and Profile of the Study Area - presents the leading aspects of the research design and the profile of the study area carries
necessary brief background information like the natural, economic and commercial conditions of Tirunelveli and Thoothukudi districts.

Chapter IV – Production Analysis - includes details of production aspects such as details of raw material, labour, overheads, cost of production of bricks, analysis of determinants of brick production in Tirunelveli and Thoothukudi districts and ranking of production problems.

Chapter V – Marketing Analysis - the marketing performance including product, price, promotion and physical distribution activities of brick works in the Study area are presented in this chapter. The price analysis and the analysis of factors that motivate the buyers to buy bricks and ranking of marketing problems are also presented.

Chapter VI – Finance and Profitability Analysis - The finance aspects such as capital invested by brick works, assets owned by brick works and profitability aspects such as income statement (which includes marginal cost statement), break-even analysis, profitability ratios and turn-over ratios are presented in this chapter.

Chapter VII – Summary of Findings, Suggestions and Conclusion - This chapter presents the leading findings along with SWOT analysis, a few suggestions for the betterment of the brick works in the years to come and a crisp conclusion.