CHAPTER III

BRICK MAKING PROCESS
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Brick Making Process

General Information:

The process of manufacturing bricks involves the following stages:

a. Quarrying,

b. Pre-processing (Grinding, sieving, wetting etc.),

c. Forming (Equipment and skill requirement),

d. Drying, and

e. Firing.

A. Quarrying:

This is the first stage in the process of brick-making. Procurement of soil of suitable quality is very important as the quality of the soil determines the quality of the brick. This first stage involves the following different activities:

i. Searching for clay deposits - The soil required for brick making is not available everywhere. Brick making requires soil with certain specifications. Only when the soil satisfies the specifications will brick making be possible. River banks, recent road and railway cuttings may be examined
for this purpose. Deposits can also be found in gently rolling hills. The soil should contain clay soil particle of a size of 0.002 mm., but clay particle of this size should not be present in very high proportions. If the clay soil particle of 0.002 size is present in high proportions, it results in the cracking of bricks due to excess shrinkage. At the same time, if the presence of such clay particle is very much less, the soil will not have the necessary cohesive strength. The soil should have plasticity and should contain silica and alumina in sufficient proportions to form strong durable glassy material. Presence of alkalis or iron etc., will be useful in the formation of glassy compound and these constituents which do produce excessive deformation or shrinkage at firing temperature will be helpful in the production of quality bricks. But the soil should not contain impurities which are likely to disrupt the structure of the brick.

Kaoline group of soil is considered to be the most typical for brick making. The soil consisting clay upto 50 per cent and sand and silt is considered to be quite a good soil for making bricks. The proportion of Silica and Alumina in sufficiently high quantity will be useful in forming glassy ceramic bonding material. The presence of compounds like sulphate of Potassium, Sodium, Magnesium, Calcium Sulphate etc. are likely to spoil the bricks. But some of these compounds being water-soluble, the problem can be overcome by allowing
rain to wash away the salts after digging or the problem can be overcome also by firing the bricks to higher temperature. Other compounds which are not soluble in water like Potassium, Sodium containing Felspar, or Mica, presence of Magnesium, Calcium, and Iron compounds will be very much useful in improving the quality of the brick. The presence of a high proportion of Calcium Carbonate of more than 2 mm particle size results in sudden cracking of bricks on firing.

Shrinkage on drying should also be taken into consideration. The Shrinkage will be more in case of fine particles. High shrinkage rate may result in cracking of bricks and this can be reduced by mixing non-reactive coarse-grained materials like sand or grog (reject bricks).

Suitability of the soil for brick making can be tested in different ways. Simple tests which can be carried out are:

a. A little soil taken in hand gives proper feeling of proportion of different particles and their sizes. If the clay content is more, the soil will be smooth and will be sticky when it is dampened. Such soil requires mixing of more sand.

b. Visual inspection with the help of a magnifying glass if necessary will be useful to understand whether the soil contains sand or not.
c. The soil may be mixed with water (or salt water) in a straight-sided, flat-bottomed jar or bottle and then allowed to settle down. Then the layers are observed. The bottom layer consists of sand and other coarse particles. The medium layer consists of silt and the top layer is that of clay. If the soil contains 25 to 50 percent clay and silt, 75 to 50 percent of sand and coarse materials, it can be considered as suitable for brick making. This test is called 'sedimentation Jar test.'

d. Plasticity and cohesion of the soil can be tested by rolling the moistened soil by hand into a cylinder and pulling it apart. If it breaks, it indicates low plasticity and if it elongates it shows high plasticity of the soil.

A long cylinder of about 10 mm thickness made out of the soil may be held by one end to see where actually the cylinder breaks. If a lengthy piece is cut apart, it shows the presence of more clay and if a short piece falls down, it indicates that the soil is too sandy and therefore some fat clay or anthill materials may have to be added for increasing the plasticity of the soil.

The moisture content can be understood by dropping the ball made of the soil on hard ground. If the ball breaks into
a large number of very small pieces, it shows that the soil is too dry.

These two tests which indicate the plasticity and the dryness show the plastic and the liquid limits of the soil. The difference between the plastic limit and the liquid limit is called plasticity index and the soil with low plasticity index is very difficult to handle. Soil with very high plasticity index requires more water for moulding bricks and such bricks require more time for drying before firing.

More difficult tests may be conducted but for that the help of experts like minerologist, geologist and chemist becomes inevitable.

Observation of the colour of the soil will be useful in understanding its properties. Red colour of the soil is indicative of the presence of iron in high quantities and is good for brick-making. Iron acts as flux in the process of brick-making.

The shrinkage of the brick due to defect of the soil can be tested by moulding a few bricks and allowing them to dry thoroughly. The difference in length of the brick before drying and the length of the brick after drying shows the drying shrinkage of the brick. Cracks on the surface of the dried bricks may be observed for taking proper decision
regarding mixing of sand or grog or clay, anthill soil etc. to make the soil fit for brick-making.

Firing shrinkage can be ascertained by burning a batch of bricks and the difference between the length of the brick before firing and the length after burning can be measured to understand the firing shrinkage.

ii. Winning the clay: First the top soil and the overburden should be removed and the digging should be started at the higher point to avoid flooding of the clay pit by surface water. The digging process depends upon the clay stratum. If the clay stratum is horizontal, the removed overburden may be piled in two rows along the excavation and the digging can be done between these two rows. If the clay stratum is sloping, the overburden to be removed will be more. But these unwanted materials (overburden so removed) will be very much useful for filling the trenches from which the useful clay is already excavated. This re-instatement of the topsoil will make the field useful for cultivation of rice etc., especially when the digging is done in rice fields. Rice fields are the main source of soil for brick making in Madagascar and Indonesia.

Steep sloping should be avoided as it is extremely unsafe. Down hill channels or sumps for collecting water may
be used for avoiding flooding of the pits. The water collected in the sumps may be removed by using buckets or pump.

Plant roots, stones, limestone nodules, harder clay inclusions and other impurities are to be removed as the digging continues.

The depth of the pit depends upon the presence of suitable clay deposit. Mixing of the material from the two faces may be done if one face is too sandy and the other one contains too fat clay.

Multi-bucket excavators and bulldozers can be used for winning the clay, and for removal of overburden etc. But the use of the mechanical process will be economical only when the bricks are produced in large quantities. The mechanical process works out economical only if the production is above 14,000 bricks per day.

Hand-digging is common in medium size production plants. Hand-digging can be adjusted according to the needs and requirements and also gives scope for removal of unwanted materials like roots, stones etc. It requires less capital investment. One man can dig enough clay for production of approximately 3,500 to 4,000 bricks per day. There should be close supervision to see that the worker separates the unwanted material.
iii. Transportation to the works: Tractors, lorries, large dumper trucks, small-gauge railway systems, arial ropeways or belt conveyors may be used for transportation of the clay to the works. This will be possible when the production is on large scale. If the scale of production is smaller, a small diesel-powered dumper, bullock carts or wheel barrows or simple litters will be convenient. Baskets and headpans are used in small units. If the production is carried on in the field itself, there is no problem of transportation.

B. PRE-PROCESSING: (GRINDING, SEIVING, WETTING etc)

Proper clay preparation is necessary for avoiding cracking of the bricks, lime-blowing etc. If the clay processing is not properly done, it may reduce the load bearing strength of the brick. It may also result in non-uniformity of the size of the bricks. Use of surface soil may cause efflorescence, sulphate attack etc.

Clay preparation consists of sorting (picking), washing, grinding, proportioning, mixing, wetting and tempering. In big units these activities can be mechanised. For small units mechanisation is not possible as it becomes costly and economically unviable.

i. Sorting: Sorting is best done while digging the clay. Unsuitable pockets of soil, stones, roots, limestone
nodules etc., can be picked and separated by the workers at the time of digging itself.

ii. Crushing: Here also mechanical crushing will be possible in units producing bricks on a large scale. Hammerhoe is the best instrument for manual crushing. The hammerhoe can be put to different uses. It can be used for digging, turning, mixing etc. Just a half turn position will bring the hammer in position and can be used for breaking the hard lumps. Pendulum crusher is a labour-intensive crushing machine which can be conveniently used in small units. A team of four men can crush on an average 20 tonnes per day which is sufficient for the production of approximately 10,000 bricks. If the soil consists of hard shales, then the process of crushing becomes a bit slow and the team of 4 will be in a position to crush soil sufficient for the production of about 8,000 bricks. Crushing becomes difficult if the soil is wet. A tonne of grog can be prepared by crushing underfired bricks in about 2.25 hours. The crusher may be animal powered too.

iii. Seiving: This is necessary for separating oversized particles from the clay. For this purpose the powered clay may be made to pass through 5 mm screening wire-
mesh fastened on to a rectangular frame resting on the ground at one end at 45° angle to the ground.

iv. Proportioning, mixing, wetting and tempering:

After crushing and seiving, the clay, grog and sand should be measured by volume to get a consistent quality product. Solid fuel is mixed in suitable measure to assist the burning of bricks. Commonsalt may be added to minimise limeblowing. Barium carbonate may be added if the clay contains soluble sulphate salts. Water is added in required quantities and the whole quantity is mixed and kneaded either manually or mechanically to form a thick paste.

It is said, semi-dry methods of manufacturing bricks were developed towards the end of the 19th century from hard, almost dry marls. Such bricks were made from a special clay called oxford clay available in Peterborough and they were popular in Northamptonshire.

For big units, motor-powered double-shafted through mixer is very useful for mixing the soil but it requires heavy capital investment. Mixing becomes easy if the wet heap of soil is kept for tempering (souring) for a few days with proper covering to avoid evaporation of water. Mixing may also be done with the help of animal-operated or electric or diesel-powered motor-operated pug mills. Foot-treading is also
very much common. For foot-treading, the clay should not be too dry as it becomes very difficult to move the feet up and down. On the other hand, if the clay is too wet, it becomes very difficult to mould.

C. FORMING (MOULDING)

Shaping or moulding starts once the preparation of the clay is over. The size and shape of the mould may vary from place to place and may also change according to the purpose for which bricks are required. The brick may be manufactured in different shapes according to the requirements. It is said triangular shaped bricks were used in ancient Rome. The bricks are also manufactured in 'L' shape and such bricks are used at the corners. "The commonest ancient bricks were cut into triangles and laid with the base out and the apex set into a concrete filling that provided additional strength." Industrial bricks are shaped according to the requirements of the industries which use them.

The present study concentrates on the bricks manufactured for common use and they are called contemporary or traditional bricks. They are used as common structural materials. They are usually of rectangular shape. "Contemporary bricks are rectangular blocks with standard dimensions of about 2.25" x 3.75" x 8" though various sizes are used."
The size and shape of the brick depends upon the size and shape of the mould used. British standard specification for bricks is 215x102.5x65 mm or 225x112.5x75 mm if 10 mm mortar joint is added. There will be no holes in the bricks produced in small units but usually a frog is indented into one bed face which reduces the weight of the brick and it also reduces the fuel requirement. It also reduces the drying time of the bricks. Perforated bricks may be produced to take the above advantages but the production of perforated bricks is possible only with the use of extrusion machines. If the bricks are of uniform size and shape, they will be very convenient to handle, transport or to stack. Even the material requirement for rendering will be less if the bricks are accurately cut and are of uniform size.

Defective bricks are likely to be produced if there is no proper lubrication of the die or due to uneven spacing of the cutting wire or even due to the use of dirty cutting wires. Use of inaccurate and bent moulds also results in the production of defective bricks. Other reasons for production of defective bricks are overfilling or incomplete filling of the mould, careless demoulding, squashing demoulded bricks too lightly between the pallets etc. which result in the production of faulty bricks.

Machines may be used for large scale moulding of bricks. Produced with due care even hand made bricks are as
good as machine made bricks. Hand made bricks are economical too. Use of machines for brick moulding depends upon the scale of production, cost and availability of fuel/power, maintenance and spare services etc. Small hand-powered machines require less capital investment and they work faster than ordinary hand moulds.

Sometimes another method of moulding called 'slop moulding' is used. In this method, wet mix of clay is thrown with force into a wetted bottomless mould and the mould is removed after scraping the excess clay with the help of the striker or hand. The mould is to be rewetted for the next use and if rewetting is not done the mud will stick to the mould. As the clay used in this method is very wet, the bricks produced under this method will have high shrinkage and distortion. This disadvantage of slop moulding can be overcome by using sand or saw dust or fine dust of dry clay for avoiding the sticking of the clay to the mould and by doing so it will also be possible to use the clay mix which is more stiff and naturally the shrinkage and the distortion will be less.

The most common type of brick-moulding is the turnover mould, in which the clot is put in the mould with a fixed base, the pallet is placed on the top of the mould after scraping the excess clay with the help of a striker or
bowcutter (tout wire on a bent stick) and then the whole mould is rotated 180° and then a sharp knock is given on the end stop for demoulding. The clot as also the mould are covered with sand or clay dust to avoid sticking.

One more method that can be used for brick-moulding is table-moulding. Under this method, the bricks are demoulded by using a foot operated lever which raises the mould bottom and the bricks so raised are removed with the help of pallets for drying.

Wheel barrows or hack barrows can be used for transporting the bricks to the drying area.

D. DRYING:

After the moulding process, the bricks are to be dried till they become leather hard before they are put in the kiln for burning. If the bricks are put in the kiln without drying, they will not have the necessary strength to take the weight of the bricks laid above them. The bricks at the bottom will have to bear the weight of about 20-25 bricks laid above them.

The bricks are to be dried till they acquire the critical moisture content stage. If the bricks are not properly dried, the excess moisture content in the brick is likely to result in excessive water evaporation at the time of burning and this will result in rupture and the bricks will be
spoiled. Also the bricks which are not properly dried consume more fuel i.e., coal ash in the burning process. Once they become leather hard, they are ready for the burning process and they can be called 'the bricks at critical moisture content stage'. Putting the bricks in kilns before they become leather hard is also likely to spoil the entire heap. Excessive shrinkage of such bricks may cause the whole heap of bricks to collapse within the kiln. The drying should not be too fast or too slow.

There are different methods of drying. They are
i. Artificial drying ii. Natural drying

i. Artificial drying:

Artificial drying involves heavy capital outlay and requires great skill and also involves the use of advanced technology. Usually tunnel dryers or humidity dryers are used for this purpose and because of this reason artificial drying process is a bit costly.

In the tunnel drying process, bricks are laid on cars with sufficient spacing and the cars are moved on rail tracks into a tunnel about 6 feet high and 100 feet long. Hot air is blown into the chamber in the reverse direction at regular intervals.
Under humidity drying process the bricks are dried on floors during cold winter months. The floor is heated and the process is a bit costly as it requires a large amount of fuel. This is called floor drying. Another method of humidity drying is the use of a chamber dryer. In this process the bricks are heated in the wet slate in an atmosphere saturated with moisture until it attains a temperature of 120° to 150° Centigrade. Then it is subjected to dry currents of air at relatively high temperature of the order of 200° Centigrade. These modern chamber dryers are useful for drying bricks in large quantities and when compared to tunnel dryers the modern chamber dryers are less costly. Tunnel dryers are not suitable for all types of clays and will be costly if the bricks are not dried within 24-48 hours.

Artificial drying is always costly as they require automatic handling of bricks special designing of the kilns etc; The kiln should be designed in such a way that the waste heat from the kiln is conducted to the dryers. Tunnel kilns will be most suitable for artificial drying but may not work with small kilns where kiln heat cannot be recovered so easily. The cost of artificial drying is less in case of rotary dryers. In this system hot air is applied to the bricks which are strategically positioned in racks.
Natural drying is cost-saving as it never involves use of fuel and is easy to adopt also. But natural drying process requires a large area. It is most useful for small producers. In this process, the bricks are laid out in a single layer on the ground. The bricks are naturally dried by the heat of the sun and the action of the wind. But natural drying is a time-consuming process.

For natural drying, the ground should be free from loose debris, bumps, dents etc. When the bricks are dry enough to handle, they are turned so that the face in contact with the ground has to dry now. After 6-7 days the bricks will be ready for turning and after turning the side they will have to be kept for another 6-7 days and then once again they will be left for drying after grouping them into hacks for 3 to 4 days. Thus natural drying takes usually 15 to 20 days before the bricks are ready for burning.

The bricks are likely to be damaged during drying. They are likely to be trodden by dogs or other animals or even by human beings. They are also likely to be damaged by rain. Such damages can be avoided by drying the bricks in sheds or by use of special covers, racks, side-screens etc.
E. FIRING:

Only after firing, the bricks acquire good mechanical properties and resistance power. If the firing is not properly done, the bricks are likely to lose shape or fuse together or melt on one face or it may have an adverse effect on the load-bearing strength of the bricks. Necessary precautions should be taken to avoid rapid changes in temperature. Even inadequacy or insufficiency of the temperature is likely to have adverse effect of the quality of the bricks.

Slow heating is considered to be safe but is time-consuming and costly. Therefore, optimal heating resulting is satisfactory quality and minimum cost is desirable. Initial heating should be slow and in this initial heating the residual moisture in the bricks is driven off and this process is called water-smoking process. Maximum temperature is needed in soaking stage when chemical reaction takes place and glassy material is formed.

Usually on firing at 100° Centigrade the moisture in the brick is removed and from 450° to 500° centigrade Di-hydroxylation takes place. Quartz crystallisation (silica changes to crystal form) which is known as quartz inversion and burning of organic compounds takes place at 573° centigrade of temperature. The carbonate decomposition takes place between 500° and 600° centigrade and 850° and 1,000°.
centigrades and onwards there will be vitrification i.e.,
glass formation. Different stages in the firing process are
shown in the graph on page 43.

Sufficient oxygen should be let in during the firing
process so that the diffusion takes place properly in time and
the organic matters are completely burnt.

KILNS IN USE FOR BURNING OF BRICKS:

Mainly there are two types of kilns.
i. Intermittent kilns. ii. Continuous kilns.

i. Intermittent kilns:

Intermittent kilns are most adaptable to market demand
but they are not fuel-efficient. The outstanding feature of
the intermittent kilns is that the entire kiln structure
itself is heated during the heating process and the heat
within the bricks and the kiln is lost into the atmosphere
during the cooling process.

Intermittent kilns may once again be of different
varieties. The different varieties are:
a. Clamp kiln
b. Scove kiln
c. Scotch kiln
d. Down draught kiln.
Changes in clay

- Mullite
- Deform
- Vitrify

- Carbonates decompose
- Quartz inversion
- Organics burn off
- De-hydroxylation
- Drying

Temperature °C

Source: I.L.O. Technical Memorandum no.6 on Small Scale Brick Making.

Effect of heat on clay
a. Clamp kiln: This is the most commonly used type of brick kiln. Usually 5 to 10 per cent of fuel material like coal-ash or sawdust is added to the clay before moulding.

Usually a checkerwork pattern of spaced out, already burnt bricks, is made in approximately 15 metre by 12 metre flat dry area of land. Then coke or small coal pieces are spread between the checkerwork forming a layer of about 20 centimetre thickness. Then the green bricks (sun-dried bricks are called green bricks) are laid on the end of the fuel bed and approximately 26 to 28 layers of bricks are closely laid with 3 or 4 holes at the base for initial ignition of the fuel bed. Two layers of already fired bricks are next laid on top of the green bricks so heaped for insulation purpose. Clamps are said to be economical only if they are of large size i.e., if the number of bricks produced is of the order of 1,00,000 or above. The fuel consumption per 1000 bricks is said to be about 7000 MJ if the bricks are produced in large quantities as mentioned above. A diagram of the clamp kiln is given on page 45.

b. Scove kiln: Scove kiln is having almost all the features of a clamp kiln and many times it is called clamp kiln by mistake. Particularly when the fuel available is of the type which cannot be spread as a thin bed at the base of the kiln, a tunnel can be built through the base of the pile to supply additional fuel by using burning wood. This type of kiln is
Source: I.L.O Technical Memorandum no.6 on Small Scale Brick Making.

Clamp kiln - schematic drawing.
called a scove because the outer surface of the piled-up bricks is scoved (plastered with mud). In other respects it resembles the clamp kiln.

Tunnels are usually two brick-length in width and the height of the kiln is usually of 26 bricks laid flat. After the first layer of bricks on the level ground, the tunnel will be of six or seven layers and usually the distance between the two tunnels varies from 2 to 6 metres depending upon the number of bricks laid in the kiln. The tunnels are made by arranging the bricks in such a way that the rows of bricks finally meet as shown in figure on page 47.

A small gap is left between the bricks while stacking the bricks in the kiln which acts as an outlet for hot gases. The top of the kiln structure slopes gradually inside and after the tunnel, the stepping will be almost one centimetre inside the kiln and like that one more stepping will be found after one or one and a half metre height and usually above the tunnel the bricks are laid up to 3 metre above the ground level.

At the top of the scove there will be 3 or 4 closeable vents. The vents are closed with the help of fired bricks to increase the temperature after the water-smoking stage. The outer layer is covered with previously burnt bricks for insulation. Some of the top bricks half-way between the tunnel
Source: I.L.O. Technical Memorandum no.6 on Small Scale Brick Making.

Source: schematic drawing.
Source: I.L.O. Technical Memorandum no.6 on Small Scale Brick Making.
are not scoved so that they can be lifted out to increase the flow of air as and when required for ventilation and for controlling the burning speed. The kiln is allowed to cool down naturally for 3-4 days. The fuel efficiency of the scove can be improved by increasing the height of the scove. Oil burners or coal can also be used in place of firewood in this type of kilns. But the fuel efficiency of the scove is not so much appreciated. It consumes about 16,000 MJ of heat per 1,000 bricks.

c. Scotch kiln: This kiln too is similar to the scove kiln except for the base, the outer walls and the fire tunnels are permanently built with bricks set in mortar. Access into the kiln, it is said, is through the doorway in the end walls. The heating of bricks in the scotch kiln is said to be very irregular, resulting in a large proportion of underburnt and overburnt bricks and so the scotch kiln is not popular.

d. Down-draught kiln: Down-draught kilns are said to be more fuel-efficient and they are mainly used for firing of other ceramic products like drainage pipes, tiles etc. The important outstanding feature of such type of kiln is the hot gases from burning fuel are deflected to the top of the kiln having a permanent roof and then they are sucked down between the green bricks and then exhausted through the chimney. The diagram of a down-draught kiln is given on page 52.
Small Scotch kiln (Madagascar)

Source: I.L.O. Technical Memorandum no.6 on Small Scale Brick Making.
Scotch kiln - Schematic drawing

Source: I.L.O. Technical Memorandum no.6 on Small Scale Brick Making.
Rectangular down-draught kiln

Source: I.L.O. Technical Memorandum no.6 on Small Scale Brick Making.
If the height of the down-draught kiln is more, too much time is consumed in arranging the bricks. Therefore the height should be restricted. The downdraught kiln can be built in a circular shape also.

CONTINUOUS KILNS:

The outstanding feature of the continuous kilns is the use of air warmed by cooling bricks for pre-heating the green bricks. The continuous kilns are more fuel-efficient when compared to the intermittent kilns. Different types of continuous kilns in use are described below:

a. Original circular Hoffmann kiln:

The original Hoffmann kiln works counterclock-wise and two wickets side by side are used. The green bricks are set in one wicket and the burnt bricks are drawn from the next wicket. One flue is opened while firing and the remaining flues are kept closed. The air blows through the open wicket and then moves anticlockwise, thus cooling the burnt bricks first and then moves to the firing zone. After burning the bricks, before moving to the chimney, it pre-heats the green bricks set on its way. Thus in this type of kiln the cool air which enters the kiln is initially heated by the hot bricks (which are in the process of cooling) and then the air gets further heated when it moves to the firing zone. As it has
Section at A-A

Original Hoffmann kiln

Source: I.L.O. Technical Memorandum no.6 on Small Scale Brick Making.
passed already the hot bricks in the process of cooling, it does not require much fuel for heating. Also, after burning the bricks, it passes through the green bricks, and thus the green bricks too are heated and kept ready for firing and because they are pre-heated, at the actual firing stage they require less fuel. Thus a maximum use is made of the fuel used in this type of kiln.

The tunnel is usually divided into 12 notional chambers of about 3.5 metre length and 5 metre width. The Hoffmann kiln is very much fuel-efficient and is said to consume about 2,000 MJ of heat per 1,000 bricks. Both sectional and horizontal designs of the original Hoffmann kiln is given on page

b. Modern Hoffmann kiln (Elliptical Hoffmann kiln):

This is an improvement over the original Hoffmann kiln. This kiln has more production capacity when compared to the original Hoffmann kiln. The original Hoffmann kiln produce about 10,000 bricks per day, whereas the modern Hoffmann kiln produces about 25,000 bricks per day. The working of the kiln is similar in all respects to that of the original Hoffmann kiln, but in the modern Hoffmann kiln the number of chambers will be more. Wood is used for firing the Hoffmann kiln. Agricultural waste, sawdust etc., can also be used in the Hoffmann kilns. Fuel efficiency of the modern Hoffmann is not
better when compared to the original Hoffmann. Modern Hoffmann consumes about 5,000 MJ of heat per 1,000 bricks. A larger number of bricks can be burnt in the modern Hoffmann and that is the only advantage of this kiln when compared to the original Hoffmann kiln.

The scheme of operation of modern Hoffmann is given in the form of a diagram on page 57.

c. Bulls trench kiln:

This is said to be designed by a British engineer and is said to overcome the cost and complexity of construction of arched tunnels, chimneys with flues and dampers etc., which were common with the existing kiln designs. The Bulls trench kiln may be constructed in either circular shape or in elliptical shape. First, a trench of the size of approximately 6 metres wide, 2 to 2.5 metres deep and about 120 metres long is made either in elliptical or circular shape and provision is made for doors (openings) for entering the kiln for setting the bricks into and drawing the bricks from the kiln.

The outstanding feature of this type of kiln is the movable chimney. The metal chimney almost 16 metre height is moved by 5-6 workers to different places on the top of the kiln depending upon the firing area of the kiln. There are
Scheme for operating a modern elliptical Hofmann kiln

Source: I.L.O. Technical Memorandum no.6 on Small Scale Brick Making.
vent holes on the top of the kiln on which the chimney with a broad base can be easily fitted. Also there will be feed-holes on top of the kiln for feeding the coal. These feed-holes will be of 1.5 centimetre size and through these feed-holes the coal is sprinkled on the bricks. Sufficient gap is to be maintained while setting the bricks for the accumulation of coal ash, and for the burning of the fuel. The kiln produces 14000 to 28000 bricks per day and is quite fuel-efficient and consumes about 4500 MJ of heat per 1,000 bricks. The diagram of the Bulls trench kiln is given on page 59 and 60.

d. Habla (Zig-Zag):

It is a variant of the Hoffmann kiln. This kiln has faster firing schedule but requires fan and electrical motor as the air has to travel a longer path. No arches are built in this type of kiln and it produces 25,000 bricks per day. The fuel consumption of Habla is said to be 3,000 MJ per 1000 bricks and in that sense, it is very much fuel-efficient. The diagram of the Habla kiln is given on page 61.

The zig-zag walls in the Habla kilns are made of green bricks and the zig-zag walls are only temporary structures which will be removed and put in the kiln for firing in the next lot and thus the green bricks used for construction of the zig-zag walls are pre-heated and so the fuel is put to the best use in the Habla.
Bull's Trench kiln - Firing sequence

Source: I.L.O. Technical Memorandum no.6 on Small Scale Brick Making.
Bull's Trench kiln: chimney and feeding
(India)

Source: I.L.O. Technical Memorandum no.6 on Small Scale Brick Making.
Section at A-A

Source: I.L.O. Technical Memorandum no.6 on Small Scale Brick Making.

 Holden type kiln -
 Firing sequence -
By making an improvement over the Habla, Indian Central Building Research Institute has developed 24 chamber high-draught kiln with a capacity of firing 30,000 bricks per day. The working of this 24 chamber high-draught kiln is similar in all respects to that of the functioning of the Habla, but the high-draught kiln has more chambers and the capacity of the said kiln is more.

e. Tunnel kiln:

The outstanding feature of the tunnel kiln is that the bricks are made to move in the tunnel and the fire remains in the same position. The tunnel will be almost 300 feet length and is provided with rails for movement of cars loaded with bricks to be burnt. The cars are pushed into the tunnel by hydraulic or gear driven rams. The kiln can be fired either by using coal or mineral oil.
REFERENCES

2. Ibid. p.939.

# PROBLEMS AND PROSPECTS OF BRICK KILN INDUSTRY IN HUBLI-DHARWAD TALUKAS IN KARNATAKA

**PHOTOS TAKEN AT THE SITE OF SURVEY**

<table>
<thead>
<tr>
<th>Photo</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.</td>
<td>Cutting the soil, cleaning it and making it ready for moulding by mixing right quantity of coal and water.</td>
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<tr>
<td>2.</td>
<td>Well mixed soil is put in the shape of a mound and is ready for moulding.</td>
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<tr>
<td>3.</td>
<td>Moulding operation is in progress - the mould, pallets and the bow cutter etc., can be seen.</td>
</tr>
<tr>
<td>4.</td>
<td>Bricks removed from the mould are laid on the levelled ground for sun drying.</td>
</tr>
<tr>
<td>5.</td>
<td>After 5-6 days the bricks are tilted and kept in this position for sun drying for an additional period of 6-7 days before they are put in the kiln.</td>
</tr>
<tr>
<td>6.</td>
<td>After sun drying but before putting the bricks in kiln, the bricks are counted and put in verticle heaps as shown here, each heap containing 20 bricks.</td>
</tr>
<tr>
<td>7.</td>
<td>Procedure of laying the kiln bed is demonstrated here (step 1).</td>
</tr>
<tr>
<td>8.</td>
<td>Procedure of laying the kiln bed is demonstrated here (step 2).</td>
</tr>
</tbody>
</table>
9. Procedure of laying the kiln bed is demonstrated here (step 3) [cow dung cake is put in the outer layer for initial ignition and medium size coal is spread to form a 2" thick bed on which the bricks to be fired will be put].

10. Watchman's shed near the kiln.

11. A pond near the brick kiln from which water is taken for brick making.
