

Technology
associated with the
manufacturing
process of bricks
engineering essay



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A brick has been around for more than 6000 years, and has been in various shape, sizes and were made from many different type of materials, each of them having their own advantage and disadvantage; and formed the basic structure of many civilisations and was used in a wide range of buildings in centuries from building palaces, housing factories, in tunnels construction, water ways, bridges, making it the oldest manufactured building material. For centuries, the brick making process was done by hand, and involved clay being moulded and then dried in the sun until the industrial revolution, when the process turned to mechanization. Today technological and mechanical advancement has helped to have a more complete knowledge of the raw material and its properties, and better control of firing, improvement in the kiln designs all have contributed to the advancement of brick quality and has made contemporary bricks more efficient and has improved the overall quality of the products.

This report will be looking at the technology associated with the manufacturing process of automated and traditional brick or “ adobe”. This plain mud brick which are still use today in certain part of the globe are called “ adobe” or sometimes “ slump brick”.

RAW MATERIAL

The main raw material in brick making is clay and it is one of the most abundant natural mineral materials on the planet. On earth, there is a wide range of clay which varies considerably in physical properties, colour, hardness and mineralogical content; making it difficult to pinpoint particular clay and say this is the best clay for brick making but they do, however, have certain properties in common.

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PROPERTIES and TYPES OF CLAYS

Clay is complex material as individual, and their deposits is unique due to their specific modes of formation and physical characteristics, and are rarely present as pure minerals but rather are mixtures of the different clay types of one group or type normally being dominant. But the Clay entering in brick manufacturing must possess and fulfil some specific properties and characteristic such as the ability to be crushed and mixed with water to form a plastic material which can be moulded into various shapes; shrinkage or swelling percentage on firing, meaning when subject to appropriate temperatures the clay particles must fuse together; the bloating characteristics, meaning the percentage of water absorption; firing colour, meaning the colour of the brick after drying and percentage of fines produced upon crushing and fire strength and these physical properties determine their commercial value.

The clays from which burnt bricks are made may be divided into three principal types, all of which have similar chemical compositions but different physical characteristics.

They are:

Surface Clays also called Alluvial and Drift Clays

Found near the surface of the earth, may be the up thrusts of older deposits or of more recent, sedimentary formation; are readily worked and require little preparation.

Shale clays or rocky clays

Shale is sedimentary deposits clays that have been subjected to high pressures until they have hardened almost to the form of slate which are often difficult to work and necessitate the use of heavy machinery to extract but, may be brought into plastic condition by long weathering (i. e. by exposure to rain, frost and sun) or by crushing and grinding in water, and they then resemble ordinary alluvial clays in every respect.

Fire Clays

Fire clays are usually mined at deeper levels of the earth than other clays where they form the bed layer under seams of coal and have refractory qualities and a high degree of resistance to heat.

MANUFACTURING PROCESS

The process of making clay brick is generally uniform, although manufactures tailor their production to fit their particular raw materials.

In general, the manufacturing process consists of essentially of six stages:

Mining and Gathering raw materials

Preparation of raw material (crushing, grinding, screening and mixing the raw materials)

Making of the brick or Forming Process (forming, cutting and coating)

Drying

Curing (firing and cooling)

Packaging and storing

Diagram of the industrial manufacturing process of clay bricks

(www.gobrick.com/omnisam/common/getfile.cfm?file=/bia/technotes/t9...)

Mining and Gathering raw materials

The choice of the mining method of clay will depend on the kind of clay, on the depth, thickness, hardness and physical geology of the clay location under the ground.

The general method of extracting clay from the quarry is once or twice a year using heavy plant machinery to stock pile large amounts, so to ensure continuous brick production regardless of the weather conditions, and because clays are rarely present as pure minerals but rather mixtures of the different clay types; laboratory testing of the clays from different parts of quarry will determine the characteristics of the layers and will be stock in separate different categories which will facilitate the blending of the raw materials.

Preparation of raw material

In the manufacturer, the clay rock is crashed and reduced in smaller particles, and then the material produced is screen through an inclined vibrating screening machine to control the particle sizes prior to water being added.

During the screening, manufactures adjust and compensate the different variations in chemical composition and physical properties by blending clays

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from different locations and sources to fit their standard of the end product. So, to fulfil their requirements of perfect clay for bricks making, or for the composition of the raw material to fulfil their standard, the different mixes and proportions of clay and chemical are blended together, prior to add water, as which of them affect the working properties of clays causing them to vary in their behaviour affecting the properties of the final product. At the same time, manufacture as standardized their end product and their manufacturing processes to limit variations in the processing and the inconsistency in end product.

For instance, a clay brick that when cure turn white may be developed commercially because, by adding various minerals like oxide of iron will affect the propriety of the brick in such a way that when cure it will produce a red brick if also there is consistency in the manufacturing processes.

Example: Clay containing from 5 to 8 % of oxide of iron will, under ordinary conditions of firing, produce a red brick; but if the clay contains 3 to 4% of alkalis, or the brick is fired too hard, the colour will be darker and purple. An excess of Alumina compound tending to make the colour lighter and brighter.

(Source: http://www.cmewa.com/eai_default.aspx?eai_general.aspx?itid=95)

Forming of the brick

The first step in forming process is to produce a homogeneous plastic clay mass work up into proper consistency by adding water to clay in a mixing

chamber with one or more revolving shafts with blade extensions. After the kneading, the plastic clay mass is ready for forming.

There are three different method of shaping brick: the stiff-mud process or extrusion process

The stiff-mud process or extrusion process

In the stiff-mud process or extrusion process, the clay is mixed with just enough water to produce clay plastic mass with water in the range of 10 to 15 percent of the clay mass. Next, the clay is extruded through a “ die”, producing a horizontal column of clay which passes by conveyor belt through an automatic wire cutter to create the individual brick. The cutter spaces and die size are precisely calculated to compensate for shrinkage during drying and firing.

Soft-mud process

In the soft-mud process or moulded process, the clay contains too much water to be extruded. The plastic clay mass contain 20 to 30 percent of water per mass is used to produce brick either by hand or machine.

Hand making

In the simplest form which is done by hand, the craftsman will produce one brick at the time by stuffing a lump of soft clay in a mould and the excess clay is stuff from the top of the mould and the brick is turned out. The mould is lubricated with either sand or water to prevent the brick from sticking in the mould.

Machine making

In the machine driven soft-mud process, standard brick are produce in mass quantities as the machine replicate the hand-making process much quicker.

The dry-press process

In this process hydraulic or compressed air rams is used to press clay with very low plasticity, containing no more than ten percent of water by weight, into steel moulds under pressures from 500 to 1500 psi creating a very compact and dense brick.

Drying process

Prior to the brick to be fired in the kiln, after the brick is formed using any of the method describes above, it containing 7 to 30 percent of moisture, depending upon the forming method. This moisture must be removed before the brick can be fired in the kiln otherwise, there will be formation of scum and certain mechanical defects from occurring or the brick will explode when the brick is subject to the intense heat of the kiln. This drying process which last about 18 to 40 hours, is normally done by placing the green brick in enclosed dryer which utilize excess heat supplied from the exhaust heat of kiln to maximize thermal efficiency. To ensure good result, devices are installed to measure and control humidity in the drying facilities.

Firing

After the drying, the brick are fired in furnace chamber called kiln for 10 to 40 hours, where there are subject to a temperature of ranging between 100 to 1200 degrees centigrade depending on clay type or material used and the type of finished brick required.

During the process, clay particles and impurities will undergo changes as the temperature in the kilns rises. The remaining water in the brick will dry up or evaporate; unlike the metal, clay softens slowly and melts or vitrifies gradually in rising temperature. The clay molecules mass breaks down becomes soft enough to stick together; the mass becomes tight, solid and non absorbent giving the brick its texture and colour. To ensure a good product and avoid the brick to be deformed due to heat also called viscous fusion, kiln is fitted with sensors to control the temperature in the different stage the firing process.

Kiln

In brief, kilns are just containers for heat; fuelled by natural gas, coal, sawdust, and methane gas from landfills or a combination of these fuels.

There are many different types of kilns but the most common types are the continuous kilns (tunnel) which are always firing; they never cool and are capable of turning out large quantities of bricks at steady constant rate and the periodic (intermittent) kilns which are fired on an intermittent schedule.

Packaging

Following the firing process is the packaging but prior to that the bricks are gradually cool down, for 10 hours for tunnel kiln and from 5 to 24 hours in periodic kiln, as the rate of cooling affects directly the final colour of the bricks.

After the brick has cool downs, there are unload from the kiln; sorted, graded, packaged and place in a storage yard or loaded rail cars or truck of delivery.

PROPRIETIES OF BRICK

The properties that the users of brick are most concern of are: durability, colour, texture, size, variation, compressive strength, and absorption.

Manufacturing process of “ adobe” clay brick

Equipment needed

Clay soil

Measuring Tape

Hammer

Hand Saw

2×4 timbers

Nails

Shovel

Bucket

Water

Straw

Testing of clay

Adobe brick are made from a mixture of mud or clay and small pieces of straw or reeds, and are formed by hand and left in the sun to dry.

The secret of make adobe bricks lays on the choice of the type of clay to use as it is made of surface clay soil. Although the bricks are made in rural area where there is no sophisticated laboratory for testing but prior using the clay it has to be tested.

The testing of the clay can be done by filling 2/3 of a graded glass jar with the clay you plan to use, and then fill the jar with water and put a lid on. Shake the jar for about two minutes making sure the clay is totally mix up with the water then let the jar and the mix to sit overnight. After about 24 hours, examine the jar and its content; the clay would have broken up into two distinct bands of sand on the bottom and clay on the top. There should not be more clay than sand on the ration of 30 percent clay and 70 percent sand for an ideal adobe brick making clay.

Preparation of bricks

After selecting the clay, an area must be clear prior to start making bricks and a shed to protect the newly made against the rain as it can take a couple of days for them to dry.

In the nearby, dig a hole of about 3 to 4 feet long, 2 to 3 feet wide and 2 to 3 feet deep as a mixing pit for the different ingredients. Then fill the hole with water and let it drain out as this will strengthen the wall of the hole for it not to crumble while mixing the clay soil. This will take at least a day to dry out.

Make mould of the bricks using timber. The traditional size is 4 by 10 by 14 inches and this is made with 2 by 4 studs nailed into a ladder like shape. See figure below

Make adobe bricks

Once the water in the pit has dry out, fill the pit halfway with the clay soil then add water gradually as mixing with the feet our shovel until the mix is stiff. Straw can be added to reinforce the mix but it is not necessary. Fill the mould using a shovel or hand then level off the excess with the shovel or with a straight edge, making sure there are no air pockets or gaps. Let the bricks set and then gently remove the mould from them leaving the wet adobe bricks to dry for several days (at least three) before handling. Wash the mould and repeat the process in a different area.

Dry the bricks

Leave the adobe brick where they are while they dry in the sun for several days before turning them on the edge to completely dry out and harden and put under the shed so that the drying time can continue. When the edges turn white, they are ready to be moved, but not used. This process could take at least 3 weeks prior the brick is use.

Different kind of Brick

In our days, there are other type of brick which is being use such calcium silicate brick or face brick and concrete brick. Their manufacturing process is similar to the clay brick but they differ only in their material composition.

Calcium silicate brick

Face brick or calcium silicate is another special type of brick made especially for exterior use with special consideration of colour, texture and size, and used as a facing on a building. It composes of a mixture of lime and sand with 90% of the mix comprise of sand rich in silica.

The manufacturing process of this brick begins by mixing different selected coloured sands of different grades. Mineral pigments are added and mixed thoroughly with the sand before the lime is added. Once all materials is mixed thoroughly and hydrated, the mix is conveyed to feed the brick press to be moulded under pressure. Each brick which is produced it is normally automatically stacked and transfer into the hardening chambers known as autoclaves, which is a large pressure cooker. Once the bricks are in place within the autoclave, steam is introduced and the pressure steadily rose for about an hour and then maintained at pressures of 8 to 16 bars and the temperature is raised up to approximately 200 °C. After some hours, the steam is then shut off and the heat is released through a valve, this allows the bricks to cool steadily. At this point the bricks are cured and have developed their final properties, especially the strength, and are ready for to be remove from the autoclave and on to packing and to be dispatch.

Concrete brick

Concrete bricks are made from aggregates such as crushed limestone or granite bonded with cement and coloured with pigments. The pigments used for colouring have to be durable and colour fast eg. iron oxides. When water is added to the mix a complex chemical reaction occurs which binds the materials together. This is just the same as the reaction which occurs in in-
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situ concrete used for foundations, ground floors etc. The only difference is that the process is closely controlled and monitored in a factory. The bricks increase in strength steadily with time and continue to do so even after the bricks are built into place.

Mechanical or hydraulic presses are used to make the bricks. They are fed with semi-dry concrete. In order to ensure a product of consistent strength and water absorption the addition of water is carefully controlled - moisture content should be in the range of 4 - 7%. Click on the graphic to learn more about the manufacturing process.

The majority of concrete bricks are solid, but a few have perforations. They are often heavier than clay bricks and have good dimensional consistency. Movement joints in concrete masonry should be provided at between 6 - 8 metre intervals. Light, bed joint reinforcement in brickwork courses below openings can help reduce the risk of shrinkage cracking. Concrete bricks should be kept dry prior to, and during, laying