

CHAPTER 1

CLAY BRICK MANUFACTURE



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Brick Manufacture

Bricks made by shaping a plastic mass of clay and water, which is then hardened by drying and firing, are among the oldest and most enduring of mankind's building materials. Until comparatively recent times the clay was dug, the bricks were made and the kilns set or drawn by manual labour with the help of animal power. About 100 years ago, the first effective machines for brick production appeared, and the trend towards mechanisation of clay winning, making and handling operations has continued at an increasing pace to this present day.

Clay brick is the simplest and most ancient of all building materials. Few other fabricated building units have enjoyed such widespread and continuous popularity. This enduring public acceptance is based on the unique combination of properties offered by clay brick to the owner and builder. This single material can be used to enclose a structure with a decorative, load-bearing wall, which is exceptionally durable and, if properly constructed in the first place, requires practically no maintenance.

Because of the versatility of the raw material, which can readily be moulded into a variety of shapes and sizes, and the flexibility that this gives to design and construction, building with clay brick has remained cost-effective, at initial use and in the long term.

Secondary clay materials are compounds of alumina, silica with minor amounts of lime, magnesia, soda or potash. Iron compounds, usually the oxides, hydroxides or carbonates are nearly always present as impurities in brick clays, and they account for most of the array of colours found in the finished product. Clays containing up to 3% of iron oxide give white to cream or buff colours, which change to pinks and reds as the iron oxide content rises to between 8-10%. By adding manganese dioxide in proportions from 1-4%, a range of grey and brown colours can be produced.

More important than their chemical composition are the facts that:

- When mixed with water, the clay minerals give a plastic mass that can be shaped by pressure to form a brick;
- At economically practical temperatures ranging between 1000°C to 1200°C, the clay particles can be fused into a cohesive mass of great compressive strength;
- Controlled evaporation of the free water surrounding the particles in plastic clay minimises excessive shrinkage and defects in the structure of the brick.

Modern brick manufacture involves high speed processing at extrusion rates of up to 25000 bricks per hour. Solid bricks of the size traditional in South Africa (222 x 106 x 73mm) weigh 3kg to 3,3kg. Therefore, 1000 finished bricks weigh approximately 3,3 tonnes. In the wet state before firing, the clay is heavier. For every 1000 bricks at least 4 tonnes of material must be dried, fired to a temperature of 1000°C to 1200°C (depending on the clay used) and cooled down.

The Manufacturing Process

Winning

Heavy earth-moving equipment such as bulldozers, scrapers and mechanical shovels are used to extract the clay and shales.

Crushing and Blending

After being transported from the pit by truck or endless conveyor, the materials are stockpiled to enable blending of the various types of clay.

The clays are fed separately by hopper or conveyor to the primary crushers - in South Africa rolls or hammer mills are commonly used. These reduce the particle size down to 3-5mm or less. The mixing of clays follows, to impart the desired properties, such as colour and strength.

Grinding

Conveyors carry the mixed clay away for secondary crushing, which is usually done by means of a pan mill. The pan mill has two heavy steel wheels on an axle that is connected to a central vertical spindle around which they rotate, crushing the clay against the base of the pan.

The base is perforated to allow the crushed material to fall through. This process, when done with dry clay, shatters the brittle particles into smaller pieces. When the pan mill is used with wet clay, the plastic material is squeezed through the perforations and then falls between high-speed rollers which complete the grinding process.

Screening - Dry Processing

Before being shaped, the clay is screened and oversize pieces are returned to the pan mill for further crushing.

Shaping

Bricks are hand formed, pressed or extruded into their final shape. The method used to shape the bricks affects their final appearance and texture, and sets certain limitations on the handling methods employed during manufacture.

Extruded Bricks (Most common method in South Africa)

Clay with 18-23% water content is forced by an auger into a horizontal cone-shaped tube that tapers down to the die. Two compaction stages are commonly incorporated, with a vacuum chamber between them to remove any air in the clay that would reduce the strength of the end product.

The extruded clay column is cut into brick-sized pieces by an arrangement of wires. Extruded bricks, although often smooth, may be mechanically patterned or textured. Most bricks of this type have anything from 3-12 perforations, and by increasing the surface area, the required drying, firing, and cooling times are

reduced. Any internal stresses are relieved by the perforations which also prevent distortion of the bricks during firing.

Drying of Bricks

In the brick-making process, the clay is refined and water is added in order to mould the brick. Before the bricks can be fired, they must be properly dried: the moisture content has to be reduced to less than 5% by mass for the clamp kiln.

In South Africa, there is adequate sun for the drying operation and most clamp kiln brick makers make full use of this free source of energy by placing the bricks on open hacklines. This operation has the disadvantage that it may make the process time-consuming, especially in the rainy season.

To reduce the drying cycle, brick makers have introduced some mechanical means of drying. The two most common methods are tunnel or chamber driers. The energy (heat) for the drying is produced in a supplementary coal heater or recycled off the kiln and the heated air is fed into the driers. These methods work as follows:

Tunnel Driers:

The bricks are produced and then off-set on flat rail trolleys or kiln cars. The cars are pushed through the tunnel. This operation can take up to 40-50 hours, from wet green to dry.

Chamber Driers:

Patented chamber driers are large rooms where bricks are packed onto pallets. The chambers may have a capacity of 50 000 to 60 000 bricks, Hot air is fed into the chamber. Drying time is between 48 -60 hours much quicker than the 14-21days needed for solar drying,

Firing

Bricks are fired at temperatures between 1000°C and 1200°C, depending on the type of clay. Light coloured clays usually require higher firing temperatures than dark coloured ones. Of the many known types of ceramic kilns, four types were used in South Africa, namely; the Down Draught kiln, the Hoffman-type Transverse Arch kiln (TVA), the Tunnel kiln and the Clamp kiln, However, the Down Draught type of kilns have since been discontinued because of their uneconomical firing procedures in terms of labour, coal, etc.

Down-draught Kilns:

Consist of a rectangular space with a barrel-vaulted roof and a slotted or perforated floor open to flues below. Green bricks (40 000 to 100 000 at a time) are stacked in the kiln. Fires are lit in fireboxes along the sides and the hot gases fire up to the curved roof, down through the bricks and from there to the chimney stack. Fires are fuelled by coal, gas or oil. When the desired temperature has been reached, the temperature is maintained for a specific period and the fires are then allowed to die. The kiln cools down, the fired bricks are removed and another batch of green bricks is placed in the kiln for firing.

TVA Kilns:

Firing in the TVA kiln is continuous. Each day green bricks are placed in cleared chambers in front of the fire, and the fired

bricks are removed from behind it, with two or three adjacent wickets being kept open for this purpose. When a chamber is full, the wicket is bricked up and fuel (coal, oil or gas) is fed in among the bricks through holes in the crown or roof of the kiln.

The fire is made to move forward by "taking on" a row of fire holes at the front and dropping a row at the back, every 2 to 4 hours in an average sized kiln. In this way the fire moves right around the kiln every 10 to 14 days. The hot gases from the firing zone are drawn forward by exhaust fans to preheat and dry out the green bricks, while the fired bricks are cooled down by the flow of air passing from the open wickets behind the firing zone.

Tunnel Kilns:

The tunnel kiln is also a continuous kiln, but the fire is stationary while the bricks move past it on kiln cars. As in the TVA kiln, the unfired bricks are preheated by the spent combustion gases. After the fire, heat released by the cooling bricks may be drawn off for use in the associated driers. With this interchange of heat, the tunnel kiln uses less fuel than the intermittent type of down-draught kiln.

Tunnel kilns have several other advantages. For example, cars can be loaded and unloaded in the open factory, and always at the same loading points, so that handling problems are simplified; and tile kiln car acts as a conveyor belt so the bricks are fired as they pass through the firing zone.

Clamp Kilns:

In clamp kilns, some fuel is placed into the body of each brick. The bricks are packed into a pyramid-shaped formation. The clamp has a layer of coal, equivalent to two courses of bricks packed at the bottom. This layer (scintle) is set alight. It ignites the fuel in the base layer of bricks and progressively, the fuel in each brick ignites in the clamp kiln.

Clamp kiln firing can take up to three weeks and although the bricks may have finished burning in that time, it could take longer before they are cool enough to be sorted. Temperatures can be as high as 1400°C in the centre of the clamp.

Vertical Shaft Brick Kilns (VSBK)

Dry bricks are packed in layers into the top of a vertical refractory lined cylinder of 1,5m to 2,0m in diameter. The vertical cylinder of bricks are supported on a movable steel grid at the bottom exit end of the cylinder.

As layers of fired bricks are periodically drawn away, further layers of dry bricks then enter the "hot zone" about halfway down the vertical shaft. Bricks are progressively lowered down the cylinder in a continuous process.

All the heat in the firing zone is derived from fuel added to the brick body, generally finely crushed coal.

Delivery

Mechanical handling of bricks is a familiar sight in South Africa. In pack systems, signode strapped packs of ±500 bricks are arranged in a suitable stack and bound together by bands or plastic wraps. The packs are lifted by forklift or crane truck. Handling on site may be by hoist or brick barrows.

