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TECHNICAL INFORMATION A1

DESIGN & SPECIFICATION CONSIDERATIONS
HOW BRICKS ARE MADE

Clay bricks are used in a wide range of buildings from housing to factories, and in the construction of tunnels, waterways, bridges etc. Their properties vary according to the purpose for which they are intended, but clays have provided the basic material of construction for centuries.

Brick is the oldest manufactured building material, and much of its history is lost in antiquity. The oldest burnt or fired bricks have been found on the sites of the ancient cities of Babylonia, some of which are estimated to be about 6000 years old. Brick is, after all, virtually indestructible.

The industry developed on traditional lines, using hand-making processes for the most part. The first patent for a clay-working machine was granted in the year 1619. Mechanisation, however, did not begin to take the place of manual methods until the middle of the nineteenth century.

The moulded products were fired in relatively inefficient intermittent or static kilns until about 1858, when Hoffmann introduced a continuous kiln, which enabled all processes connected with the firing to be carried out concurrently and continuously.

Since the introduction of clay working machinery and the Hoffmann Kiln, the Industry has made great progress, particularly since 1930, the output of bricks in Great Britain doubled between 1930 and 1938.

RAW MATERIALS

WHAT IS CLAY?

In brick-making terms, clay covers a range of naturally occurring raw materials which are used to make a product. The clays vary considerably in physical properties, colour, hardness etc. and mineralogical content. They do, however, have certain properties in common. They have the ability to be crushed and mixed with water to form a plastic material which can be moulded into various shapes. This can then be fired to a high temperature during which process it attains a hard, weather resistant characteristic.

The key, in geological terms, is the mineral content of the raw material. This is common to all clay types.

Pure clay mineral is formed from the erosion and weathering of primary igneous rocks. The clay mineral is transported away by the action of water, wind, ice etc. and re-deposited elsewhere. In the process it picks up a number of impurities, quartz, mica, calcium carbonate (lime), iron oxide etc. The deposited layers subsequently become sedimentary rock.

Due to variances in the age of the deposit, the conditions of its deposition and the impurities involved there will be variations between different clay types and even on occasions within the same deposit. These variations may affect the brick making process and the properties of the finished product.

CLAY WINNING

The choice method of clay winning will depend on the depth, thickness, hardness and physical geology of the clay beds.

The usual method for winning clay (extracting from the quarry) is once or twice a year by heavy plant machinery, whether it be excavators, back actors etc. to stockpile large amounts. The advantages of bulk winning are that it can take place during good weather, a large reserve close to the factory means that breakdown of quarry plant is not critical to the production schedule.

Layering the stockpile with the excavated clay helps to eliminate localised variations in the clay strata.

Laboratory testing of the clays from different parts of the quarry determine the likely characteristics of the layers and clay is mixed according to the required properties of the finished item.

Particular attention is given to environmental factors both during the clay win and when restoring the landscape after excavations are complete.

CLAY PREPARATION

Clay preparation methods may have to accommodate the physical characteristics of the raw material. Preparation consists of transforming the clay rock into plastic mouldable material by a process of grinding and mixing with water.

A typical factory might have a primary crusher, these are used to break down large lumps of rock to manageable size, which can then be fed to a secondary crusher, for example pan mill, where the clay is reduced in size further. Water can be added here or if it is a dry pan the clay is reduced to dust and water added later. Further crushing takes place through convey or rollers reducing the clay particles to about 1-2mm.

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FORMING THE BRICK SHAPE

Most bricks are formed by one of two basic processes.

EXTRUSION

The clay body is mixed to a fairly stiff texture and is then loaded into an extruder where a worm screw pushes it along a barrel into a vacuum chamber which compresses it through a taper and out through a die.

The die is set at a precise size and shape larger than the finished size of the brick, taking into consideration how much the clay will shrink during the drying and firing process. The clay emerges as a continuous brick shaped column. Initially this is smooth but it can be modified by removing a thin sliver from the top and sides using a taught wire to produce a 'wire-drag' effect or by placing textured rollers over the column to create a rusticated effect or even by blasting the column with sand. The clay column is then cut into single bricks by wires and palletised ready for the dryers or in some factories, are loaded directly onto kiln cars. Extruded bricks are generally perforated and can be solid but cannot be frogged.

These variations may affect the brick making process and the properties of the finished product.

Column of extruded clay undergoing a rusticating texture.

SOFT MUD MOULDING

This covers a number of processes where bricks are formed in mould boxes. There are several methods but all have a common theme, soft clay.

The clay is thrown into a mould, a mould release medium prevents the clay from sticking to the box (sand, oil or water). The excess clay is struck off from the top of the mould and the bricks are turned out. In its most simple form this is done by hand by an artisan who would produce one brick at a time. This is labour intensive, slow and expensive usually only used now for making special shapes or decorative bricks.

For standard bricks large automated machines can replicate the hand-making process much quicker by using banks of mould boxes continually on a circuit where the boxes are washed, sanded, filled with pre sanded clots of clay, struck off level and the formed brick turned out.

Because the clay is dropped into the moulds a creased effect is achieved. Soft mud pressing is achieved in a similar way with the moulds but the clay is pressed into them creating a smoother, sandy texture. A variation of this process is water-struck where water is used as the release medium. A relatively smooth, sand free texture is achieved. Again the boxes are made larger to accommodate clay shrinkage during the rest of the process. As a general rule, moulded bricks tend to be frogged (an indentation in one or more of the bed surfaces) although some are also solid.

DRYING

Before the bricks can be fired, as much moisture as possible must be removed or they will explode in the kilns. Drying involves the removal of water from the wet brick in such a way as to dry them out evenly from inside out. If the outer skin of the brick dries first it becomes impossible for the moisture inside to escape without cracking the brick surface. In the kiln the extreme temperatures will force remaining moisture out and some cracking (fire-cracking) may occur.

To minimise this the dryers are kept at temperatures of about 80 –120 degrees centigrade and the atmosphere is very humid keeping the exterior of the brick as moist as possible.

The bricks will shrink in the dryers as the clay particles come together and they become strong enough to be stacked, but at this stage they have no weather resistant qualities.

Drying schedules vary but between 18 to 40 hours is typical for an automated plant. Special shapes and large units can take up to a week or more.

The dry bricks are then set onto kiln cars ready to be fired.

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FIRING

Firing temperatures vary considerably between different clay types and are often quite critical. During firing, bricks undergo a physical change. Clay particles and impurities are fused together to produce a hard durable and weather resistant product.

This is called vitrification. This is usually accompanied by further shrinkage and a colour change.

Temperatures vary greatly depending on clay type but are generally in the range of 900 – 1200 degrees C.

Obviously bricks cannot suddenly be subjected to these temperatures so firing is in three stages.

1. Pre heating – this ensures total dryness of the brick and utilises combustion gasses in the kiln to raise the brick temperature. (Where wet setting has taken place great care needs to be taken at this stage)
2. Firing - a fuel, usually natural gas or coal is used to raise and maintain the temperature to the required level over a few hours.
3. Cooling - cold air is drawn into the kiln to cool the bricks slowly ready for sorting and packing. This air becomes hot and can be drawn off and recycled for use in the drying process.

KILNS

There are several different types of kiln but they can be allocated to two main categories.

INTERMITTENT KILNS

These are static, usually small kilns and are used for firing small batches of products e.g. special shapes. The kiln is loaded with ware, taken through the firing process then unloaded.

CONTINUOUS KILNS

For large scale production continuous kilns are more economical and are capable of turning out large quantities of bricks at a steady constant rate. There are two main types of continuous kiln, Chamber and Tunnel.

CHAMBER KILN

In its simplest form a chamber kiln is an annular tunnel divided off into chambers (usually 12-20). A section of the kiln (about 4-5 chambers) is being fired at any one time. The firing is drawn round the kiln with chambers being lit in front of the firing and the chambers behind are allowed to go out.

Bricks are loaded into the kiln in front of the fire and pre-heated for 1-2 days before the fire reaches them. The bricks then fire for 2-3 days. Once the fire has passed, the bricks cool before being removed from the kiln. They are then replaced with fresh dry bricks awaiting the fire's next circuit.

TUNNEL KILN

In a tunnel kiln dry bricks are loaded onto a fireproof trolley or kiln car. This then travels very slowly through the kiln. Typical schedule through the kiln from end to end is 3-4 days but variations occur depending on production schedules.

Although tunnel kilns are generally more expensive to build than chamber kilns they are more economical to run and lend themselves to high degrees of automatic control. It is essential that tunnel kilns are run on a continuous basis for ideally several years at a time between shutdowns.

Different firing schedules are necessary for different clay types. This is not just a matter of peak temperature. To maximise production it is clearly necessary to arrange for long production runs and as few changes as possible in order to achieve best results.

Kiln car exiting a tunnel kiln.

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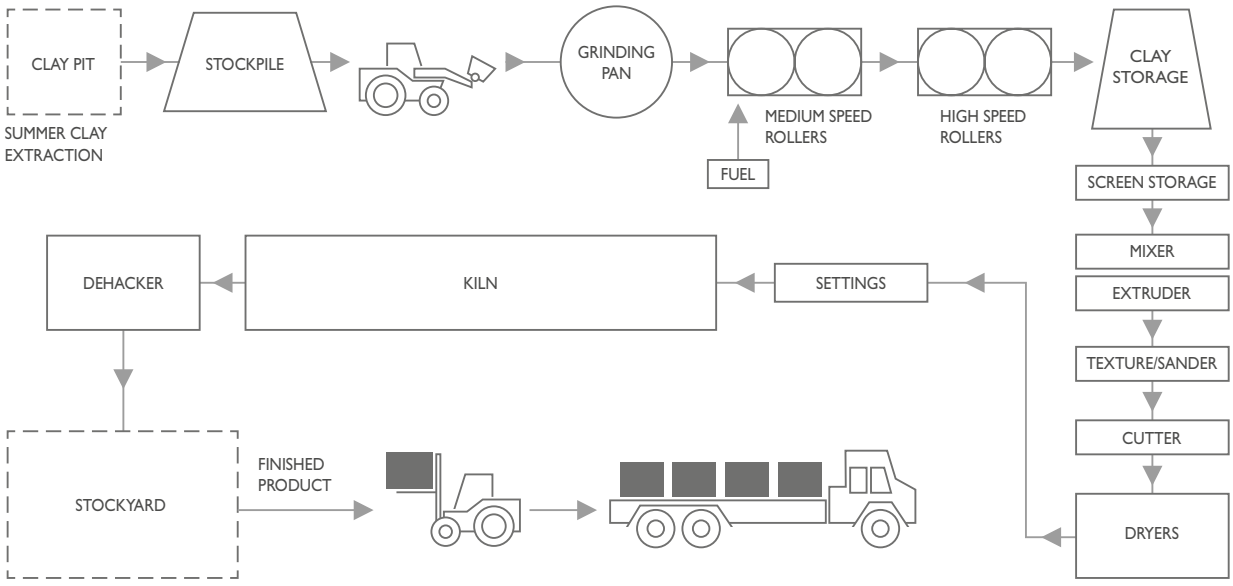
SELECTION & PACKAGING

Following firing, bricks are selected and packaged. This may be by a manual method or by machine. Mechanised packing is limited to regular production types where all bricks are of the same size and shape. Special shapes are packed manually. Bricks are unloaded from the kiln car (de-hacked) and are inspected by operatives who remove any substandard product leaving the best quality to be banded together in packs of between 300 – 500 bricks.

Packs can be classed as best quality meeting the intended colour and technical requirements, off-shades where the technical requirements are met but the colour is not to standard, non-best where one or more of the technical requirements have not been met, or commons which are not for fair-faced external works.



THE EXTRUSION PROCESS


Dragfaced


Smooth sanded


Smooth


Handmade


Rolled/creased


Frogged, machine moulded & traditional stock bricks - are laid frog up


Sand creased


Sandfaced


Waterstruck - should be laid with the lip at the bottom


Rusticated - should be laid with texture pointing downwards

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