Learning text part 05

Brick and block production

Contents

Health and safety

All mortar mixtures, both wet and dry, are abrasive and alkaline. When working with wet mortar, waterproof or other suitable protective clothing should be worn. Guidance on the use of these materials can be found in MPA Mortar data sheet No. 20.

Introduction

This learning text looks at the manufacture of bricks and blocks beginning with the historical development before moving onto current production methods of each of the masonry types. A glossary of terminology and a bibliography are included, along with self-assessment questions and answers.

The majority of residential building in the UK uses masonry cavity wall construction. This involves building the external walls of a house as a double layer of masonry with a cavity in between. The external leaf is generally built of facing brick, but can also utilize concrete blocks which are then usually covered with cladding, render, tiles or other material. The inner leaf will usually be constructed with blocks, and then plastered or dry lined.

History of brick making

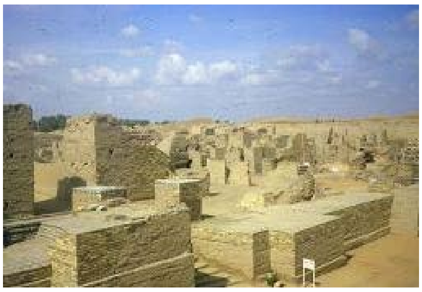


Figure 1: ***The city of Babylon where bricks were used some 6,000 years ago***

Bricks are among the most durable of building materials. Their use is mentioned in the bible and the Romans introduced their use to the UK but it was not until the 14th century that their use spread as they were reintroduced by Flemish refugees into East Anglia and gradually the sight of yellow "stocks" became common in London. The great fire of London in 1666 encouraged the introduction of brick partition walls in domestic construction and the use of bricks became more widespread although until the 18th century, most UK houses were still built from stone, wood or clay.

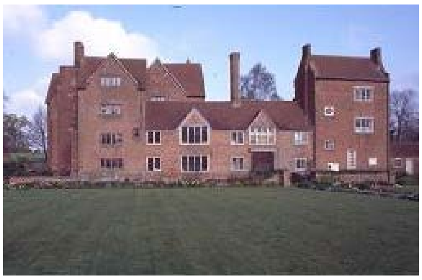


Figure 2 ***Harvington Hall in Worcestershire, a fine example of Elizabethan Brickwork. The bricks were, it is believed, fired in two nearby fields.***

Historically bricks were made individually by hand in wooden moulds and left to dry in the sun. Makers then discovered that harder, more durable bricks could be made by firing the bricks in clamps or kilns, something discussed later in this learning text. The industrial revolution introduced mechanisation into brickmaking and while today most bricks are made by machine in large factories, some are still made by hand.

Clay Bricks

Raw materials

Approximately 96% of bricks in the United Kingdom are manufactured from clay. Geologically, brickmaking clays are composed of quartz and clay minerals, the type of clay depending on the locality of the brickworks. In the Midlands, Etruria or Keuper Marl are used, Weald clay or clay from the Reading Beds is employed in the South East of England, while in the South West, Devonian Shale or clay from the Culm Measures is selected.

Mineral compounds within the clay are responsible for the brick's colour, eg, iron compounds give rise to red and blue colouration. Minor constituents such as sodium and potassium assist in the vitrification process. The manufacturer has to control the content of some minerals, which may affect the characteristics of the finished brick, eg, calcium sulfate, coal, lignite and calcium carbonate.

Raw materials for brick making are extracted from quarries or pits and then processed and mixed with water. Most manufacturers stockpile clay to minimise the need for extraction in wet weather when the movement of trucks on the clay material is difficult. Stockpiles may contain sufficient raw materials for a year's production. Stockpiling ensures better intermixing of the extracted material and minimises segregation as well as weathering the raw material. Rainwater washes out some of the soluble salts, which might later cause efflorescence - white patches - on the face of brickwork. An alternative weathering method is to wash the clay thoroughly in a wash mill and store it in an open area traditionally called a 'clay back'.

When clay is removed from the stockpile, a full vertical cut is made so as to produce a consistent material for the next stage of the brickmaking process. A flow diagram illustrating the clay brick manufacturing process is shown in Figure 3.
+ other captions for fig 3!

Clay processing involves grinding and working the material to obtain plasticity and uniform workability. Fineness of the clay influences not only the external appearance of the finished brick but also physical characteristics such as compressive strength and water absorption. The mixing stage

Figure 3: ***Clay brick production***

Excavation of clay →	Weathering →	Processing →	Moulding →	Drying →	Firing
	(a) By stockpiling in the open in winter months (b) By passing through a wash mill and stacking clay bricks		(a) By hand (b) By machine	(a) By storing in the open in drying areas (b) In drying chambers	(a) In clamps (b) In continuous kilns (c) In intermittent kilns

involves the addition of water to produce a homogenous material, the quantity added depending on the production method being used. In some works, other materials such as lime, pulverized fuel ash or crushed clinker may be added to act as fuel, while pigments may also be incorporated to produce specific colours.

For shaping or forming the brick, the clay feed must be consistent in content, grading, plasticity and water content and three principal processes are used - soft mud moulding; extrusion/wirecutting; or semi-dry pressing.

Soft mud process
The clay used in the soft mud process has a water content in the range 20-30%, and gets its name because the processed clay looks like sloppy mud. The two variants of this process are hand moulding and machine moulding. In hand moulding, processed clay is thrown into a sand-coated mould and excess material cut off with a wire. The characteristic folded appearance on the faces of the brick is caused by the dragging of the clay against the mould side as it is thrown. A skilled brickmaker can produce up to 100 bricks per hour. Nowadays, most production is by machine, which imitates the hand moulding process. The majority of bricks have a small frog - depression - formed by a raised central area on the bottom face of the mould.

The high water content of these bricks means they cannot be handled or stacked immediately after moulding without deformation. Also because of the high drying shrinkage of such wet mixes and the plasticity of the unfired brick, the size and shape of such units are fairly variable and they therefore are not suitable for use in thin mortar beds.

Extrusion process
The stiff plastic process - sometimes called the extrusion process - involves grinding and mixing clay to produce material with a moisture content of 10-15%. This is extruded and cut into brick-shaped pieces which are allowed to dry for a short period before being pressed into a die. The stiff clay retains its shape when ejected from the die and the relatively low moisture content means that shrinkage is low and that the size is easier to control. A further advantage of this process is that drying time is relatively short. This type of unit will normally have at least one shallow frog. Engineering bricks, facing bricks and other brick products with very accurate dimensions are normally produced in this way.

Wire cut process
The wire cut process uses clay with a moisture content in the range 20-25%. A continuous ribbon of clay is extruded from a mixer through a rectangular die with a cross section the same as that of the required bricks. The clay ribbon is then cut by a multiple wire cutter into bricks. Cutting wires are set apart a distance depending on the height of the unit plus an allowance for shrinkage that takes place during drying and firing. The wire cut is made perpendicular to the face and ends of the brick. This type of production process produces bricks with no frogs in their bed faces and also allows perforations along the length of the product by placing bars within the die head. Stains may be applied to the extruded clay to obtain a variety of colours.

Semi-dry pressing process
The semi-dry pressing process involves placing clay with a moisture content in the range 17-20% in a press and applying hydraulic pressure to produce the required shape. In the UK only the Lower Oxfords clay is used in this process. This material contains approximately 7% natural shale oil which results in a reduction in firing costs. For these reasons bricks made using the Fletton process (named after the village in Huntingdon where they were first made) are relatively cheap to produce. The clay is dug and then ground to pass either a 2.4mm or a 1.2mm sieve. The coarser size is used for common bricks and the finer for facing bricks. Processed material is fed into automated presses, which form a deep-frogged, standard size brick. The external appearance of the brick may be enhanced by techniques such as applying a surface layer of sand and firing the unit. Following the moulding stage, the bricks are allowed to dry prior to being fired. The drying stage is important for two reasons: excessive shrinkage may cause cracking if not controlled and preliminary drying reduces the overall energy requirement.

Firing
Historically bricks were dried in 'hacks', stacks about seven courses high. Today, most bricks are dried either in a drier or in a kiln.

Firing enhances the colour and develops the strength and durability of the bricks. There are several types of kiln in use and the particular installation at brickworks will depend partly on the levels of production.

During firing the bricks go through a number of property changes. Initially, at temperatures up to 150°C - the drying stage - residual moisture is driven off. In the next stage - dehydration - the temperature rises to 650°C and clay minerals are broken down, releasing water. Carbonaceous material which may be present in the clay or added as fuel is ignited at temperatures between 200°C and 900°C, which results in a more open, lower density structure. The highest temperature range reached is between 900°C and 1300°C and is known as the vitrification stage. It is at this point that the brick colours are formed. The final stage is cooling. At approximately 573°C, silica undergoes a major volume change and careful control of temperature is essential. During the firing process bricks generally shrink by several per cent from their original - green - size and this has to be allowed for in the process.

There are two broad categories of kiln:
- Intermittent
- Continuous/semi continuous

Intermittent kilns (clamp, Scotch, down-draught) are now only used where special colour effects are required.
(i) A clamp kiln is constructed on a level floor of burnt bricks, with channels filled with fuel. On top of this layer are three or four layers of green bricks and then a further layer of fuel. Layers of bricks are then stacked to a height of three or four metres.

The outside of the clamp is normally sealed with a coating of clay. The fuel is ignited and the clamp allowed to burn out, which could take from three to twelve weeks depending on the number of bricks included.

(ii) A Scotch or up-draught kiln was a permanent structure with a number of firing chambers built with burnt bricks and the floor perforated along its full length. Bricks were stacked on the floor with a small gap for the hot air to circulate. The top of the kiln was closed with old burnt bricks to conserve the heat.

(iii) A down-draught kiln is a circular construction with a domed roof and fire holes spaced around the base of the wall. There is one opening for access which is sealed during the burning process. Traditionally coal was used as fuel but this has now largely been replaced by oil. The burning process takes about ten days to complete.

The Hoffman kiln is a multi-chamber, continuous kiln with damper doors between the chambers. Bricks remain stationary during the firing process and the fire is transferred from one chamber to another, gradually moving around the kiln with the area in front of the fire being heated up, that immediately behind the fire gradually cooling down. Brick loading and unloading meanwhile takes place in other chambers. Bricks remain in the kiln for a number of days depending on the number of chambers to complete the cycle of preheating, firing and cooling down. This process is mainly used for the production of Flettons and, due to the organic content of the raw materials, firing is undertaken under oxidizing conditions.

In a continuous tunnel kiln, the green bricks are loaded onto steel trucks or kiln cars, which form a continuous line. These pass into a long chamber, which has a firing zone in the middle of its length. The trucks slowly pass through the kiln, warming as they reach the firing zone prior to being burnt and then cooling prior to emerging from the kiln. It takes about four days for a car to pass through the kiln.

Properties

A are a number of brick properties to be taken into account:

- Dimensions
- Compressive strength
- Durability
- Water absorption

Dimensions

BS EN 771-1 states that the manufacturer of a clay masonry unit shall declare the dimensions for length, width and height in terms of the work size.

Compressive strength

The compressive strength measures the resistance to crushing and is used by engineers to assess brickwork strength. Clay bricks have a vast range of compressive strengths ranging from less than 10 N/mm^2 for a soft mud brick to more than 100 N/mm^2 for an engineering brick.

Table 1 lists typical properties for a number of brick types.

Table 1: ***Properties of bricks***

Brick type	Compressive strength N/mm^2	Water absorption %	Bulk density Kg/m^3
Fletton	15 - 30	15 - 25	1330
London Stock	5 - 25	22 - 35	1450
Solid wirecut	90	4.1	2370
Perforated wirecut	40	10 - 20	1500

Durability and water absorption

Water absorption does not necessarily indicate the behaviour of a brick in weathering. Low absorption ie, less than 7% by mass, usually indicates a high resistance to damage by freezing, although some types of brick of much higher absorption may also be frost resistant. Very small quantities of salts, usually sulfates, which may be present in the bricks may produce efflorescence during the period when the building is drying out.

Perforations in a brick result in a number of advantages. Firstly, less material is required to produce the unit giving savings in raw material and associated processing costs. Secondly the more open structure results in a reduction in drying time and hence costs. The hardened unit also has slightly enhanced thermal insulation properties. Thirdly the lower masses of these units makes them less tiring for the bricklayer to lay.

The technical standard for clay masonry units (BS EN 771-1) groups units according to the percentage of voids.

Calcium silicate bricks

The production process for calcium silicate bricks was developed in 1866. They are manufactured from a mixture of calcium lime, siliceous sand or crushed flint, sand and water. Additionally, pigments may be added. Today, approximately 1% of bricks in the UK are made from these materials and these types of bricks are sometimes referred to as sandlime or flintlime bricks depending on the type of sand used in their manufacture.

Constituent materials are proportioned and then mixed before being moulded under great pressure into the required shape. Green bricks are loaded into trucks, which are moved into curing chambers called autoclaves, similar to a very large pressure cooker. When the green bricks have been loaded inside the curing chamber the ends are closed and steam at an approximate temperature of 175°C is injected into the sealed chamber. This increases the pressure inside the chamber and results in the lime and sand combining chemically. Bricks remain in the autoclave for seven to ten hours and are then unloaded and allowed to cool. The calcium silicate reacts with the atmosphere to form calcium carbonate. Dimensional changes from the pressed green to the fully cured brick are negligible.

Generally calcium silicate bricks have a comparable weight to that of a clay brick. They have negligible soluble salts content and are not, therefore, prone to efflorescence.

Concrete bricks

Some 4% of UK bricks are made from concrete. Raw materials used for their production are Portland cement and aggregates, with a pigment generally being incorporated into the mix. Constituent materials are proportioned, mixed, placed in moulds, vibrated or compacted, de-moulded and then cured. Performance requirements for concrete bricks are given in BS EN 771-3 but sizes are not specified. Common sizes are given in Table 2.

A range of compressive strengths are produced, typically from 7-40 N/mm^2 Concrete bricks are typically 30-40% heavier than clay bricks of similar dimensions.

Table 2: ***Dimensions of concrete bricks***

Length mm	Height mm	Thickness mm
290	90	90
215	65	103
190	90	90
190	65	90

Concrete blocks

Concrete blocks are also known as concrete masonry units and have become increasingly important as a construction material. Technological developments in the manufacture and utilisation of the units have accompanied the increase in their use. Concrete masonry walls, correctly designed and constructed, will satisfy a variety of building requirements including fire resistance, durability, aesthetics and acoustics.

In the UK, concrete blocks have traditionally been divided into three types:

• Solid blocks which have no formed voids or cavities

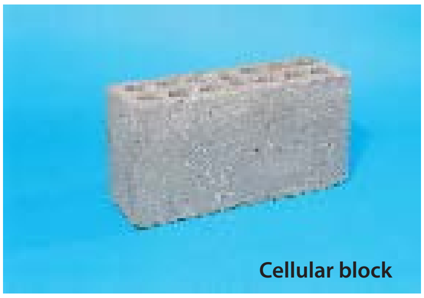
• Cellular blocks which have one or more formed voids or cavities, which do not pass right through the block

• Hollow blocks, which have one or more formed voids or cavities, which pass right through the block.

Figure 4 shows these three types of block

Figure 4: ***Types of block***

Solid block



Cellular block

Hollow block

In April 2006, the new standard for aggregate concrete masonry units (BS EN 771-3) was introduced. This requires that products are identified according to the following groupings:

Group 1 < 25% voids

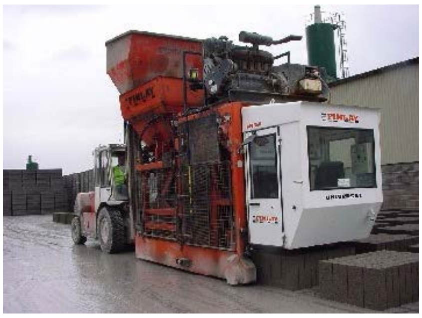
Group 2 > 25; < 60% voids

Group 3 > 25; < 70% voids

Group 4 > 25; < 50% voids (horizontal holes)

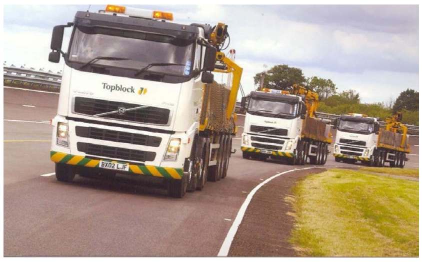
Concrete blocks were first produced in the early part of the last century by placing fresh concrete into moulds made of steel or wood. The moulds were stripped when the concrete had hardened. The disadvantage of this method was that a large quantity of moulds were required to produce a number of blocks. A development from single moulds was the so called 'egg layer' machine. Using this, mixed concrete was loaded into a hopper on the machine, material was fed into moulds, vibrated and left on a slab to cure. The machine then moved a short distance and repeated the process. The number of blocks made in a single operation depended on the size of the block. Initially, most machines pressed blocks on their longest dimension but designs have been developed over the last thirty years that make blocks on end. The 'egg-laying system' is relatively simple. All that is required is a concrete mixing plant, a vehicle to transport the concrete to the block machine, the machine itself and a flat slab on which to press the blocks. Generally the fresh blocks are left on the slab for two to three days to gain strength and then transported to a storage area. The process may be carried out on uncovered slabs, but some production units have a roof covering. Figure 5 shows an 'egg-layer' machine.

Figure 5: ***An egg layer block machine***



Most modern block making plants in the UK are highly automated and the block making machine is stationary. Earth-dry concrete is fed to the mould where it is vibro-compacted onto steel, timber or plastic pallets.
The blocks are de-moulded immediately and transported on a pallet by conveyor to the curing chambers where they may be treated either with heated air or steam to accelerate strength increase. After curing the blocks are taken from the chambers and automatically stacked for delivery. To preserve their appearance, blocks to be used for facing work may be shrink-wrapped in polythene. Figure 6 shows blocks on delivery.

Figure 6: ***A delivery of blocks***



Concrete blocks can be manufactured from either natural or lightweight aggregates. Standard blocks have a more open texture intended for finishing with plaster or plasterboard while paint-quality or close-textured blocks have a superior finish so that they can be directly decorated.

Blocks generally have a face size of 440mm x 215mm and have a thickness (termed width in BS EN 771-3) ranging from 75 to 215mm. Individual blocks have a mass ranging from 5.0kg to 40.0kg and compressive strengths ranging from 3.6 - 40.0 N/mm^2. Cellular blocks are manufactured with a thickness ranging from 100 to 215mm with individual blocks having a mass ranging from 8.0 to 27.0kg and a compressive strength of 3.6 - 22.5 N/mm^2. Hollow blocks are produced with a thickness ranging from 100 to 215mm. Compressive strength is generally 3.6 - 22.5 N/mm^2 and the weight of the individual blocks ranges from 8.0 to 27.0kg.

Concrete blocks are generally very stable and durable and can be used for a wide range of applications including below ground where they may come into contact with aggressive soils.

Autoclaved aerated masonry units

Aerated concrete was originally known as cellular concrete and first produced in Scandinavia in 1924. In the UK it is commonly called Aircrete. Aerated concrete is unlike traditional concrete as it does not contain coarse aggregates. The normal method of manufacture is to incorporate an aerating agent in the mix, the most common of which is aluminium powder. This reacts with the alkali derived from the cement and/or the lime present, to form complex hydrates and hydrogen gas. It is this gas which forms the voids and thus the cellular structure.

Powdered zinc (rarely used) may be used instead of aluminium powder. The principal constituent material of aircrete blocks is either pulverised fly ash (pfa) or quartz sand, while other constituent materials may comprise cement, lime, aluminium powder and water. Anhydrous calcium sulfate ($CaSO_4$) is also used by some manufacturers.

Ground quartz sand or pfa is mixed with water to form a slurry which is then fed to a high-speed mixer. Cement and sometimes lime are then added, followed by aluminium powder. The quantities of the constituent materials are adjusted depending on the target density required in the finished product. Mixed material is poured into moulds and the mixture, called 'cake', is allowed to rise due to the hydrogen evolving and then partially set prior to de-moulding. The demoulded cake is cut by wires into predetermined sizes. Profiling and handgrips can be machined at this stage which makes the blocks easier to handle and transport. The cut cakes are then placed in an autoclave for high pressure steam curing at an approximate temperature of 190°C and at a pressure of 11-12 bar. Autoclaving may last up to twelve hours during which time the constituent materials combine to form calcium silicate hydrates. When the product is removed from the autoclave it is fully cured and may be used as soon as it has cooled. Figure 7 shows the flow diagram for aircrete block production.

Autoclaved masonry units have good thermal properties but lower sound insulation than concrete masonry units. They also have a lower range of compressive strengths and need to be handled more carefully. However, they are easy to cut and shape.

Figure t: ***The aircrete process***

Raw material storage
↓
Mixing Constituent Materials
↓
Casting
↓
Rising and Settling
↓
Profiling (not normally done in the UK)
↓
Horizontal and Vertical Cutting
↓
Autoclaving

Table 3: ***Properties of blocks***

Block type	Compressive strength N/mm^2	Weight per block kg	Nominal dry density Kg/m^3	Thermal conductivity W/m^3K
Dense aggregate	7.3 - 40	10.0 - 40.0	1800 - 2100	1.25
Lightweight aggregate	3.6 - 17.5	5.0 - 3.0.0	650 - 1500	0.47
Aerated	2.9 - 8.4	3.0 - 24.0	400 - 800	0.10 - 0.19

HSE guidance

HSE guidance for one person repetitively handling masonry units is that such units should not exceed 20kg in mass. This ruling effectively only applies to concrete blocks and autoclaved aerated blocks. Units above 20 kg should be handled mechanically, non-repetitively or by more than one person.

Glossary of Terms

Aircrete/Aerated concrete unit
A lightweight concrete masonry unit produced by mixing pulverised fly ash or ground quartz sand with cement, lime, water and aluminium powder and then autoclaving the partially set material.

Autoclave
A sealed vessel or chamber in which materials are heated under pressure. In concrete production it is used for accelerated curing.

Bar
A unit of pressure. 1 bar = 105 Newtons per square metre.

Block
Masonry unit exceeding the size of a brick in any dimension.

Breeze block *(deprecated)*
See FBA block.

Brick
Masonry unit that does not exceed 338mm in length, 225 in width nor 113mm in height.

Calcium silicate unit
Masonry unit formed essentially from a mixture of lime, siliceous aggregate and water, cured in high-pressure steam.

Cellular unit
Masonry unit in which formed voids do not pass through the masonry unit.

Clamp
A type of kiln.

Common
Common brick: a brick with no face, designed to be used out of sight.

Drylining
Dry-covering to any internal building surface (usually refers to plasterboard).

Engineering brick
Brick sized fired-clay unit that has a dense and strong semi-vitreous body that conforms to defined limits for water absorption and compressive strength.

Facing unit
Masonry unit specially made or selected to give an attractive appearance without an applied finish.

FBA block
Lightweight aggregate concrete block using furnace bottom ash as the base aggregate. (The use of the term breeze block is deprecated).

Fletton
A brick made from clay found in Bedfordshire and Huntingdonshire, characteristics are sharp edges and a deep frog.

Flintlime units
Masonry unit formed essentially from a mixture of lime, crushed flint aggregate and water, cured in high-pressure steam.

Frog
Depression formed in one or both of the largest surfaces of a brick.

Frogged brick
Brick in which any frogs do not exceed 20% of the gross volume of the brick.

Green bricks
Bricks that are waiting to be fired.

Hand made brick
Brick formed by throwing by hand a clod of soft clay into a mould.

Hollow clay blocks (Not common in the UK)
Hollow clay blocks are produced by extrusion, dried in a tunnel or chamber driers and fired in zig zag Hoffman kilns. They have textured faces and are used for external walls on factory and farm buildings or as the inner leaf of cavity walls in housing.

Lightweight aggregate concrete block
Lightweight concrete block manufactured using lightweight aggregate.

Masonry unit
Brick, block or stone.

Perforated bricks
Bricks having formed voids which pass through the unit.

Sandlime units
Calcium silicate unit of which the aggregate is natural sand.

Solid brick
Brick having no holes, cavities (holes closed at one end) or frogs.

Specials
Masonry units that are not a standard shape or size, but are made to order for various different uses.

Standard block
Block suitable for general building work, offering all round performance and normally available in 440 x 215mm face size.

Stock brick
Brick originally hand made in the South East of England, so called from the timber stock fixed to the bench that forms the frog.

Wire cut brick
Brick without frogs shaped by extruding a column of clay through a die, the column being subsequently cut to the size of a brick by means of taut wires.

Work size
Size of a masonry unit specified for its manufacture, to which the actual size conforms within permissible deviations.

Yellow stocks
The name generally used for London stock bricks.

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BS EN 771-4: Specification for masonry units. Autoclaved aerated masonry units.

BS EN 771-5: Specification for masonry units. Manufactured stone masonry units.

BS 4729: Clay and calcium silicate bricks of special sizes. Recommendations.

BS 6073-2: Precast concrete masonry units. Methods for specifying precast concrete masonry units.

BS 6100-5.3: Glossary of Building and civil engineering terms- Part 5: Masonry- Section 5.3 Bricks and blocks.

Brick Development Association - Data Sheets.

Concrete Block Association - Data Sheets.

Self-assessment questions

1 What are the four main quality requirements for clay that is to be fed to the shaping process?

A

2 What are the five principal stages in the brick making process?

A

3 What is a Fletton brick?

A

4 What are the seven important properties of a brick?

A

5 In what type of brick production is an autoclave used?

A

6 List the advantages and disadvantages of aircrete blocks compared to other types of concrete blocks.

A

7 What is an egg layer?

A

8 What is the difference between a cellular concrete block and a hollow concrete block?

A

9 What is the face size of a standard concrete block?

A

10 What is the HSE guidance on the maximum weight of unit that one person should repetitively handle?

A

Answers to self-assessment questions

1 Consistent composition, grading, plasticity and water content.
2 Clay extraction, Clay processing, Forming the brick, Drying, Firing.
3 A brick made from clay found in Bedfordshire and Huntingdonshire, characteristics are sharp edges and a deep frog.
4 Voids in the brick, Water absorption, Crushing strength, Durability, Efflorescence, Suction rate, Appearance.
5 The production of calcium silicate bricks.
6 Advantages: (i) Good thermal insulation properties, (ii) Relatively light, (iii) Easy to work with (cut etc).
Disadvantages: (i) Lower sound insulation, (ii) Lower compressive strength range, (iii) Needs more careful handling.
7 A machine for producing concrete blocks.
8 In a cellular concrete block the cavities do not pass right through the unit, in a hollow concrete block the cavities pass right through the unit.
9 440 x 215 mm.
10 That the mass of the unit should not exceed 20kg.

MPA Mortar Learning Texts include:

1 Introduction to modern mortars
2 Cementitious materials
3 Aggregates
4 Admixtures, additives and water
5 Brick and block production
6 Properties of masonry mortar
7 Production, deleivery and storage of mortar
8 Mortar testing
9 Specifications
10 Quality assurance
11 Construction
12 Properties of rendering mortar
13 Best practice - potential site problems

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