Civil Engineering Materials

SAB 2112

Introduction to Bricks & Blocks

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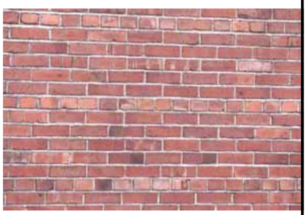
CONTENT SCHEDULE – 3rd Meeting

1. Types of bricks, blocks and their use;
2. Manufacturing of clay bricks, characteristics and testing of bricks; and
3. Mortar for brickwork.

Learning Objectives

Student should be able to:

1. describe the process of brick manufacturing.
2. identify the different types of bricks and blocks.
3. describe the usage of bricks and blocks in construction.
4. recognize the classification of bricks.
5. understand the properties of bricks and blocks.



One of the oldest building materials!

- Manufactured of bricks still follows the same basic procedures
  1. Modern plants are more efficient
  2. With complete knowledge of raw materials
  3. Better kilns
  4. Better machinery

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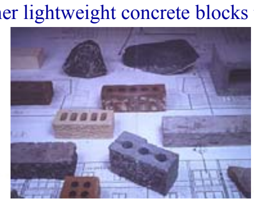
Introduction

- A brick is defined in **BS 3921** as a walling unit with size of **225 mm length, 112.5 mm width and 75 mm height** has an actual dimensions of 215 x 102 x 65 mm.
- Brickwork is used primarily in the construction of walls by the bedding and pointing of bricks into bonding arrangements. The term also covers the hollow and other lightweight concrete blocks that conform to BS 3921.



Principal Ingredient is clay

1. Must have plasticity when mixed with water
2. Sufficient tensile strength
3. Must fuse together

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Principal Forms of Clay

Clay occurs in three principal forms – same chemical properties – different physical properties

1. Surface clays – found near the surface of the earth
2. Shale's – subjected to high pressures relatively hard
3. Fireclays – deeper levels – uniform physical and chemical properties – withstand higher temp.

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- Clay is a complex material
  - Compounds of silica and alumina and other small ingredients
- Divided into two classes
  - Calcareous Clays
    - 15 % calcium carbonate – burn a yellowish color
  - Noncalcareous Clays
    - 2 to 10% feldspar and iron oxide – reddish color

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Manufacturing of Brick and Tile

- Mining and Storage
  - Mined open pit
  - Clay is in form of large clumps – undergoes preliminary crushing
- Preparing Raw Material
  - Crushed into small pieces no larger then 2 in.
  - Grinders reduce it to a fine powder

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- Forming
  - First step is tempering (adding water)
  - Amount of water depends on method
    - **Stiff mud process** – only enough water to produce plasticity (12 to 15%)
      - Clay forced into a die producing a continuous column of clay of proper size and shape then cut to size
    - **Soft mud process** (20 to 30% water)
      - Clays which contain to much natural water
      - Clay is placed into molds
      - Oldest method of brick making
    - **Dry press process** (-10% water)
      - Clay is placed into molds under high pressure

Manufacturing of Brick and Tile

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Manufacturing of Brick and Tile

- Drying
  - Before drying must have between 7 to 30% water
  - Kilns are used to dry
  - Shrinkage occurs
  - Temp range from 28 to 204 degrees C
  - Drying time ranges from 24 to 48 hours

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Manufacturing of Brick and Tile

- Glazing
  - Gives glass like coating
- Burning and Cooling 40 to 150 h
  - Water smoking – evaporation of free water 204 C
  - Dehydration – removal of all water 149 – 982 C
  - Oxidation – 538 – 932 C
  - Virtirification – 871 – 1315 C
- Storing and Shipping

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Brick Sizes

- 4 in. building module
- Standard Imperial – nominal size of 4 x 2 ¼ x 8 in – actual 3 5/8 x 2 1/16 x 7 1/2

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Common Bricks

- Comes in 3 grades
  - SW – wet conditions – high resistance to frost action compression strength rating of 3000 psi
  - MW – dry conditions – low resistance to frost – 2500 psi
  - NW – back up interior – no freezing – 1500 psi
- Two common designs
  - Wire cut – 8 holes
  - Pressed – 3 holes

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Mortar

- Joints are ½ or 3/8 in. size
- Types
  - Type M – General use – use below grade
    - 1 part portland cement, ¼ part hydrated lime, 3 parts sand
  - Type S – General purpose mortar bond high resistance to lateral force
    - 1 part portland cement, ½ part hydrated lime, 4 ½ parts sand
  - Type N – Exposed masonry above grade
    - 1 part portland cement, 1 part hydrated lime, 6 parts sand
  - Type O –Less then 100 psi – no freeze or thaw
    - 1 part portland cement, 2 parts hydrated lime, 9 parts sand

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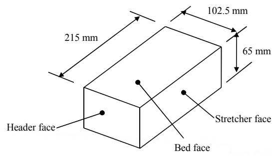
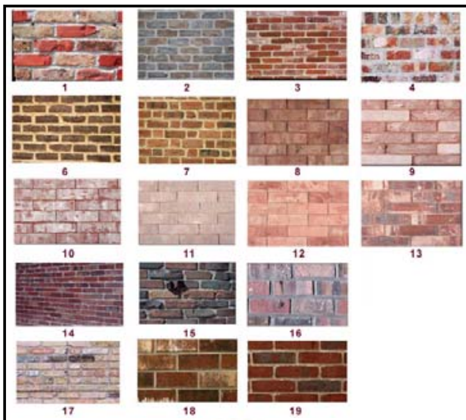
Bricks

- A **brick** is a block of ceramic material used in masonry construction, usually laid using mortar.
- Bricks may be made from clay, shale, soft slate, calcium silicate, concrete, or shaped from quarried stone.
- Clay brick is the most common material, with modern clay bricks formed in one of three processes - soft mud, dry press, or extruded.





Sources: http://www.urbanrevivals.com/images/brick/brick_all_web.jpg

Bricks

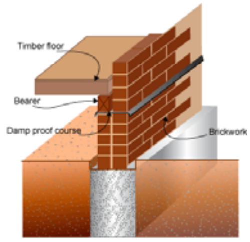
- **Uses of bricks in construction**
- Internal and external walls,

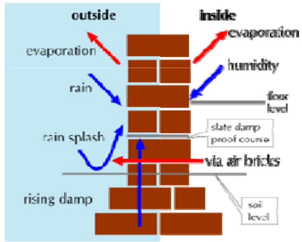
Bricks

- **Uses of bricks in construction**
- Facing walls,


Bricks

- **Uses of bricks in construction**
- Damp proof course,

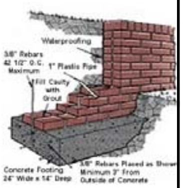




Bricks

- **Uses of bricks in construction**
- Earth retaining wall,



Bricks

- **Uses of bricks in construction**
- Sewerage work



Types of Bricks

There are basically two types of bricks:

1. Clay bricks

- Clay bricks are made by shaping suitable clays to units of standard size, which are then fired to a temperature in range 900 to 1200°C.
- The fired product is a ceramic composed predominantly of silica SiO_2 (generally between 55% – 65% by weight) and alumina Al_2O_3 (10 – 25%) combined with as much as 25% of other constituents.
- The normal size of the building brick is **215 x 102.5 x 65 mm**. Allowing for 10 mm mortar joints, this corresponds to the standard format of *225 x 112.5 x 75 mm*.

Types of Bricks

2. Calcium silicate bricks

- Calcium silicate makes wonderful bricks that are attractive, durable and strong, with a long and proven heritage. They have been used successfully both for internal and external walls since 1898 throughout the UK, Europe, the USA and Asia, and can be found in many of the world's best known buildings.
- Calcium silicate bricks are made from sand, lime and a pigment for colour if required, with sufficient water to enable the mix to be moulded and then hardened by exposure to steam under pressure.
- Hydrated calcium silicate is formed from the sand and lime by the heat from the pressurised steam, forming a very strong and permanent bonding agent, which binds the sand grains together.
- A natural calcium silicate brick is near white if a white sand is used in its production and a little pink if a red sand is used.
- The colour is permanent and therefore maintained even after years of weathering.

Types of Bricks

- **Calcium silicate bricks**
  - Using pigments, many colours can be manufactured.
  - Their near perfect geometrical shape, sharp arrises (edges), uniformity of size and aesthetic appeal make calcium silicate bricks the ideal **facing brick solution**.
  - Combining this with the maximum light reflection without glare also makes them perfect for internal areas, especially where maintenance costs need to be minimised.

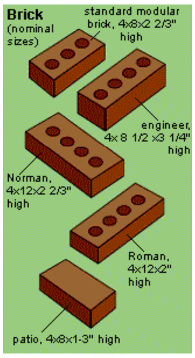


Classification of Bricks

- The building industry broadly recognizes 3 kinds of bricks, which are differentiated on the basis of function. These are:
  1. **Common bricks:** for general building purposes. Common brickwork is used to describe brickwork which will generally have a 'finish' applied to it or whose external appearance is not of great importance.
  2. **Facing bricks:** manufactured for acceptable appearance. It is a type of brick where special attention has been paid to the external appearance, including the use of decorative or coloured bricks. Facing bricks can have one or both of the following features:
     - A special colour either inherent in the base material or added to it or applied to the surface.
     - Texture deliberately impressed on the surfaces or as a result of the base material texture and/or the manufacturing process.

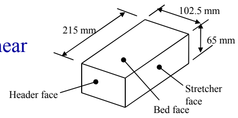
Classification of Bricks

3. **Engineering bricks:** for use where high strength and/or low water absorption are required. There are 2 types of engineering bricks:
   - *Engineering brick A:* Having compressive strength ≤ 70 N/mm² and water absorption ≤ 4.5 %.
   - *Engineering brick B:* Having compressive strength ≤ 50 N/mm² and water absorption ≤ 7.0 %.

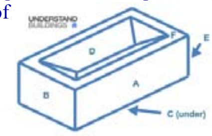


Types of Bricks by Shapes

- **Solid:** Bricks can just be rectilinear pieces of material, and these are described as solid.



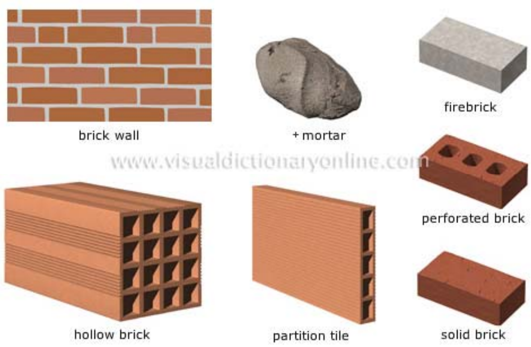
- **Frog:** Bricks might have a depression in one or both beds. Frogs can be quite shallow or quite deep but they will not exceed 20% of



Types of Bricks by Shapes

- **Hollow (Perforated or Cellular)**
- **Perforated:** Holes not exceeding 20% of the volume in total;
- **Cellular:** Having cavities or depressions exceeding 20% of the volume in total.





Mechanical Properties of Bricks

- **Compressive strength**
  - The **compressive strength** is the only mechanical property used in brick specification. It is the failure stress measured normal to the bed face.
  - Generally, ***compressive strength decreases*** with ***increasing porosity***, but strength is also influenced by material composition and firing.
  - The Young's modulus of elasticity of brick lies usually in the range 5 to 30 kN/mm^2.
  - Flexural strengths of brick materials are sometimes required in calculations of the lateral strength of brickwork.
  - Brick is relatively ***weak in tension*** and the flexural strength (or modulus of rupture) is typically only 5-10% of the compressive strength.

Mechanical Properties of Bricks

- **Moisture expansion**
  - Fired brick exhibit a long term expansion on exposure to moist air.
  - Moisture expansion is progressive and continues indefinitely, although at a diminishing rate, such that the total expansion increases roughly as log(time).
  - It is recognized that the long term contribution of moisture expansion to movement in clay brick masonry can be considerable. It is essential to allow for this in design.
  - *Reversible* change in dimension on wetting and drying brick are less than 0.01% and are negligible for most purposes.

Mechanical Properties of Bricks

- **Thermal properties**
  - The thermal conductivity of brick is controlled by the proportions of crystalline and glassy constituents, and the porosity.
  - Dry brick of bulk density 2400 kg/m^3 has a conductivity of about 1.2 W/mK, but the conductivity falls to about 0.4 W/mK at a brick density of 1600 kg/m^3.
  - Thermal conductivity rises sharply with increasing moisture content – about 60% at 3% volumetric water content and about 135% at 15% water content.
  - The coefficient of thermal expansion of most clay bricks lies in the range 5 x 10^6 1/K – 7 x 10^6 1/K.

Mechanical Properties of Bricks

- **Behavior under fire condition**
  - Because it is itself a fired material, the performance of bricks under fire condition is generally excellent.
  - The fire resistance of perforated brick and cellular brick is somewhat lower than that of the same thickness of solid bricks, which generally has greater resistance to thermal shock and better resistance to the transmission of heat at high temperatures.
- **Resistance to chemical attack**
  - Bricks are generally very resist to alkalis, acids and most commonly encountered chemicals.
  - It is attacked only under extreme conditions.

Blocks

- Block is defined as an unit having one or more dimensions greater than those of the largest possible brick. Typical block size: **440 x 215 x 100 mm**, **200 x 200 x 100 mm**.
- The essential materials for making blocks are OPC binder, water, and aggregate (dense or lightweight, max size 10mm). And sometimes additives (colors) or admixtures (retarders, accelerators and water reducing agent).
- Aggregates are of two kinds, fine (sand) and coarse (normally gravel or crushed stone).
- The binder is normally ordinary Portland cement (OPC).
- The water is necessary to trigger and complete the chemical reaction which makes the mixture 'set'.

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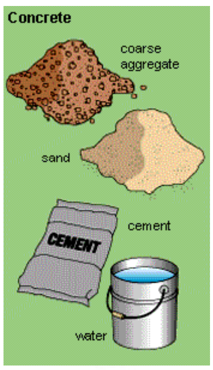

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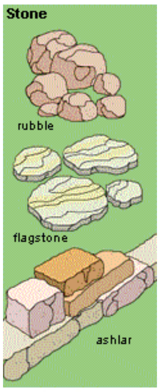
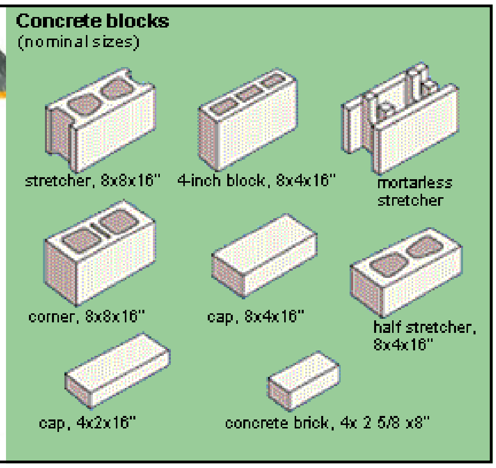
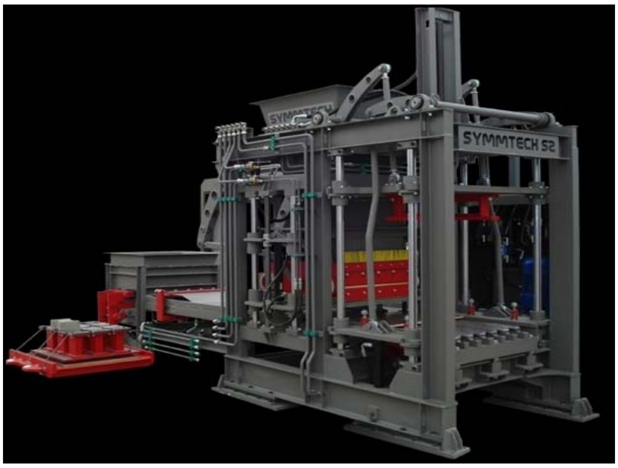




Block Manufacturing Process



Sources: http://www.bridgat.com/files/FullAutomatic_Concrete_Block_Production_line.jpg

Types of Blocks

- There are generally two types of concrete blocks, namely:
  - **Aggregate concrete block:**
  - The manufacturing process involves compaction of the newly mixed constituent materials (basically binder, water and aggregate) in a mould followed immediately by extrusion of the pressed block, so that mould can be used repeatedly.
  - Since the finished blocks are required to be self-supporting and able to withstand any movement and vibration from the moment they are extruded, very much drier, higher fine aggregate content and leaner mixes are used than in normal concrete work.

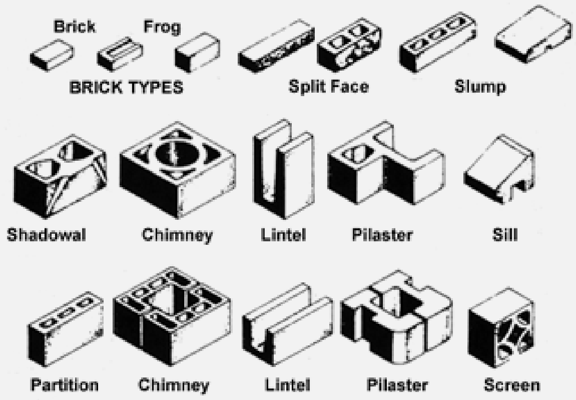
Types of Blocks

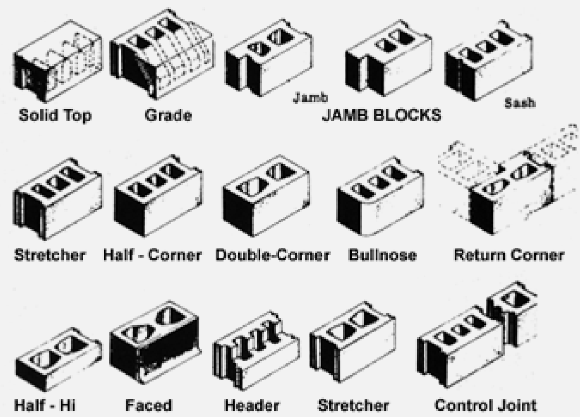
- There are generally two types of concrete blocks, namely:
  - **Aerated concrete block:**
  - For aerated block, a slurry of binder, pre-heated water and siliceous materials mixed together with aluminium powder is first cast as a "cake" in large moulds (usually 1m x 2m x 1m high).
  - The aluminium powder reacts with lime in the cement producing a mass of minute hydrogen bubbles within the mix, which thus expands to fill the mould.
  - As the mix sets, the hydrogen within the now cellular structure diffuses and is replaced by air.
  - After the initial set, while the aerated "cake" is still in its plastic stage, the mould shutters are stripped off and the "cake" is cut into the required block sizes by thin wires on a cutting machine.
  - This cut cake is then placed in an autoclave for high pressure steam curing for about 24 hours, when the blocks are ready for use as soon as they have cooled to the ambient temperature.

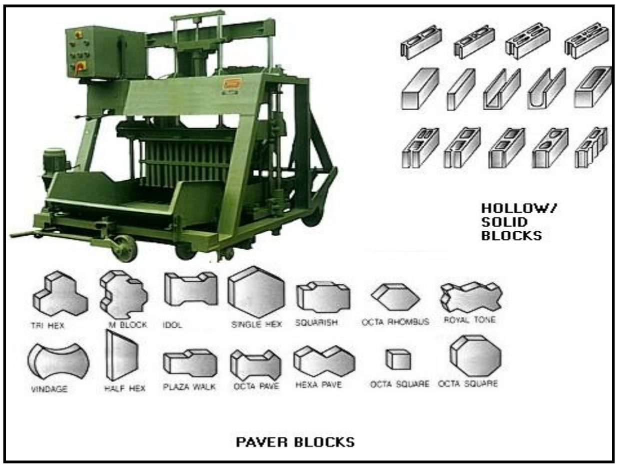
Form and Shape

- There are three basic forms of concrete block; solid, cellular and hollow as shown below.

TYPICAL SHAPES OF CONCRETE BLOCK







Properties of Blocks

- **Density:** Density of concrete blocks is largely a function of the aggregate density, size and grading, degree of compaction or aeration and block form. Dry density is typically range between 500 – 2100 kg/m^3.
- **Strength:** Compressive strength of concrete blocks is dependent mainly on their mix composition, degree of compaction (or aeration) and to a lesser extent on the aggregate type and curing normally used. The strength will increase with its density. Most commonly used block fall in 3.5 – 10 N/mm^2.
- **Durability:** Concrete blocks are adequately durable for most normal application. In extreme condition, such as pollution (chemical attack) and weather (frost attack), fair faced blocks with strength > 7 N/mm^2 should be used.
  Use of autoclaved blocks and sulfate-resisting Portland cement and/or pulverised-fuel ash increase the resistance to sulfate attack.

Properties of Blocks

- **Fire resistance:** Generally, concrete blocks have good fire resistance properties. Most concrete blocks of 100 mm thickness can provide an adequate fire resistance up to 2 hours if load bearing, and if non-load bearing up to 4 hours.
- **Thermal conductivity:** The thermal conductivity of concrete block is largely dependent on it block density. Therefore, autoclaved aerated concrete and lightweight concrete blocks have relatively low thermal conductivities.
  Cellular and hollow blocks (due to lower net density) have lower thermal conductivities than their solid counterparts.
  Thermal conductivity of concrete block is further affected by its moisture content, increasing as the moisture content increases.

Sources: http://www.northstonematerials.com/...store/images/P1010059.JPG