Brick Masonry

History, types, manufacturing and properties.

History of Bricks:

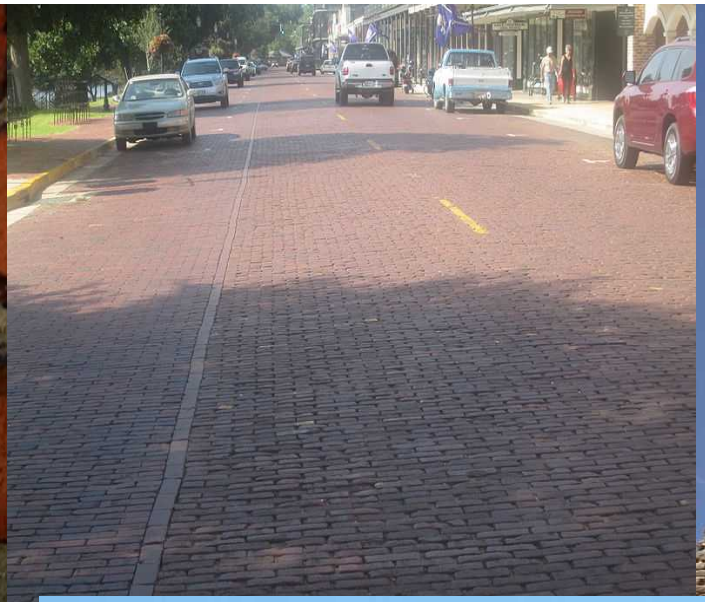
- Bricks are one of the oldest types of building blocks.
- They are an ideal building material because they are relatively cheap to make, very durable, and require little maintenance.
- A **brick** is a block of ceramic material used in masonry construction, usually laid using various kinds of mortar.
- Bricks dated 10,000 years old were found in the Middle East.
- Examples of the civilizations who used mud brick are the ancient Egyptians and the Indus Valley Civilization, where it was used exclusively. In particular, it is evident from the ruins of Buhen, Mohenjo-Daro and Harappa.
- The first sun-dried bricks were made in Mesopotamia (what is now Iraq), in the ancient city of Ur in about 4000 BC

Roman (70 BC - 476 AD) used masonry extensively. They invented the arch construction which allows them to build large openings. They also discovered natural cement (pozzolana).

Roman Colloseum
(70-80 AD)

- Masonry has been used extensively in the constructions throughout the middle ages and renaissance period.

Leaning Tower of Pisa (1173-1372)



Advantages of bricks :

*** Brick will not burn, buckle or melt.**
*** Brick will not rot and allow Termites to invade.**
*** Brick will not rust and corrode.**
*** Brick will not dent.**
*** Brick will not fade from the Sun's UV Rays.**
*** Brick will not be damaged by high winds, rain or hail.**
*** Brick will not require constant maintenance.**
*** Brick will not devalue.**
*** Brick will not limit your personal expression.**
*** Brick will not limit your design options.**

General Characteristics of Bricks

- Brick is made of clay or shale formed, dried and fired into a durable ceramic product.
- There are three ways to form the shape and size of a brick: extruded (stiff mud), molded (soft mud) and dry-pressed.
- The majority of brick are made by the extrusion method.
- Brick achieves its color through the minerals in the fired clay or through coatings that are applied before or after the firing process. This provides a durable color that never fades or diminishes.
- Brick shrink during the manufacturing process as vitrification occurs. Brick will vary in size due to the manufacturing process. These variations are addressed by ASTM standards.

- The method used to form a brick has a major impact on its texture.
  - Sand-finished surfaces are typical with molded brick.
  - A variety of textures can be achieved with extruded brick.
- •Brick manufacturers address sustainability by locating
- manufacturing facilities near clay sources to reduce transportation, by recycling of process waste, by reclaiming land where mining has occurred, and by taking measures to reduce plant emissions. Most brick are used within 500 miles of a brick manufacturing facility.

Raw material for clay:

- Clay is one of the most abundant natural mineral materials on earth. For brick manufacturing, clay must possess some specific properties and characteristics.
- Such clays must have plasticity, which permits them to be shaped or molded when mixed with water; they must have sufficient wet and air-dried strength to maintain their shape after forming.
- Also, when subjected to appropriate temperatures, the clay particles must fuse together.

Types of Clay

- : Clays occur in three principal forms, all of which have similar chemical compositions but different physical characteristics.
  - Surface Clays. Surface clays may be the upthrusts of older deposits or of more recent sedimentary formations. As the name implies, they are found near the surface of the earth.
  - Shales. Shales are clays that have been subjected to high pressures until they have nearly hardened into slate.
  - Fire Clays. Fire clays are usually mined at deeper levels than other clays and have refractory qualities.
  - Surface and fire clays have a different physical structure from shales but are similar in chemical composition.

varying amounts of metallic oxides.

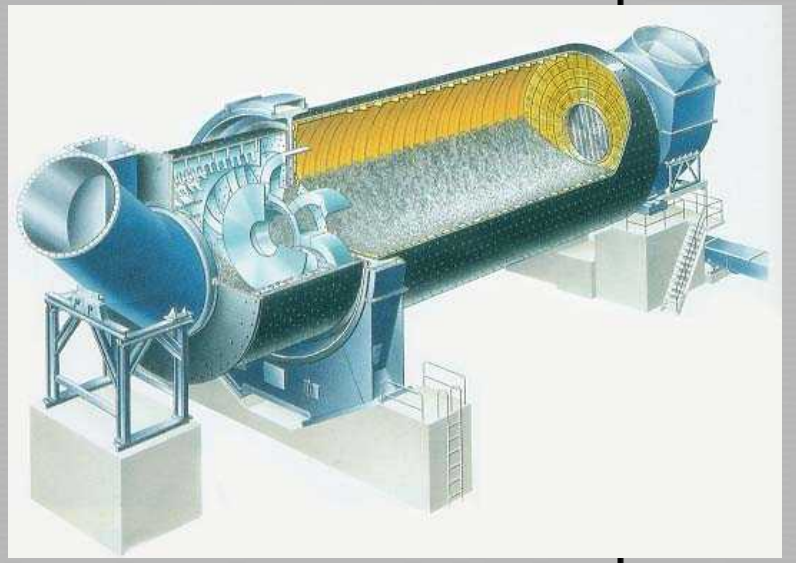
- Metallic oxides act as fluxes promoting fusion of the particles at lower temperatures. Metallic oxides (particularly those of iron, magnesium and calcium) influence the color of the fired brick.
- The manufacturer minimizes variations in chemical composition and physical properties by mixing clays from different sources and different locations in the pit.
- Chemical composition varies within the pit, and the differences are compensated for by varying manufacturing processes. As a result, brick from the same manufacturer will have slightly different properties in subsequent production runs. Further, brick from different manufacturers that have the same appearance may differ in other properties.

- Raw material is dug out of the ground

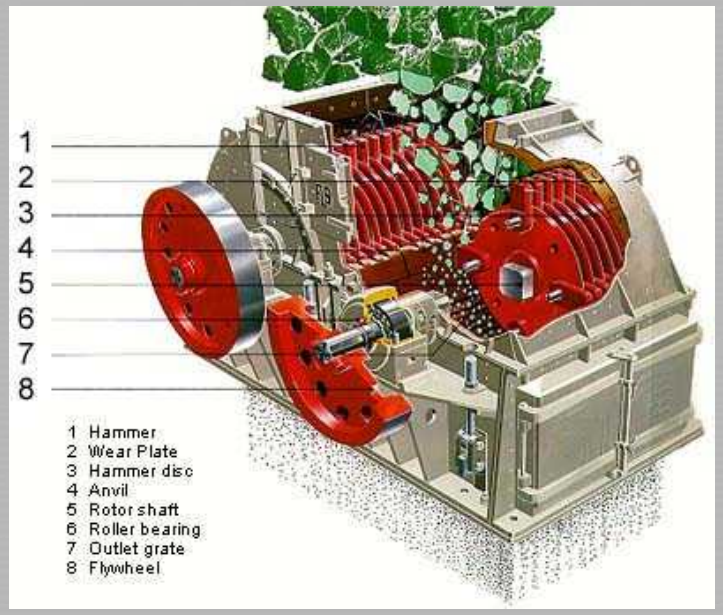
Preparation of materials before forming

Bricks

- Manufacture - 4 stages
  - Material preparation
  - Manufacturing
  - drying
  - Firing
- **Preparation**: material (clay) washed and grinding (fineness)



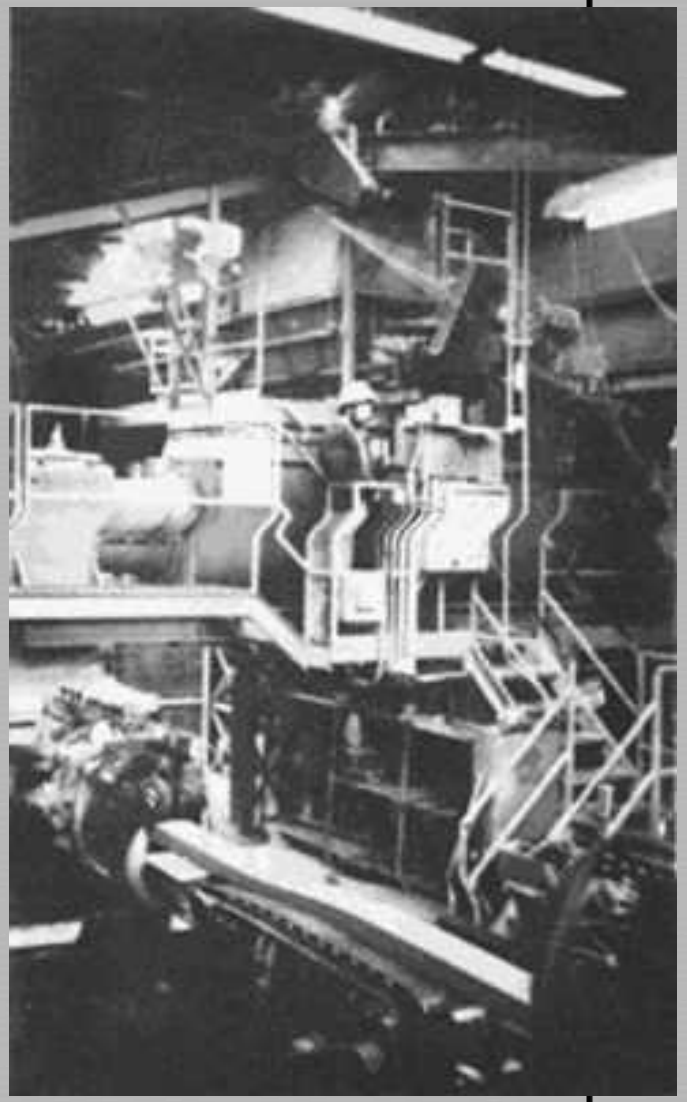
Sample of grinding machine for clay



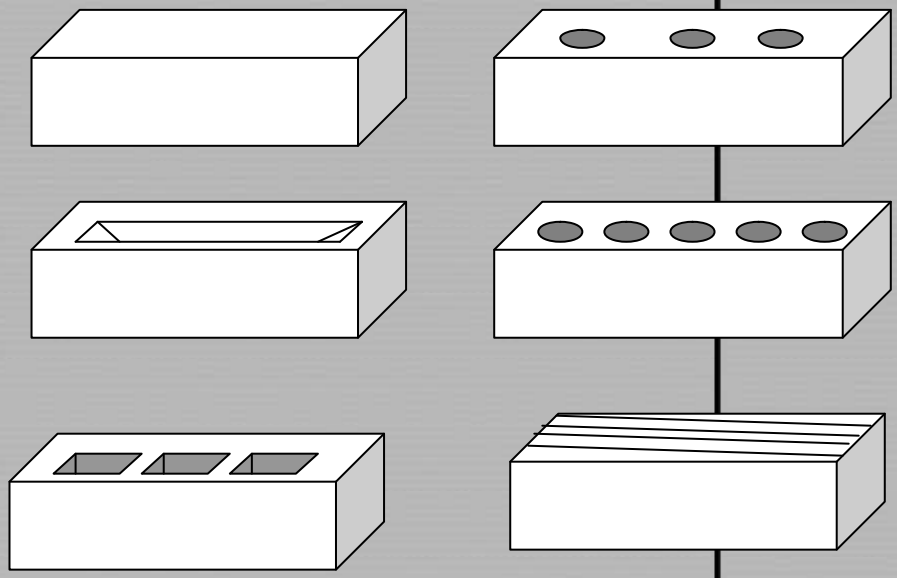
Sample of crushing machine

Brick

- **Manufacturing** : Clay will grinded with 15% of water. The clay will be pushed through the mould base on the shape. After that, Clay will cut to get a standard size of brick using wire.
- Sometimes, bricks will produced using big mould that clay will be press that using hydraulic machine (This method, clay will grind 10% of water) or without hydraulic press (with 30% of water)

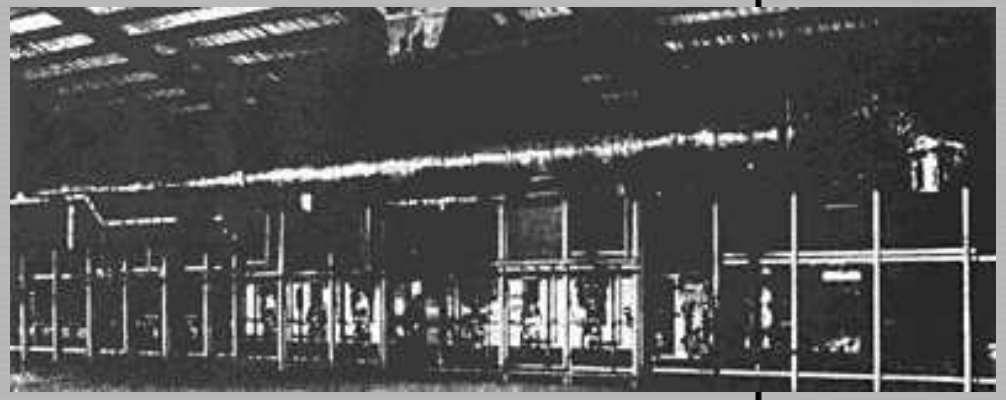


- After bricks in form, identification or perforation to the bricks.
- **Drying :** Wet unit bricks will be drying in space or room with control temperature to make sure the bricks in complete dry.

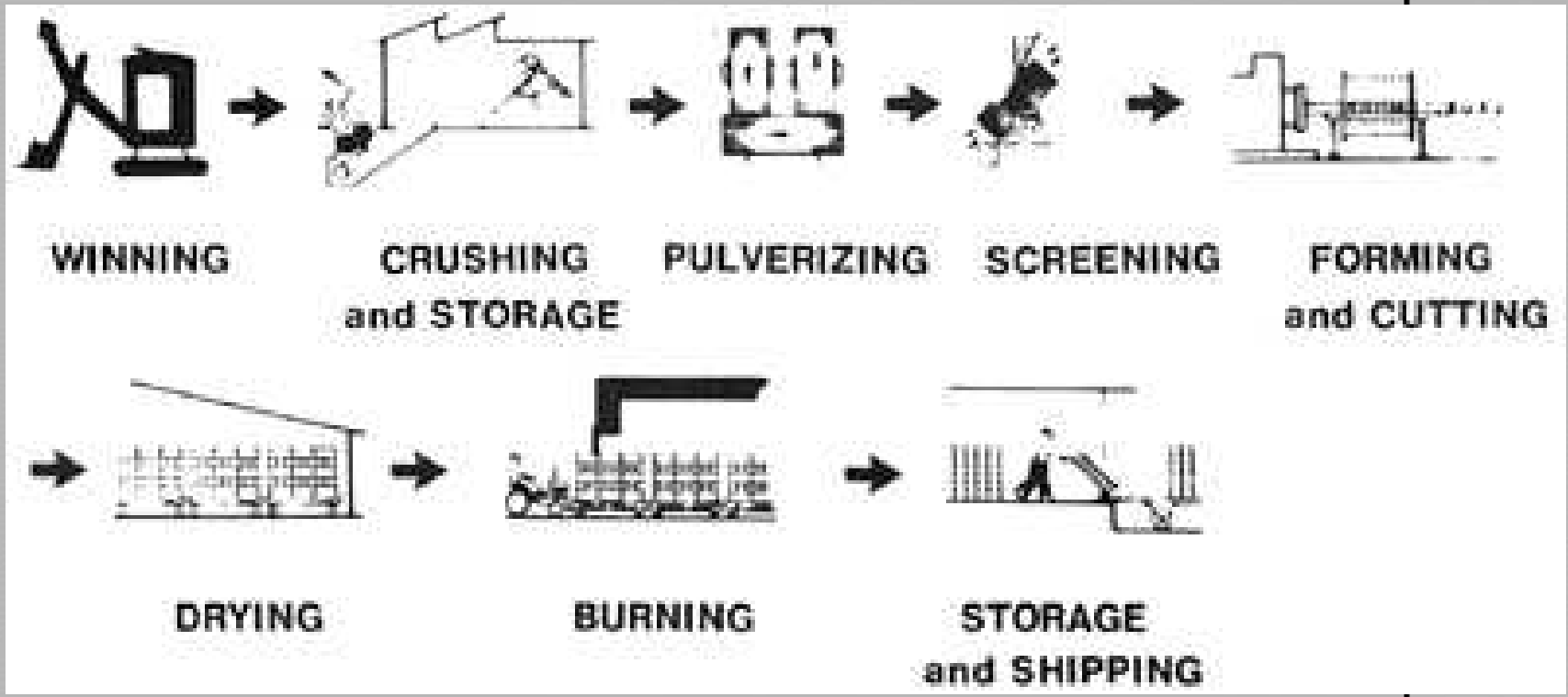


Brick was compile before bring to the kiln

- **Firing** : Dry bricks, was compile in kiln to firing process with 600^{o}C (temperature). This is for burn the carbon and sulfur that have remain. After that, temperature will increase to 900^{o}C to get a vetrification process.
- Normally, vitrification process occurred around 800^{o}C.
- Bricks become hard/strong after vitrification process.

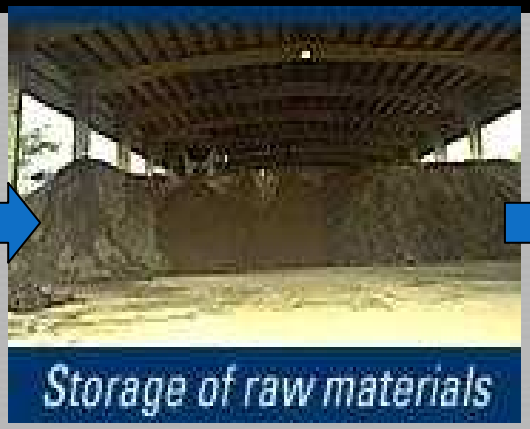


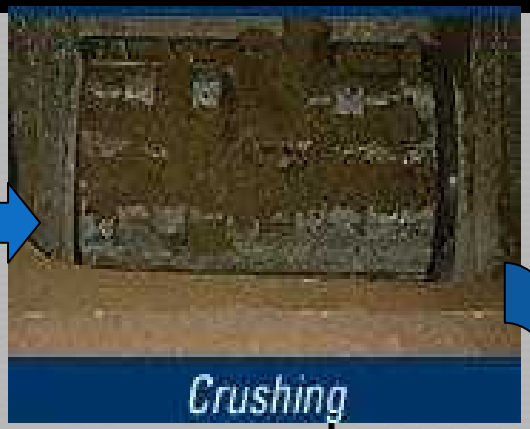
Bricks



Bricks manufacturing process flow


Gathering raw materials


Storage of raw materials


Crushing


Pug mill


Grinding


Screening

MATERIAL PREPARATION


Inside die head


Core hole die


Extruded column


Cutting

Manufacturing

Mold boxes

Throwing brick

Squeegee

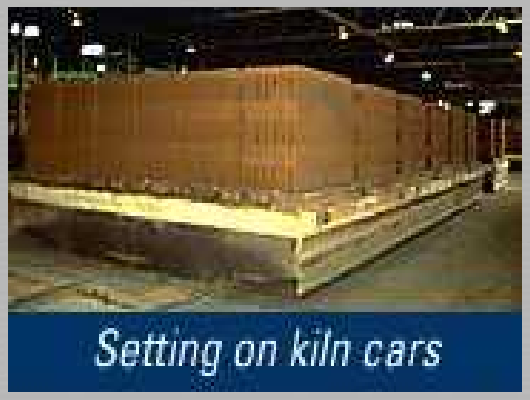
Dumping mold box

Hand setting

Manufacturing

Setting

Setting machine



Setting on kiln cars

Green brick

Setting

Inside kiln

Firing

Firing Process

Packaging

PROPOERTIES OF BRICKS

- The most important properties of brick are

1) durability, 2) color, 3) texture, 4) size variation, 5) compressive strength and 6) absorption.

- **Durability:**
  - The durability of brick depends upon achieving incipient fusion and partial vitrification during firing. Because compressive strength and absorption values are also related to the firing temperatures, these properties, together with saturation coefficient, are currently taken as predictors of durability in brick specifications. However, because of differences in raw materials and manufacturing methods, a single set of values of compressive strength and absorption will not reliably indicate the degree of firing.

- **Texture:**
  - Coatings and Glazes : Many brick have smooth or sand-finished textures produced by the dies or molds used in forming.
  - A smooth texture, commonly referred to as a die skin results from pressure exerted by the steel die as the clay passes through it in the extrusion process. Most extruded brick have the die skin removed and the surface further treated to produce other textures using devices that cut, scratch, roll, brush or otherwise roughen the surface as the clay column leaves the die Brick may be tumbled before or after firing to achieve an antique appearance.

firing temperatures and the method of firing control.

- Of all the oxides commonly found in clays, iron probably has the greatest effect on color. Regardless of its natural color, clay containing iron in practically any form will exhibit a shade of red when exposed to an oxidizing fire because of the formation of ferrous oxide. When fired in a reducing atmosphere, the same clay will assume a dark (or black) hue. Creating a reducing atmosphere in the kiln is known as flashing or reduction firing.
- Given the same raw material and manufacturing method, darker colors are associated with higher firing temperatures, lower absorption values and higher compressive strength values. However, for products made from different raw materials, there is no direct relationship between strength and color or absorption and color.

are made in the forming process to achieve the desired size of the finished brick. Both drying shrinkage and firing shrinkage vary for different clays, usually falling within the following ranges:

- Drying shrinkage: 2 to 4 percent
- Firing shrinkage: 2.5 to 4 percent

- Firing shrinkage increases with higher temperatures, which produce darker shades. When a wide range of colors is desired, some variation between the sizes of the dark and light units is inevitable.
- To obtain products of uniform size, manufacturers control factors contributing to shrinkage. Because of normal variations in raw materials and temperature variations within kilns, absolute uniformity is impossible. Consequently, specifications for brick allow size variations.

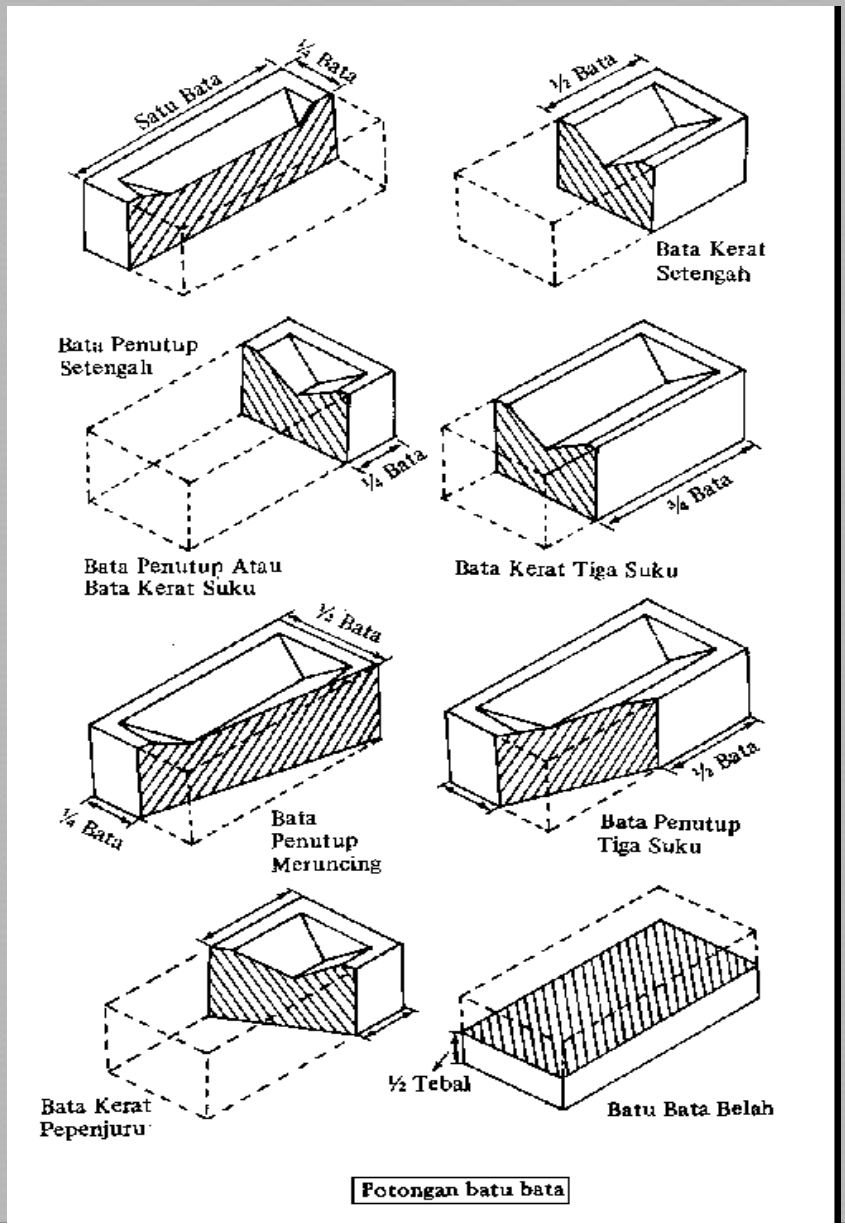
- Both compressive strength and absorption are affected by properties of the clay, method of manufacture and degree of firing.
- For a given clay and method of manufacture, higher compressive strength values and lower absorption values are associated with higher firing temperatures. Although absorption and compressive strength can be controlled by manufacturing and firing methods, these properties depend largely upon the properties of the raw materials.

Tests on bricks:

- Clay Masonry Units -ASTM C 67, Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
  - These test methods cover
  - Procedures for the sampling and testing of brick and structural clay tile.
  - Tests include modulus of rupture, compressive strength, absorption, saturation coefficient, effect of freezing and thawing, efflorescence, initial rate of absorption and determination of weight, size, warpage, length change, and void area.

Brick Work

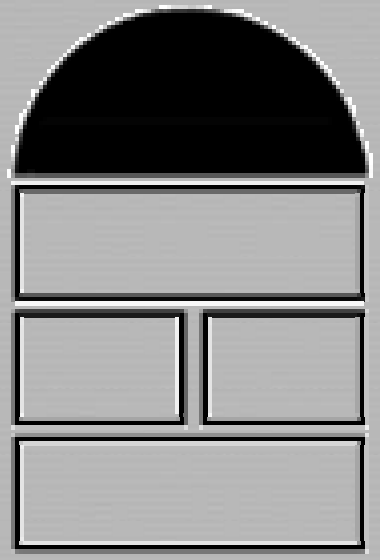
- Brick shape in brick work
  - To produce the variety of arrangmenet or special purpose in brick work

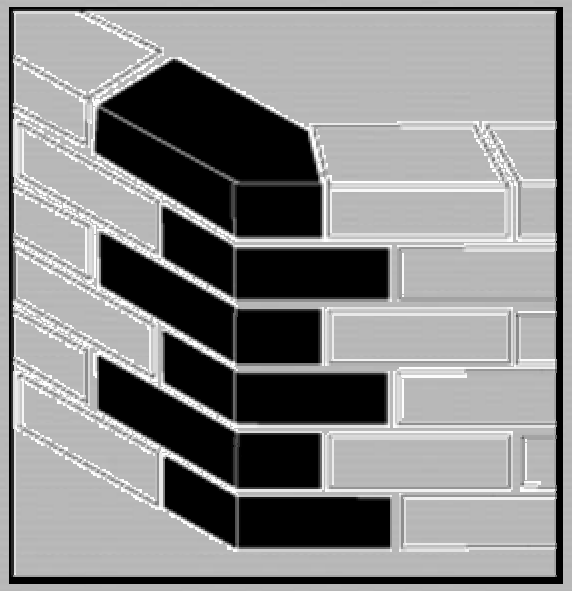


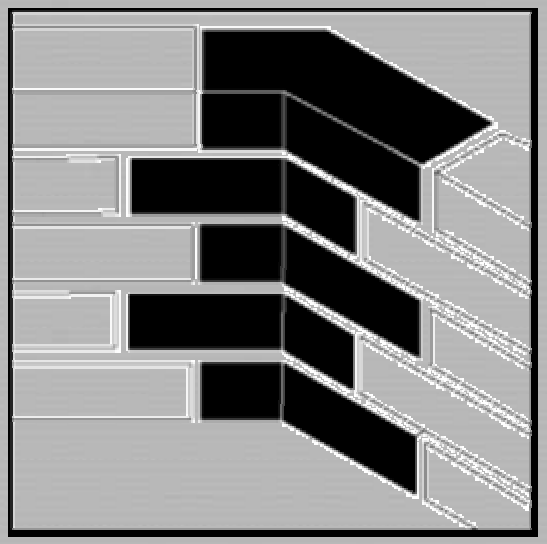
Potongan batu bata

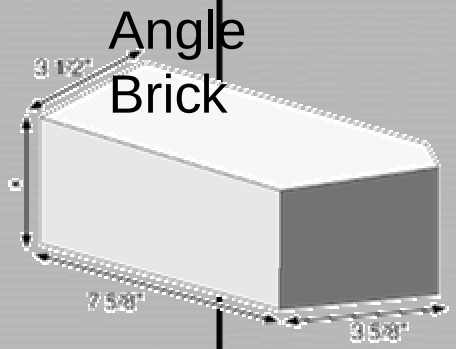
Brick Work

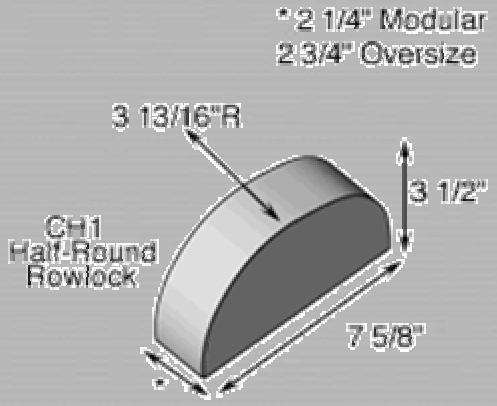
- Brick shape in brick work











Brick Work

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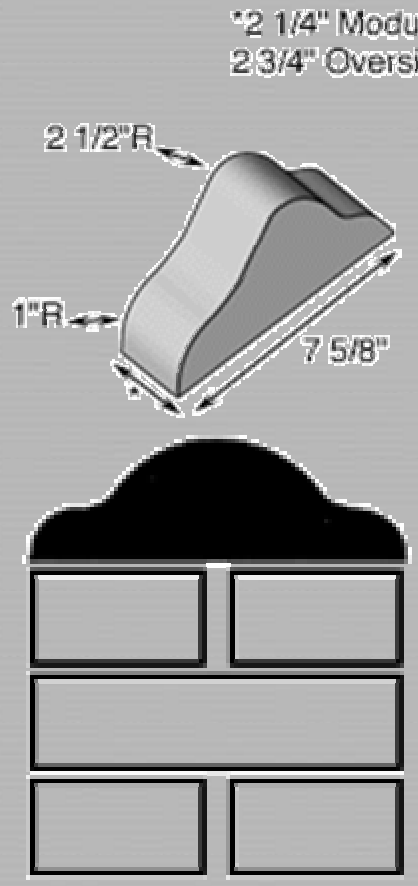
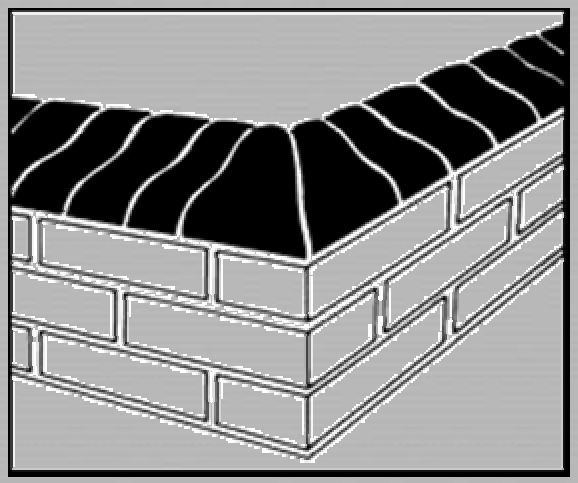
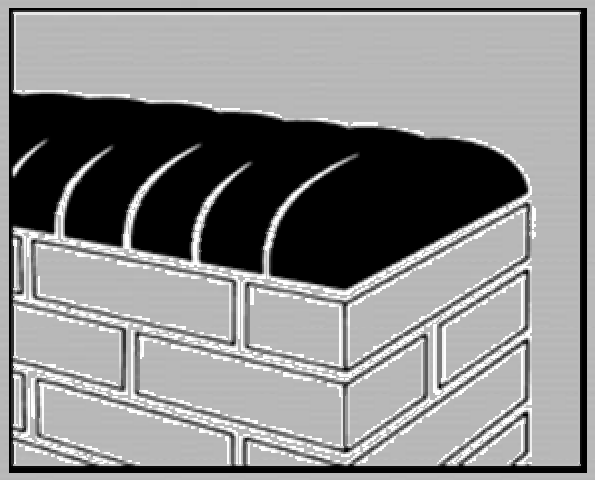
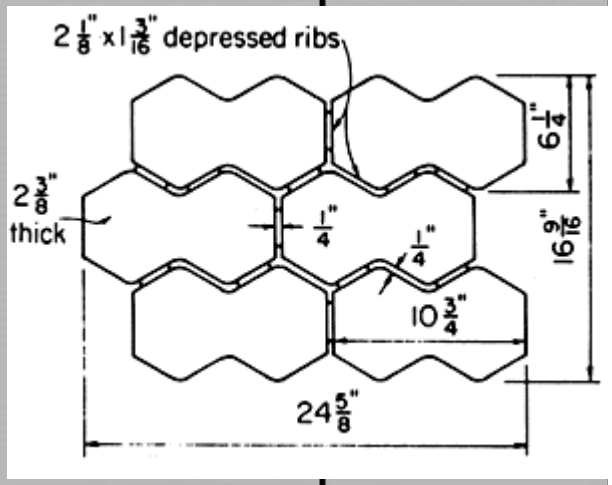


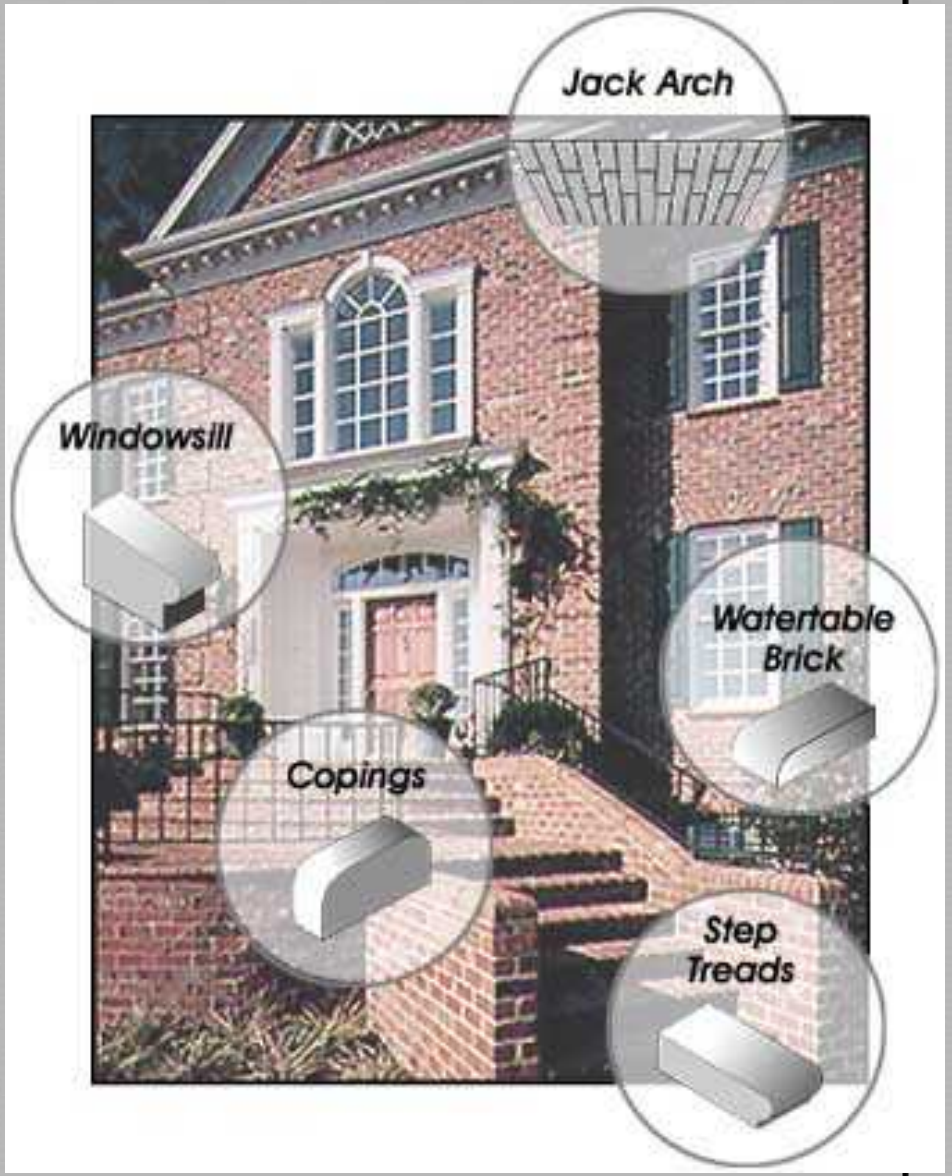






Brick Work

- Brick arrangement in brick work



Brick work

- Brick arrangement in brick work

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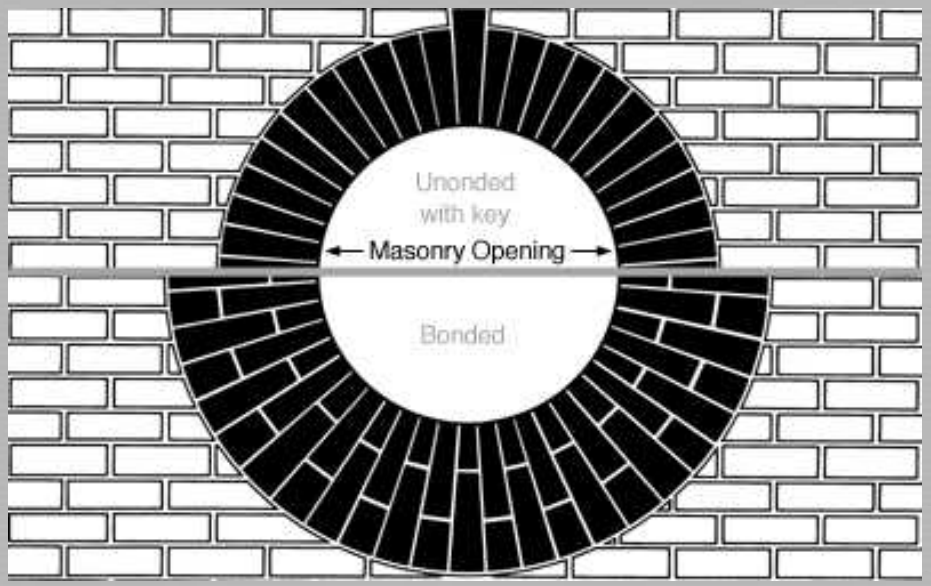
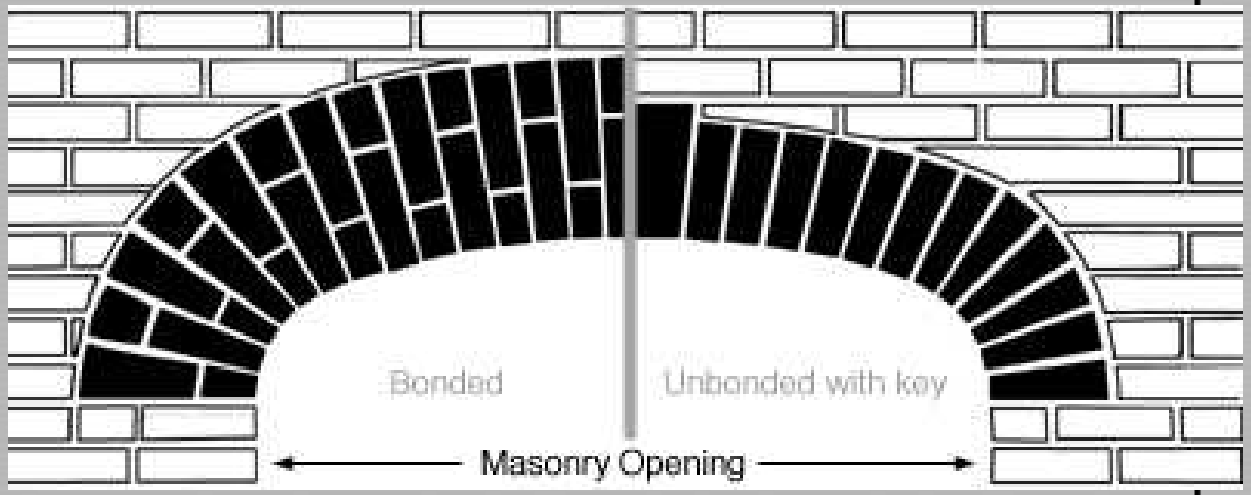


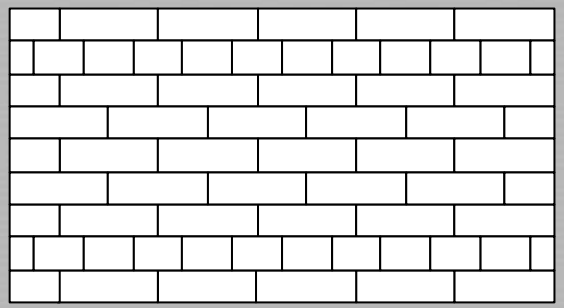


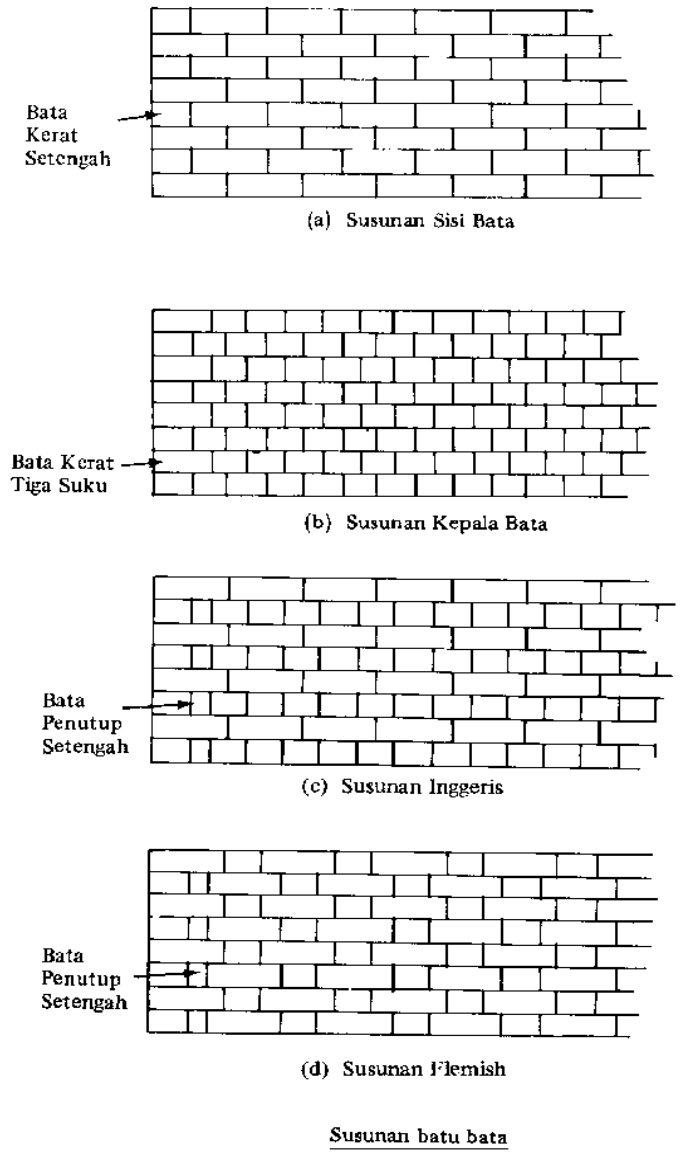
Brick work

Brick arrangement in brickwork

- Some of the popular brick arrangement is:
  - *Brick edge Arrangement*
  - *Brick head Arrangement*
  - *American Arrangement*
  - *English Arrangement*
  - *Flemish Arrangement*

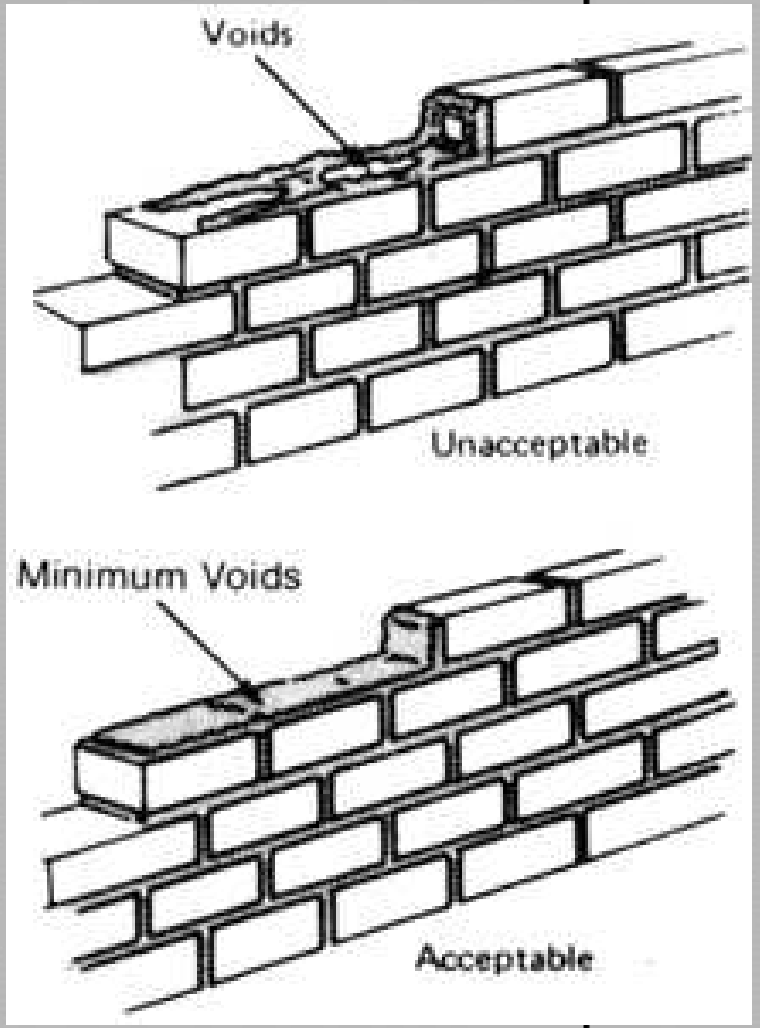
American Arrangment





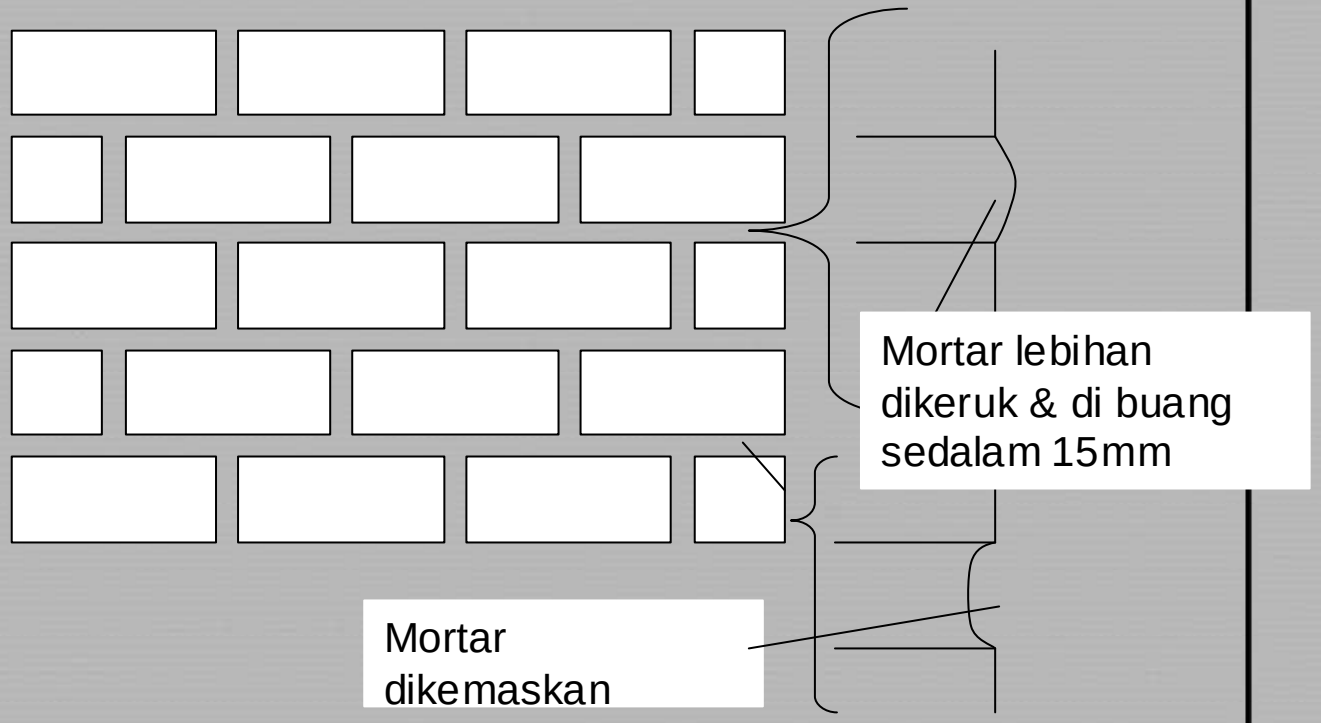
Brick Work

- **Brick laying**
  - Material that was used in mortar (mix of cement or lime with sand or both
  - Ratio; binder : sand = 1:3
  - Thickness or mortar normally in range 6.5mm - 9mm



Brick Work

- Brick lying finishing: Normally, brick lying will followed by brick lying finishing. The objective is to get good appearance or good finishing to brick lying joint.
- It can be make slowly without fully complete or after it complete



Brick Work

- **Plastering**
  - These have been done after brick lying finishing. The purpose is to get a smooth surface and uniformity in color. The wall should scratch to get a rough surface that will easy when plastering work
  - Materials that was used : lime, cement Portland, gypsum
  - Plastering work should be in two layers, which one base layer and finishing layer.
  - Base layer ; cement :Lime : sand = 1:2:8-9 @ 1:1: 5-6 @ cement : sand = 1:3 @ gysum : sand = 1:1-3 @ gypsum : lime : sand = 1:3:7-9
  - Finishing layer; lime : gypsum = 1: 0.25 - 0.5

Photo advantages of brick

Walk way

Decorative of brick work

Photo advantages of brick