9. CLAY BRICKS
• Introduction

Building units which are easily handled with one hand. By far the most widely used size at present is the brick of 300 mm x 200 mm x 100 mm (length, width, depth).

The basic ingredient of brick is clay, which has specific properties:
- It must have plasticity when mixed with water, so that it can be molded or shaped
- It must have sufficient tensile strength to keep its shape after forming
- Clay particles must fuse together when subjected to sufficiently high temperatures.
Clay occurs in three principal forms, all of which have similar chemical compositions but different physical characteristics:

- **Surface Clay:**
  As the name implies, they are found near the surface of the earth.

- **Shales:**
  They are clays, which have been subjected to high pressure until they have become relatively hard.

- **Fireclay:**
  Fireclays are found at deeper levels than the other types and usually have more uniform physical and chemical qualities. Their most important characteristic is their ability to withstand high temperatures.
CLAYS

• Clays are complex materials, but basically they are compounds of silica, and alumina with varying amounts of metallic oxides.

• They may be divided into two classes, depending on basic composition:
  – **Calcereous clays**: They contain about 15% calcium carbonate (CaCO$_3$) and burn to a yellowish color.

  – **Noncalciferous clays**: They are composed of silicate of alumina and iron oxide. These clays burn to red or salmon (yellowish-pink), the color depending largely on the iron oxide content (2-10%).
Manufacturing of Bricks

Manufacturing of bricks has seven phases.
• 1-) Mining and storage of raw materials
• 2-) Preparing raw materials
• 3-) Forming units
• 4-) Drying
• 5-) Glazing
• 6-) Burning and cooling
• 7-) Drawing and storing the finished product.
Forming

The first step in forming process is tempering(softening): the mixing of clay with water in a mill (mixer). The amount of water used depends on the method being used to form the units. There are three principal methods in use.

a-) The stiff-mud process:
• Only enough water is used to produce plasticity (12% to 15% by weight).
• The plastic clays go through a machine to remove air pockets and bubbles. This also increase workability and strength.
• The clay is then forced by an auger through a die, which produces a continuous column of clay of the proper size and shape, and at the same time imparts the desired texture to the surface.
• The clay column passes through an automatic cutter which cuts of the proper lengths.
• These are carried by belt to an inspection area, where good units are unloaded onto drier cars, and imperfect ones are returned to the mill for reprocessing.
Forming

• b-) Soft-mud process:
  - Used for making brick only with clays.
  - 20% to 30% water is used in tempering and the bricks are formed in molds.
  - Molds are lubricated by sand or water.

• c-) Dry-press process:
  A process using the least water in tempering (softening), (max. 10 percent).
  The relative dry mix is fed to machines which form the bricks in steel molds under high pressure, much the same way which concrete blocks are produced.
Drying

• When the units come from the forming machines, they contain from 7 to 30 percent moisture (Green Bricks). Most of that moisture is removed in drying process.
• Drying may be in natural or kiln driers.
• Natural drying is very rare today. Today's system of drying is by drier kilns.
• Drier kiln temperature: 38 to 204°C,
• Drying time: 24 to 48 hours, depending on the type of clay.
• Drying causes shrinkage, which must be allowed for when the bricks are being formed so that the finished product will be the proper size.
• Heat in kilns is usually provided by the exhaust heat from the burning kilns.
• Heat and humidity are carefully regulated to avoid too-rapid shrinkage.
Glazing

• Usually done at the end of the drying period.
• Ceramic glazing consist of spraying a coating of a mineral ingredients on one or more surfaces of brick.
• The glaze melts and fuses to the brick at a temperature, producing a glasslike coating which is available in almost any color.
Burning & Cooling

• Burning is a very important step in the manufacture of brick.
• The time required: 40 to 150 hours (depending on the type of kiln, the type of clay, the type of glaze).
• Kiln types: tunnel kilns and periodic kilns.
• In the tunnel kiln, dried bricks pass through various temperature zones on special cars.
• In periodic kilns the temperature is varied periodically until the burning is completed.
• Fuel: natural gas, oil, or coal.
• Burning may be divided into six general steps;
  – water-smoking or evaporation of free water (Temperature=204 C),
  – Dehydration (Temperature=149-982 C),
  – Oxidation (Temperature=538-982 C),
  – Vitrification (Temperature=871-1315 C),
  – Flashing,
  – Cooling.
• Near the end of the burning process, the bricks may be flashed to produce color variation.
• This is done by injecting natural gas at the appropriate time or place.
• When extra fuel burns, variations in color are formed throughout the stack of bricks.
• Cooling: 48 to 72 hours, depending on the type of kiln;
  – must be carefully controlled because the rate of cooling has a direct effect on color and because too-rapid cooling will cause cracking in the bricks.
• **Drawing & Storing**
  Drawing is the process of unloading a kiln after the bricks are cool. At this time they are normally stored, graded, packed and taken to storage yards or loaded on trucks for shipment.

• **Types of Bricks**
  There is a wide range of bricks available, varying in the materials used, method of manufacture and form of brick and these are also changes from country to country. Bricks can be classified in three different ways.
Varieties and Functions

1-) **Common:**
   Suitable for general building work but generally of poor appearance.

2-) **Facing:**
   Specially made or selected to give an alternative appearance.

3-) **Engineering:**
   Dense and strong semi-vitreous(nature) to defined limits for absorption and strength.
Qualities

1-) **Internal:**
   Suitable for internal use only.

2-) **Ordinary:**
   Normally sufficiently durable for external use.

3-) **Special:**
   Durable in situations of extreme purposes.
Types

1-) Solid:
   Not more than 25% small holes of volume of brick.

2-) Perforated:
   Small holes exceeding 25% of volume.

3-) Hollow (big holes):
   Larger holes, exceeding 25%.

4-) Cellular:
   Holes closed at one end, exceeding 20%.
Mortars

• Bricks are bedded in and jointed with mortar.

• A good mortar spreads easily, remains plastic while bricks are being laid to provide a good bond between bricks and mortar.

• Resists frost and acquires early strength, particularly in winter.

• Mortars should not be stronger than necessary, as an excessive strong mortar concentrates the effects of any differential movements in fewer and wider cracks.
The types of mortars are as listed below:

1. Lime Mortar
   This mortar was used in past. It is composed of one part of lime to three parts of sand (1 lime : 3 sand). With the advent of cement its use diminished.

2. Cement Mortar
   A mix of (1 cement : 3 sand) cement to sand is workable but too strong for or every day use.
   It would be suitable for heavily loaded brickwork or in extremely wet situations.
   The sand should be clean and well graded.
3. Cement Lime Mortar
   Most useful for general purposes.
   Utilized to produce a mortar which has good working, water retaining and bonding qualities, and also develop early strength without an excessive high mature strength.

4. Air Entrained Mortar
   Provides an alternative to lime for improving the working qualities of lean cement-sand mixes.
   Hence, a 1:6 cement-sand mortar gauged with plasticiser is a good alternative to a 1:1:6 cement-lime-sand mix.
Properties of Brick and Brickwalls

Color

The color of a burned brick depends on its chemical composition, the heat of the kiln and the method used to control the burning.

All clays containing iron will burn red if exposed to an oxidizing fire.

If clay is underburned salmon (orange-pink) colors are produced.

Overburning produces dark red bricks.
Texture

Texture is produced by the surface treatment of clay and is given as it leaves the die (forming unit).

Size

Most clays shrink during drying and burning, from 4.5 to 15 percent, and allowances are made for this when the units are molded.

Shrinkage will vary, depending on the composition of the clay, its fineness, the amount of water added, and the kiln temperature.

As a result, absolute size uniformity is possible, and consequently specifications normally include permissible variations in size.
Strength of Bricks

The considered strength of bricks are compression, tension and shear strength. In different standards, they are given.

Water absorption of brick

The water absorption of brick is defined as the weight of water, expressed as a percentage of the dry weight, which is taken up under a given test method.

The water is taken in through the pores which act as capillaries to suck water into the unit.

This initial rate of absorption or suction, of a brick has an important effect on the bonding between brick and mortar.

Test indicate that maximum bond strength is obtained when suction rate at the time of laying is about \(20 \text{ g/min}\).
Table 1: TS 705 Specification Requirements for Factory Bricks

<table>
<thead>
<tr>
<th>Classes of Bricks</th>
<th>Types of Bricks</th>
<th>Type No</th>
<th>Symbols of Bricks$^{(1)}$</th>
<th>Highest Average Bulk Weight (kg/dm$^3$)</th>
<th>Average Compressive Strength$^{(3)}$ (kgf/cm$^2$)</th>
<th>Lowest Compressive Strength$^{(3)}$ (kgf/cm$^2$)</th>
<th>Highest Total Hole Area (%)</th>
<th>Marks on the Brick</th>
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<td>Solid Brick</td>
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TOTAL 24
7. Clay Bricks
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