Metals, Introduction

- In the materials world we are living in, when making a new device/component, most often we come across a very familiar problem. This is nothing but select the right material. Selection of material can play very important role preventing failures. Selection of material for a specific purpose depends on many factors. Some of the important ones are: strength, ease of forming, resistance to environmental degradation, etc. Another dimension an engineer should be aware of it is how to tailor the required properties of materials.
- Materials can be are broadly classified as metals, ceramics, plastics etc. A solid material which is typically hard, shiny, malleable, fusible, and ductile, with good electrical and thermal conductivity (e.g. iron, gold, silver, and aluminium, and alloys such as steel) is called a metal.

Metals, Types

Types of metals and alloys:

Metallic materials are broadly of two kinds – *ferrous* and *non-ferrous* materials. Ferrous materials are those in which iron (***Fe***) is the principal constituent. All other materials are categorized as non-ferrous materials. Another classification is based on their formability. If materials are hard to form, components with these materials are fabricated by casting, thus they are called *cast alloys*. If material can be deformed, they are known as *wrought alloys*. Materials are usually strengthened by two methods – *cold work and heat treatment or hot rolled*. Strengthening by heat treatment involves either precipitation hardening or martensitic (a scientist) transformation, both of which constitute specific heat treating procedure. When a material can not be strengthened by heat treatment, it is referred as non-heat-treatable alloys.

Metals, *Ferrous materials*

Ferrous materials are produced in larger quantities than any other metallic material. Three factors account for it:

(a) availability of abundant raw materials combined with economical extraction, (b) ease of forming and (c) their versatile mechanical and physical properties.

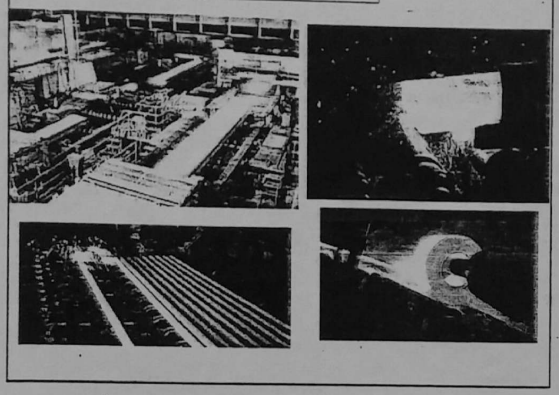
One main drawback of ferrous alloys is their environmental degradation i.e. poor corrosion resistance. Other disadvantages include: relatively high density and comparatively low electrical and thermal conductivities. In ferrous materials the main alloying element is carbon (C). Depending on the amount of carbon present, these alloys will have different properties, especially when the carbon content is either less/higher than 2.14%. This amount of carbon is specific as below this amount of carbon, material undergoes eutectoid (from one phase to other) transformation, while above that limit ferrous materials undergo eutectic transformation. Thus the ferrous alloys with less than 2.14% C are termed as *steels*, and the ferrous alloys with higher than 2.14% C are termed as *cast irons*.

Metals, *Steel*

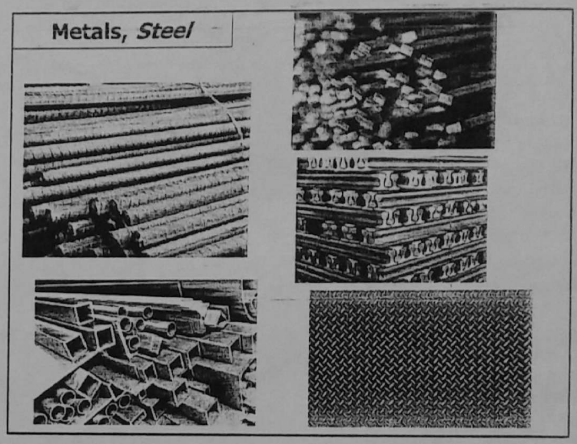
Steels are alloys of iron and carbon plus other alloying elements. In steels, carbon present in atomic form, and occupies interstitial sites of Fe microstructure. Alloying additions are necessary for many reasons including: improving properties, improving corrosion resistance, etc. Arguably steels are well known and most used materials than any other materials. Mechanical properties of steels are very sensitive to carbon content.

Hence, it is practical to classify steels based on their carbon content. Thus steels are basically three kinds: low-carbon steels (% wt of $C < 0.3$), medium carbon steels ($0.3 <$% wt of $C < 0.6$) and high-carbon steels (% wt of $C > 0.6$). The other parameter available for classification of steels is amount of alloying additions, and based on this steels are two kinds: (plain) carbon steels and alloy-steels.

Metals, *Steel*



Metals, *Steel*



Metals, *Steel types*

Low carbon steels: These are arguably produced in the greatest quantities than other alloys. Carbon present in these alloys is limited, and is not enough to strengthen these materials by heat treatment; hence these alloys are strengthened by cold work. Their microstructure consists of ferrite and pearlite, and these alloys are thus relatively soft, ductile combined with high toughness. Hence these materials are easily machinable and weldable. Typical applications of these alloys include: structural shapes, tin cans, automobile body components, buildings, etc.

Medium carbon steels: These are stronger than low carbon steels. However these are of less ductile than low carbon steels. These alloys can be heat treated to improve their strength. Usual heat treatment cycle consists of austenitizing, quenching, and tempering at suitable conditions to acquire required hardness.

Metals, *Steel types*

- They are often used in tempered condition. As hardenability of these alloys is low, only thin sections can be heat treated using very high quench rates. Ni, Cr and Mo alloying additions improve their hardenability. Typical applications include: railway tracks & wheels, gears, other machine parts which may require good combination of strength and toughness.
- High carbon steels: These are strongest and hardest of carbon steels, and of course their ductility is very limited. These are heat treatable, and mostly used in hardened and tempered conditions. They possess very high wear resistance, and capable of holding sharp edges. Thus these are used for tool application such as knives, razors, hacksaw blades, etc. With addition of alloying element like Cr, V, Mo, W which forms hard carbides by reacting with carbon present, wear resistance of high carbon steels can be improved considerably.

Metals

The name comes from their high resistance to corrosion i.e. they are rust-less (stain-less). Steels are made highly corrosion resistant by addition of special alloying elements, especially a minimum of 12% Cr along with Ni and Mo. Stainless steels are mainly three kinds: ferritic & hardenable Cr steels, austenitic and precipitation hardenable (martensitic, semi-austenitic) steels. This classification is based on prominent constituent of the microstructure. Typical applications include cutlery, razor blades, surgical knives, etc.

Cast irons:

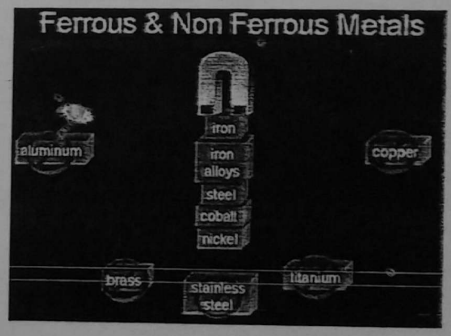
- Though ferrous alloys with more than 2.14 wt.% C are designated as cast irons, commercially cast irons contain about 3.0-4.5% C along with some alloying additions. Alloys with this carbon content melt at lower temperatures than steels i.e. they are responsive to casting. Hence casting is the most used fabrication technique for these alloys.

Non-ferrous Metals

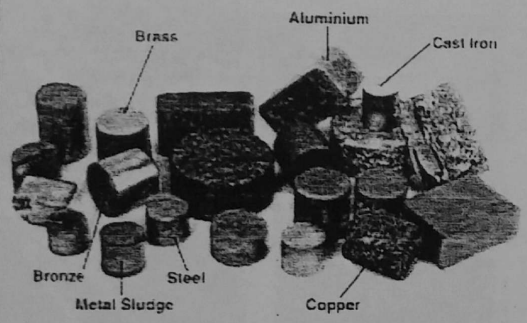
Non-ferrous Metals, Introduction

- Ferrous metals (that contain iron, such as steel and tin) have less value than nonferrous metals. The nonferrous metals are nonmagnetic, and are processed differently than their ferrous-cousins. These metals include brass, copper, lead and zinc.
- Non-ferrous metals have lesser or no iron in them. Therefore they do not rust and cannot be picked up by magnets.

Ferrous and Non-ferrous Metals,



Non-ferrous Metals, Introduction



Non-ferrous Metals, properties

NON-FERROUS METALS

- Non-ferrous metals, or metals without significant iron content, are also strong. However, they are lighter than ferrous metals and cannot suspend similar loads. They are more malleable as well, and both traits can be an advantage.
- They were the first metals to be used in the art of metallurgy. Silver, copper and gold have been collected and used since ancient times as currency, jewelry, weapons and architectural components.
- The lightweight quality of nonferrous metals like copper, tin, aluminum, brass and lead has its advantages. It is far more malleable, thus greater potential to restructure and make new metals is more possible. It still has good tensile strength even though it is lighter.

Non ferrous metals

Non-ferrous materials have specific advantages over ferrous materials. They can be fabricated with ease,relatively low density, and high electrical and thermal conductivities. However different materials have distinct characteristics, and are used for specific purposes. This section introduces some typical non-ferrous metals and their alloys of commercial importance.

- Other advantages of this metal are its high conductivity of electrical current (i.e. copper), its resistance to corrosion (i.e. zinc) and its near immunity to magnetic force.
- These metals are either transformed into finished products or intermediary metals. Deformation processes like rolling, extruding and forging transmit the intermediary metal to a finished product.

Non-ferrous Metals and alloys, Types

NON-FERROUS METALS

- Aluminium
- Copper
- Tin
- Duralumin
- Brass
- Bronze
- Lead
- Zinc

Non-ferrous Metals, Introduction

POPULAR NON-FERROUS METALS
-Aluminum :
Second most widely used metal after steel in construction; it is lighter in weight, good conductor of electricity and heat; greyish-white; easy to cut and machine
Uses: cooking foil, drink cans, overhead power cables, casings and panels for electrical goods, road signs etc

Aluminium is malleable, ductile and a powerful heat and electricity conductor. Found in many household items. Piping, bike frames, baseballs bats and siding are examples.

Non-ferrous Metals, Aluminium alloys

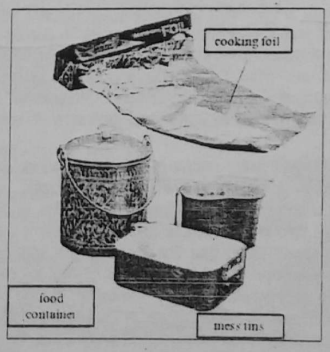
Aluminium alloys:

- These are characterized by low density, high thermal & electrical conductivities, and good corrosion resistant characteristics. As Al has crystal structure, these alloys are ductile even at low temperatures and can be formed easily.
- However, the great limitation of these alloys is their low melting point (660°C), which restricts their use at elevated temperatures. Strength of these alloys can be increased by both cold and heat treatment – based on these alloys are designated in to two groups, cast and wrought.

Non-ferrous Metals, Aluminium alloys

- Chief alloying elements include: Cu, Si, Mn, Mg, Zn. Recently, alloys of Al and other low-density metals like Li, Mg, Ti gained much attention as there is much concern about vehicle weight reduction. Al-Li alloys enjoy much more attention especially as they are very useful in aircraft and aerospace industries.
- Common applications of Al alloys include: beverage cans, automotive parts, bus bodies, aircraft structures, etc. Some of the Al alloys are capable of strengthening by precipitation, while others have to be strengthened by cold work or solid solution methods.

Non-ferrous Metals, Aluminum

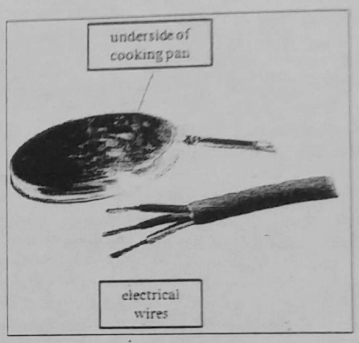


Non-ferrous Metals, Copper

Copper
Used in various alloys. It is a great conductor. It is malleable and soft. It is used in electric motors, wiring, currency, architecture like the Statue of Liberty and sheathing for ships.

Properties: reddish-brown; ductile, malleable; can be cut sawn, filed and machined easily; excellent conductor of heat and electricity
Uses: electrical fitting and wires, printed circuit boards, tips of soldering iron, domestic water pipes, cylinders, cooking utensils, decorative ornaments

Non-ferrous Metals, Copper



Non ferrous metals

Copper alloys: Bronze is the major alloy of copper that has been used for thousands of years. It is actually an alloy of Cu and Sn. Unalloyed Cu is soft, ductile thus hard to machine, and has virtually unlimited capacity for cold work. One special feature of most of these alloys is their corrosion resistant in diverse atmospheres. Most of these alloys are strengthened by either cold work or solid solution method.

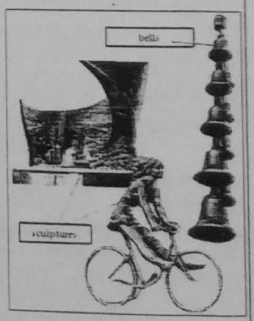
- Common most Cu alloys: Brass, alloys of Cu and Zn where Zn is substitutional addition (e.g.: yellow brass, catridge brass); Bronze, alloys of Cu and other alloying additions like Sn, Al, Si and Ni. Bronzes are stronger and more corrosion resistant than brasses. It is worth mentioning that Beryllium coppers that are possessing the combination of relatively high strength, excellent electrical, corrosion properties and wear resistance, can be cast, hot worked and cold worked. Applications of Cu alloys include: costume jewelry, coins, musical instruments, electronics, springs, bushes, surgical and dental instruments, radiators, etc.

Non-ferrous Metals, Bronze

Bronze:
This alloy is made of copper and zinc. There are corrosion resistant forms but it is susceptible to seasonal cracking. It is used in brass instruments, ancient art, doorknobs and household fixtures, locks, valves and more.

Properties: made by mixing copper and tin; reddish-yellow, hard-wearing, corrosion resistant, easily machined
Uses:

- ship propellers, bells, gears, bearings, statues



Non-ferrous Metals, Tin

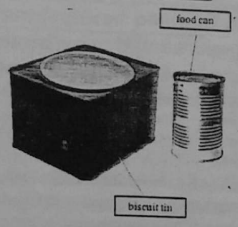
Tin

Properties:

- silvery-white, non-toxic, soft; normally used by plating it onto other metals such as mild steel (tinplate)

Uses:

- food cans, plating on copper tracks of printed circuit boards



Non-ferrous Metals, Zinc

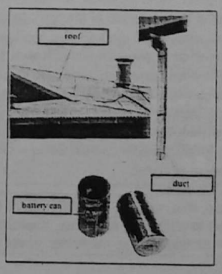
Zinc

Properties:

- silvery-blue, does not corrode easily, ductile, not very strong

Uses:

- manufacture of other metals such as brass and galvanised iron, batteries, rust-proof paints



Non-ferrous Metals, Lead

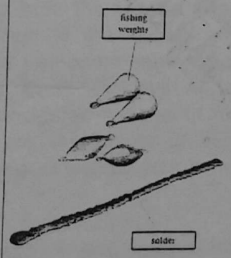
Lead

Properties:

- very heavy, but soft; appears bright and shiny bluish-grey when cut but surface changes quickly to a dull grey; toxic, resistant to corrosion and many chemicals

Uses:

- Can be used to produce high density concrete for radiation shielding purposes around nuclear reactors.
- can be mixed with other materials to make them easier to machine; acts as a protection against x-rays and radiation, core of some batteries



Non-ferrous Metals, Brass

Alloys of copper and zinc are termed brasses. Zinc is added to improve the strength and ductility of the alloy. There are many formulas for brasses which include other alloying elements than copper and zinc. Brass is used in decorative metal products, cartridge cases, piping and tubing, and many of the same application as copper.

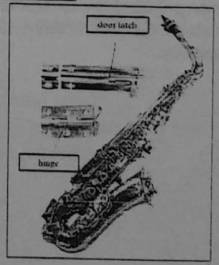
Brass

Properties:

- good conductor of heat and electricity, golden yellow alloy, easy to machine and solder, made by mixing copper and zinc

Uses:

- pins of electrical plugs, nuts, bolts, screws, hinges, some machine parts, musical instruments, decorative artifacts, locks, keys



Non-ferrous Metals, Silver

Silver

Silver also finds application in photographic films and papers. At one time, it was used to plate mirrors. It is now used in the manufacture of photochromatic lenses. Photochromatic lenses darken when exposed to ultraviolet light. Silver is also used in brazing alloys and long-life batteries. Silver fulminate ($Ag_2C_2N_2O_2$) is used as an explosive. Silver and silver compounds are found in many creams, ointments, and salves used for medicinal purposes. Silver iodide has been used to seed clouds to make rain.

Like gold, this precious metal is a great conductor and very resistant to corrosion, elements, chemicals and temperature. It is used in natural energy, medicine, jewelry and fine china.

Non-ferrous Metals, Platinum

Platinum

Platinum is found in a group of six metals extracted from nickel ores -- iridium, osmium, palladium, rhodium, ruthenium, and platinum. Of these, platinum has the most widespread application. It is used in corrosion-resistant coatings, as a catalyst for chemical reactions, high-resistance furnace wire, and in catalytic converters. A large percentage of platinum is used in laboratory equipment, medical instruments, and fine jewelry. Platinum is more expensive per pound than gold.

Non-ferrous Metals, Gold

--Gold

This rare, precious and highly sought after metal is extremely resistant to corrosion, heat, pressure and elements. Because it withstands heat and chemical reactions, and because it is so malleable and soft it is commonly used in electrical connectivity.

Tiles & Terra cotta

Tiles, Terra-cotta tiles

- ***A tile is a natural or manufactured piece of hard-wearing material that could generally be used for covering, protection and/or decorating finished or unfinished surfaces like roofs, floors, walls, ceilings, facades, slabs, etc.***"
- ***Terra-cotta,*** meaning "fired earth", is a clay product which has been used for architectural decorative purposes since the days of ancient Greece and Rome. Modern terra-cotta is machine extruded and moulded or pressed. The machine made product, usually refer to as a ceramic veneer, is a unit with flat face and flat or ribbed back. The moulded or pressed units, called architectural terra-cotta, are available in sculptured, as well as plain faces.

Tiles, Terra-cotta tiles

Tiles are important items used to provide surface furnishing to floors and walls. They also serve in accessorising the look of the entire household. No residential or commercial project will be complete without the help of tiles.
These items are highly favoured because of the aesthetical and functional contributions they deliver to every viewer.

Tiles, Terra-cotta tiles

Tiles do serve as protective coverings to the floors and walls in your home - starting from the facade going straight to the living room then to the kitchen and dining areas. Bathrooms and bedrooms show much beauty with the presence of these overlays At an overall viewpoint, tiles are considered as one of the most favourite materials to provide beauty to your kitchen and bathroom renovation as well as your home construction.

Basic types of tiles:

The classification presents an idea of how each of the subcategories is made and why they are favoured. Take a look at the following basic types of tiles.

Tiles, Terra-cotta tiles

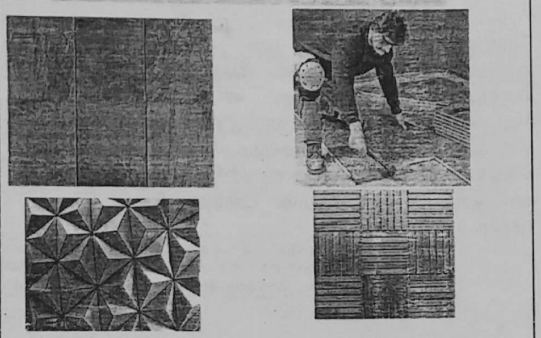
Earthenware tiles:

These are the tiles that comprise of fired /baked tiles made from mud, clay & earth (soil). These tiles are quite porous in nature and are often used indoors. Ancient (earlier) types of such tiles were also called Terracotta tiles.

Wooden tiles --

These are made out of original (raw) wood, manufactured ply boards, artificial wood, etc. and are used for all kind of ceilings, floors, claddings, etc.

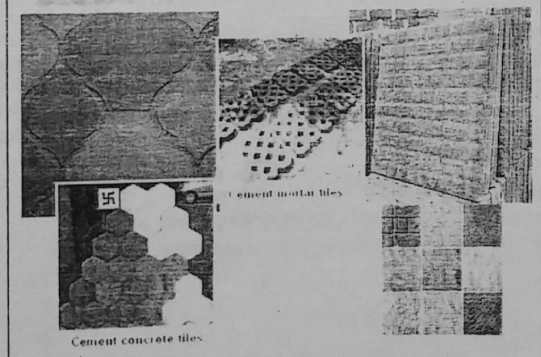
Earth tiles--Wooden tiles



Tiles, Terra-cotta tiles

Cement / Concrete tiles -- These are the tiles that are made from cement mortar and/or cement concrete along with certain admixtures, coloring agents and patterns. Most commonly used cement tiles are the checkered & pattern tiles that are used to furnish the walkways, driveways, parking, open public areas and the likes. These tiles are used for heavy public traffic areas due to their higher ruggedness.

Cement concrete tiles



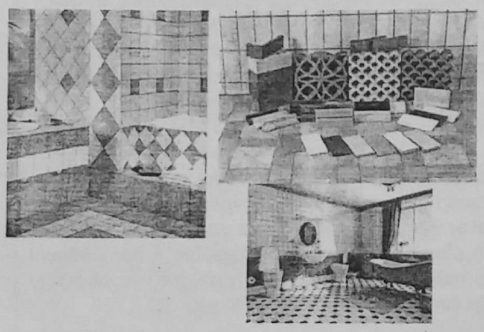
Tiles, Terra-cotta tiles

Ceramic tiles: This is perhaps one of the most popular choices amongst all types of tiles. It is made out of the combination of sand, gypsum and shale. These three items form into clay.

Bisque (smooth, creamy, highly seasoned soup of French origin) is utilised in order to shape the clay and form the ceramic tiles. The higher the temperature in the bisque, the more durable the output will be.

Since the output is kind of porous, glazing is usually needed. The glaze adds up to the beauty of the output. From there, the ceramic tile is formed into different designs and colours.

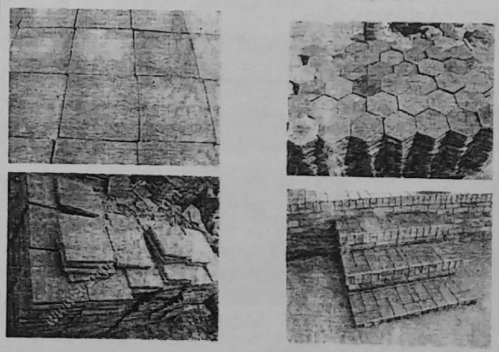
Ceramic tiles



Tiles, Terra-cotta tiles

Quarry tiles. Traditionally, this type of tile is made out of materials from quarrying operations such as mining and excavation. This is the reason why it got such a name. With the conventional technique in producing quarry tiles, there are three processes involved namely cutting, grinding and polishing. Nowadays, manufacturers make use of the extrusion method to process a glasslike material that turns out to be as hard as stone. This type of tile is highly favourable as flooring materials but not for kitchen countertops or any other surfaces where food preparation is being done.

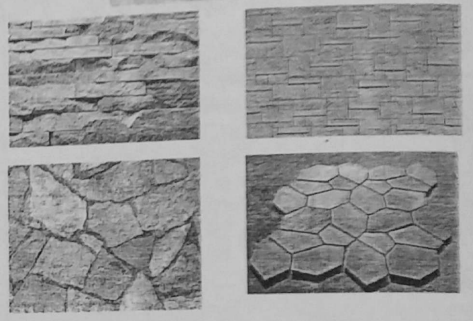
Quarry tiles



Tiles, Terra-cotta tiles

Stone tiles. Basically, most stone tiles are made out of granite. Therefore a lot of manufacturers sell these materials as granite tiles. These materials have been given much recognition in the market The cognisance (awareness) extended to the tiles was not enough to overlook its disadvantages. It is porous thus it needs polishing from time to time. It cracks easily and cannot withstand high temperature. Despite all these however, natural stone stands out to be a good choice. Because natural stone is variegated - meaning it has different colour patches - these tiles have the capability to provide innate accents to your home.

Stone tiles

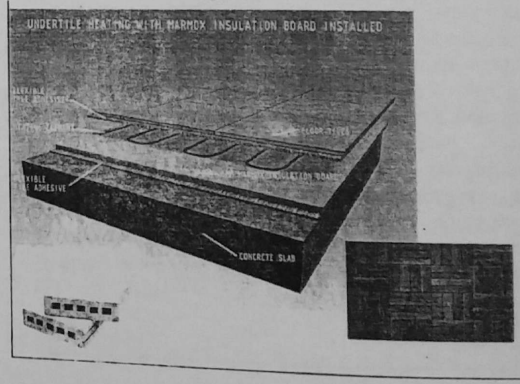


Tiles, Terra-cotta tiles

Insulating / Anti-static tiles --
These tiles are made with composite soundproofing compounds like asbestos, gypsum, mineral wool boards, PVC, rubber, etc. and are usually used to insulate closed spaces from intruding sounds & heat. Such tiles are used as false ceilings, partition panels, in-fills, and even under floors.

Wooden tiles --
These are made out of original (raw) wood, manufactured ply boards, artificial wood, etc. and are used for all kind of ceilings, floors, claddings, etc.

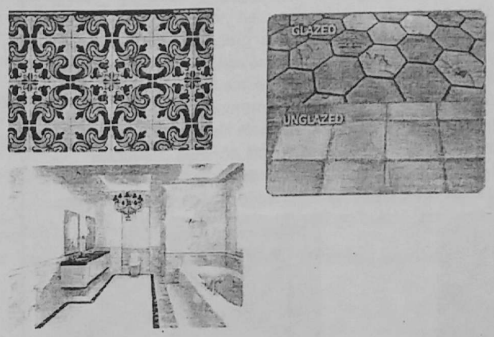
Insulating tiles, Wood tiles



Tiles, Terra-cotta tiles

Ceramic tiles, Glazed tiles, Vitrified tiles, Homogenous vitrified tiles – Ceramic, Glazed, Vitrified, Homogenous vitrified tiles are nothing but modified, modern, composite and bettered forms of Earthenware, Stoneware and Porcelain tiles, all put together. The inner core of these tiles are made from baked & burnt earthen material that are processed under high heat, pressure and special techniques so as to flux them with minerals, alloys and suitable composite materials that provide a hard wear-proof coating surface on one side, having glossy or matt finish.

Glazed tiles

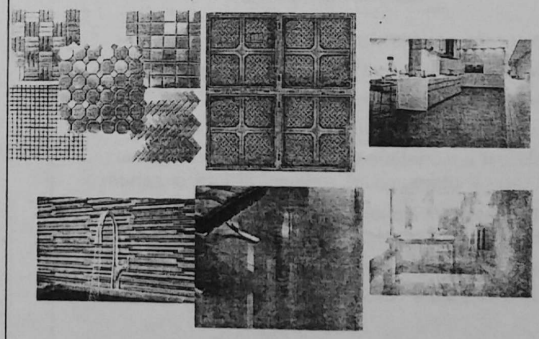


Tiles, Terra-cotta tiles

Metal tiles: Again as the name suggests, these are the tiles made from metals, alloys and/or composite materials like colored aluminum tiles, galvanized iron sheet tiles, stainless steel tiles, etc. These tiles are either snap-fit type or are riveted or tack welded to the parent frame. These are mostly used as decorative-cum-functional false ceilings and wall claddings.

Porcelain tiles: These are the tiles that are made by artificially processing of special porcelain mud/ clay along with minerals like quartz, feldspar and other fluxes under very high pressure and heat. These tiles are very less porous as well as sturdy (well built)due to which these are used in external surfaces also.

Metal tiles, Porcelain tiles



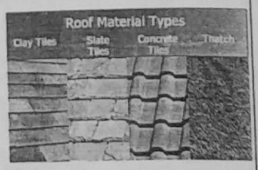
Glass tiles

Glass tiles are pieces of glass formed into consistent shapes. Since the 1990s a variety of modern glass tile technologies, including methods to take used glass and recreate it as 'green' tiles, has resulted in a resurgence of interest in glass tile as a floor and wall cladding. It is now commonly used in kitchens, spas, and bathrooms. And while smalti tiles are still popular, small and large format glass products are now commonly formed using cast and fused glass methods. The plasticity of these last two methods has resulted in a wide variety of looks and applications, including floor tiles.



BRICKS AND CLAY BUILDING TILES

- **The Process Of Production**
- The manufacturing process has the following phases:
  - Mining of raw material
  - Preparing of raw material
  - Forming units
  - Drying
  - Glazing
  - Burning and cooling
  - Storing



Basic !ngredients

- Basic content of bricks, tiles and ceramic is clay.
- Clays are produced naturally from natural rocks.
- Pure clay is mainly silica and alumina.
- It is made up of certain minerals, chiefly feldspar.
- Feldspar is a crystalline mineral made up of alumin silicates with potassium, sodium, calcium, or barium.
- Fine clays have higher percentages of aluminium silicates, flint and feldspar.
- Clay grains are usually smaller than 0.002 mm.
- Pure clay usually has white colour.

Basic Ingredients

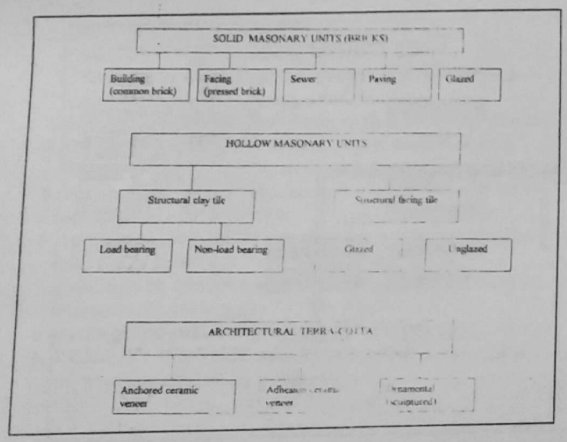
- The different characteristics of these materials make possible the great variety of clay products that we have today.
- Clay is normally dug from the ground. But its composition may differ from place to place.
- Clay is ground in miles, mixed with water to make it plastic and moulded, either by hand or machine, to the shape and size of a brick.
- Clay is ground in miles, mixed with water to make it plastic and moulded, either by hand or machine, to the shape and size of a brick.
- Bricks that are shaped and pressed by hand in a sanded wood mould and dried, and fired. These type of bricks have a sandy texture.

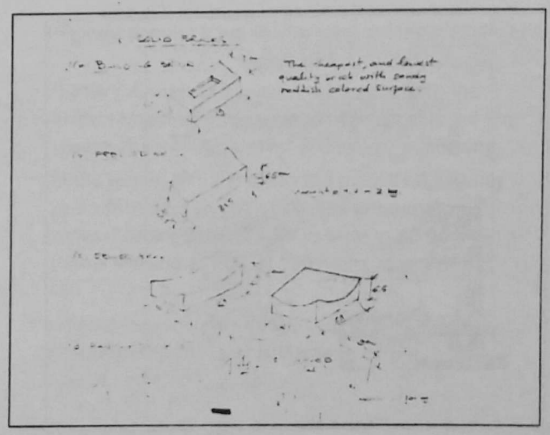
Basic Ingredients

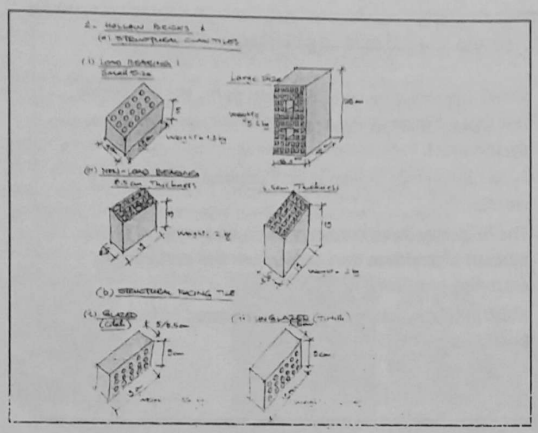
- Machine made bricks are either hydraulically pressed in still moulds or extruded as continuous band of clay in the form of a ribbon or column.
- The thickness and width of the ribbon is the same as the dimensions of the brick being produced.
- Wires are used to cut the ribbon to lengths desired. Bricks made this way are called wire-cuts.
- Press moulded bricks generally have a frog or indent.Therefore, the bricks are placed in a draying kiln for 24 to 48 hours.
- They may, on the other hand, be allowed to air dry.
- temperature.

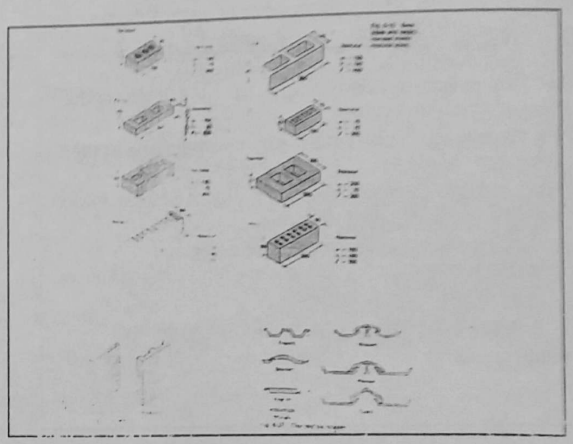
Basic Ingredients

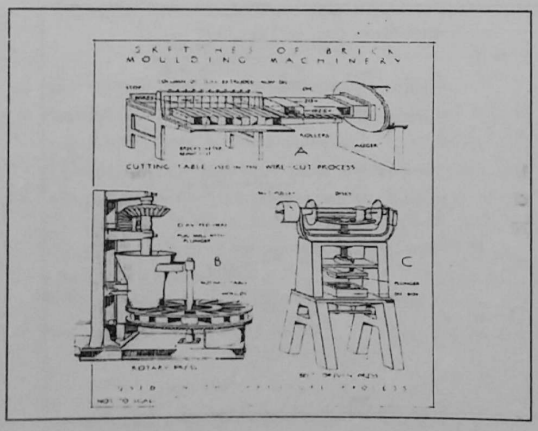
- When the moisture conditions are right, the bricks are put into a kiln designed to maintain temperature to a certain level.
- Even distribution of heat is very important for uniform results.
- The brick that have not been fired will contain 5 to 30 percent moisture as they come from the moulding or extruding machines.
- Most of this moisture must be evaporated before the bricks are burnt.

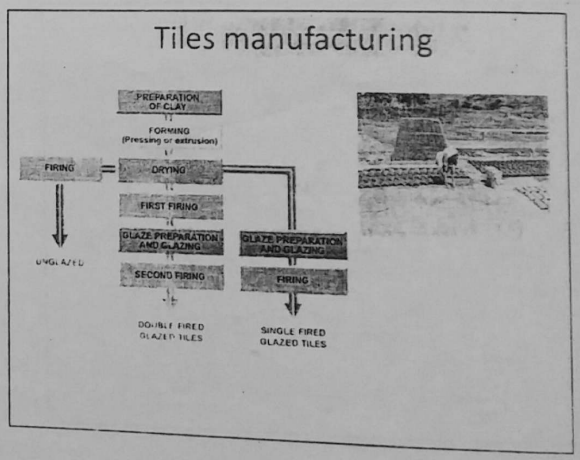




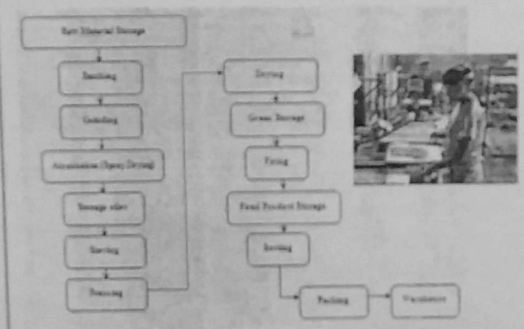




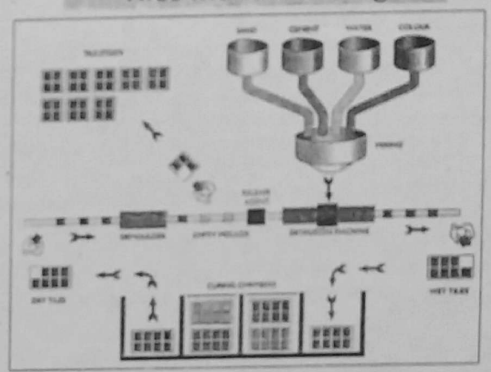




Tiles manufacturing



Tiles manufacturing



Tiles manufacturing

1. The process starts with the choice of raw materials - principally clays, feldspar, sand, etc.
2. Milling takes place in efficient, high technology plants.
3. Pressing into the final shape, which is then glazed.
4. Drying is carried out in horizontal dryers using hot air.
5. Glazing and decorating, using the latest generation of equipment, enabling us to achieve natural designs.
6. Firing in roller kilns burning natural gas, to guarantee that the product will have the best properties.
7. Selection by trained personnel using criteria based on international standards.
8. Packing and palletizing is fully automated.
9. A QUALITY CONTROL system is applied to all stages of the tile manufacturing process.

The most popular types of kilns used are the periodic and tunnel kilns

- Primary difference between the two is that, the bricks remain stationary in the periodic kiln and the temperature is changed for each stage of burning.
- In the tunnel kiln, the bricks are placed on moving cars which pass through different temperature zones. Burning time may be as little as 50 hours in a tunnel kiln and as long as 150 hours in a periodic kiln.
- Cooling may require over 50 hours. This prevents checking (small cracks) and maintains the right colour.

PROPERTIES OF BRICK UNITS

- All properties of brick are affected by the composition of the raw material used and the manufacturing process involved.
- Those properties include colour, texture, size, strength and absorption rate. The colour 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 it is burned in a reducing atmosphere, the same clay will take on a purple tint, owing to the ferrous silicate content.
- Over burning produces dark red brick.
- Buff clays produce the buff and brown bricks, depending on the temperature of burning.

- Most clays shrink during drying and burning from 4.5 to 15 percent, and allowances are made for this when the units are moulded. 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 impossible, and consequently specifications normally include permissible variations in size. The strength characteristics of brick also vary with the raw materials and the manufacturing processes involved. For example, the compressive strength of brick varies from 10.3 to 137.9 Mpa (60 – 100 kg/cm2).

- Texture is produced by the surface treatment, the clay is given as it leaves the extruding die.
- A smooth texture is produced by the pressure of clay against the sides of the steel die.
- Rough textures may be applied to the clay as it leaves the die.
- These include scored finishes, in which the clay surface is grooved; combed finishes, produce by placing parallel scratches on the surface, and rough-texture finishes, produced by wire cutting or wire brushing the clay surface as it emerges from the die.

CLAY TILE APPLICATIONS

- Much like brick, clay tile is durable and inert and has a wide range of applications. Glazed, it produces a surface that is aesthetically pleasing and easily cleaned. Unglazed, it has a warm appearance that blends in with the surroundings. In applications such as roofing, it will last almost indefinitely. Various shapes and sizes are available, depending on the intended use.