



CLAY **PRODUCTS**

BUILDING MATERIALS II

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CLAY PRODUCTS

Clay products are one of the most important classes of structural materials. The raw materials used in their manufacture are clay blended with quartz, sand, chamatte (refractory clay burned at 1000–1400°C and crushed), slag, sawdust and pulverized coal. Structural clay products or building ceramics are basically fabricated by moulding, drying and burning a clay mass.

According to the method of manufacture and structure, bricks, tiles, pipes, terracotta, earthenwares, stonewares, porcelain, and majolica are well recognized and employed in building construction.

ADVANTAGE : Clay bricks have pleasing appearance, strength and durability whereas clay tiles used for light-weight partition walls and floors possess high strength and resistance to fire.

Clay pipes on account of their durability, strength, lightness and cheapness are successfully used in sewers, drains and conduits.



HEAVY DUTY BURNT CLAY BRICKS : These are similar to burnt clay bricks and of the same size but with high compressive strength.

Classification

Class 400: compressive strength not less than 40.0 N/mm² but less than 45.0 N/mm².
Class 450: compressive strength not less than 45.0 N/mm².

These are further subdivided as subclasses A and B based on tolerance.

Tolerance

| Dimensions (cm) | Tolerances (mm) | |
|-----------------|-----------------|------------|
| | Subclass A | Subclass B |
| 9 | ± 3 | ± 7 |
| 19 | ± 6 | ± 15 |

Water absorption: should not be more than 10 per cent after 24 hours immersion in water

Efflorescence: should be nil.

Bulk density: should be less than 2500 kg/m³.

BURNT CLAY PERFORATED BRICKS : Perforated Bricks contain cylindrical holes throughout their thickness, have high compressive strength and less water absorption. These bricks are light in weight, require less quantity of clay and drying and burning of these bricks is easy and economical. The direction of perforations can be vertical or horizontal. These are used in building walls and partitions. The area of perforations should not exceed 30 to 45% of the area of face. In case of rectangular perforations, larger dimensions should be parallel to longer side of the brick.

These are available in the following sizes.

(i) $19 \times 9 \times 9$ cm.

(ii) $29 \times 9 \times 9$ cm.

(i) Dimension of perforation parallel to short side should not be more than 20 mm in case of rectangular projection and 25 mm in case of circular projection.

(ii) Area of each perforation should not exceed 500 mm².


Compressive strength : *should not be less than 7.0 N/mm².*

Water Absorption : *should not be more than 15 per cent.*

Efflorescence : *should not be more than slight.*

Warpage : *should not exceed 3 per cent.*





BURNT CLAY PAVING BRICK : The iron content is more than that in the ordinary clay bricks. Excessive iron causes vitrification of bricks while burning at a low temperature, gives natural glaze to the brick, making it more resistant to abrasion. Paving bricks can be manufactured from surface clays, impure fire-clays or shale. However, shales are the best raw material for paving bricks. These are generally burned in continuous kiln for seven to ten days.

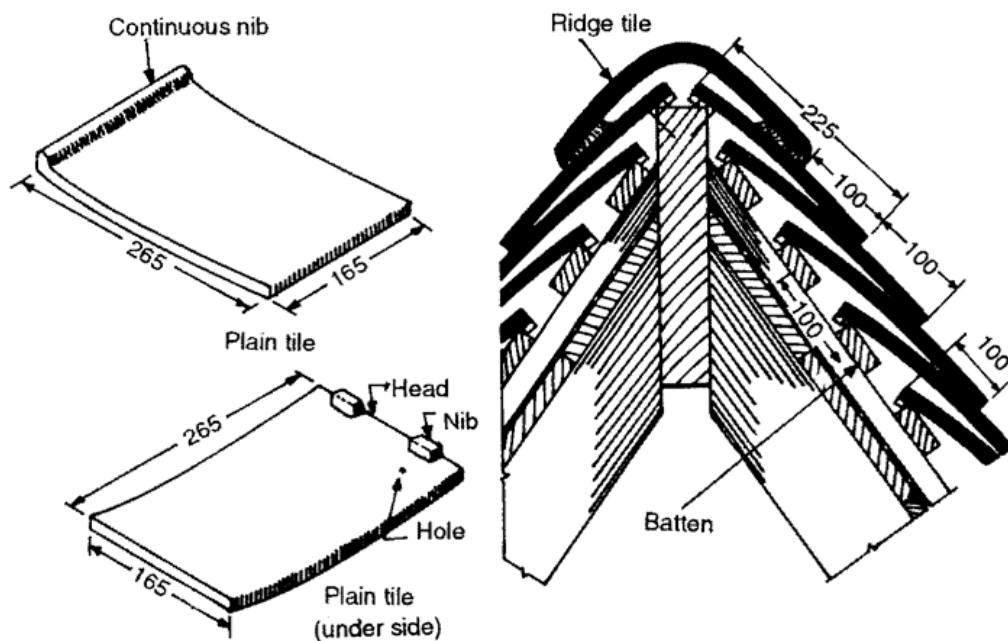
BURNT CLAY HOLLOW BLOCKS : Hollow blocks, also known as cellular or cavity blocks, are manufactured from a thoroughly ground, lump free, well mixed clay mass of medium plasticity to allow moulding. The process of manufacture is similar to that of stiff-mud bricks. These are used to reduce the dead weight of the masonry and for exterior as well as partition walls. They also reduce the transmission of heat, sound and dampness.

BURNT CLAY JALIS : These are normally used for providing a screen on verandah and construction of parapet or boundary walls. Total void area should not exceed 40 per cent. Keys for bonding with mortar should be 10 mm wide and 3 mm deep. These are generally hand moulded but superior qualities can be produced by machines.

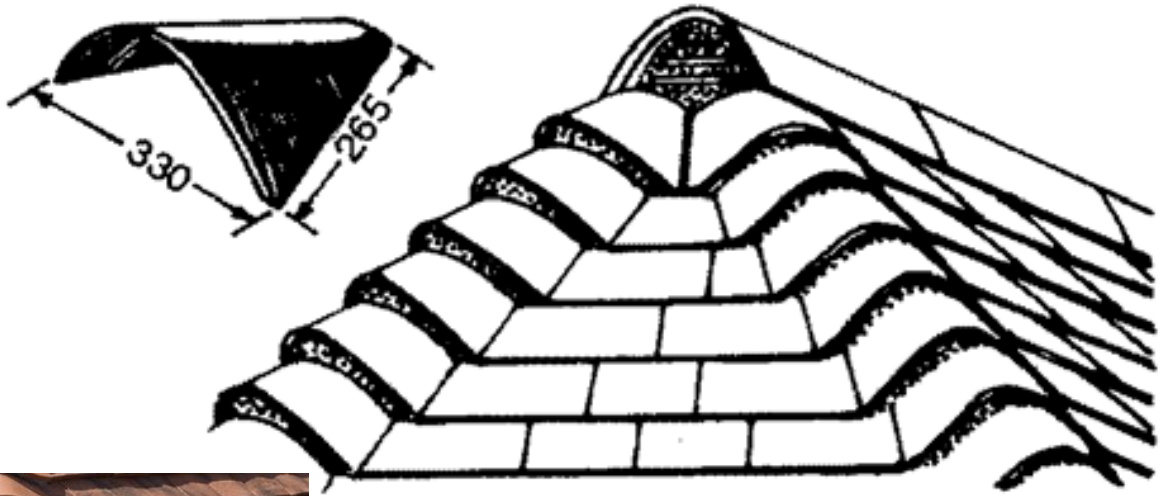
CLAY TILES : Tiles are thin slabs of low melting clays used for various purposes in engineering constructions.

These give a very pleasing appearance and good service properties. Roofing tiles, flooring tiles, wall tiles and partition tiles are some of the examples. Due to the considerable mass, labour consuming manufacture, drainage problems, and appreciable transportation charges, roofing tiles have lost their importance and are recommended locally.

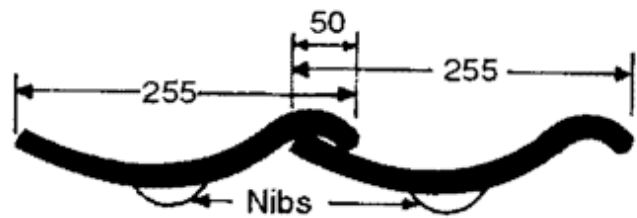
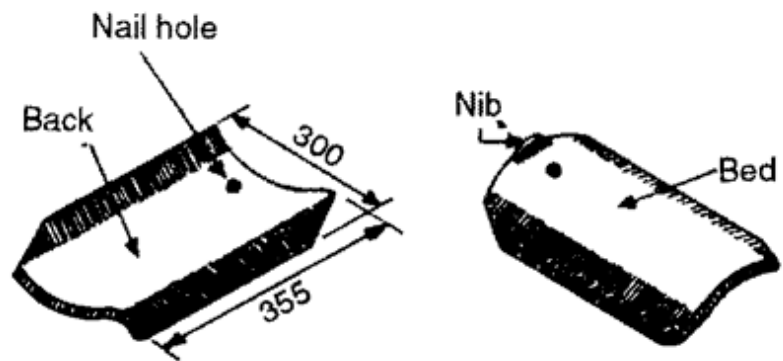
DIFFERENT TYPES OF ROOFING TILES



PLAIN TILE



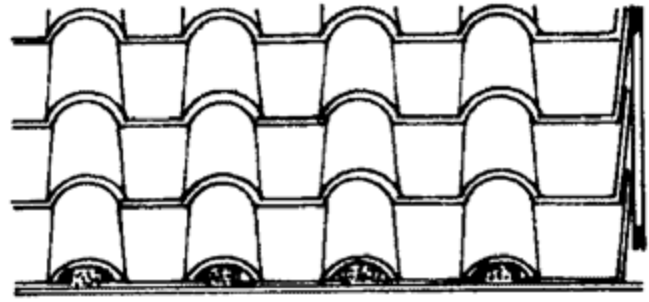
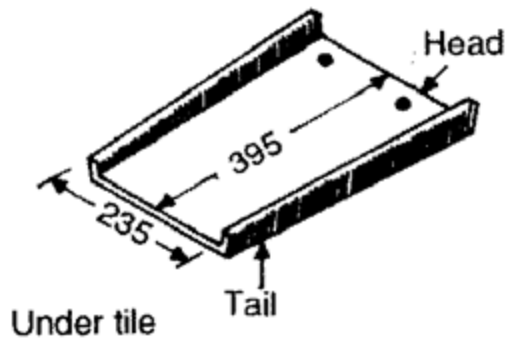
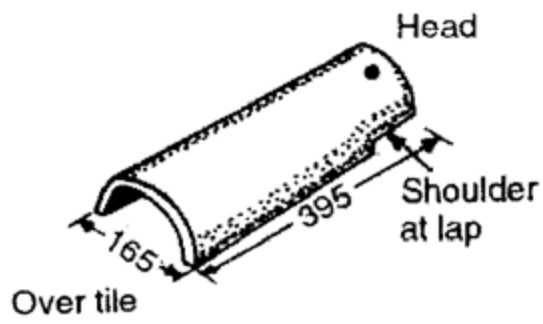
HIP TILE



Section through Two Pan Tiles

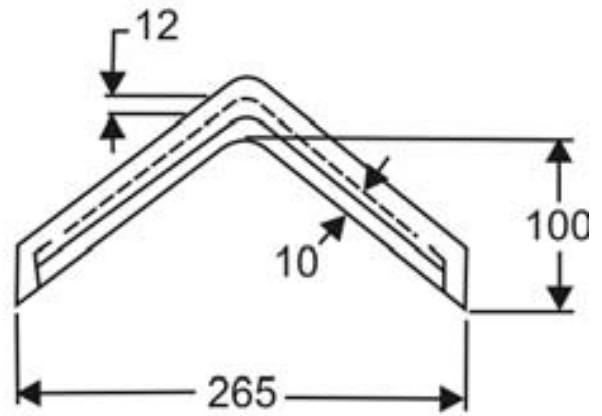
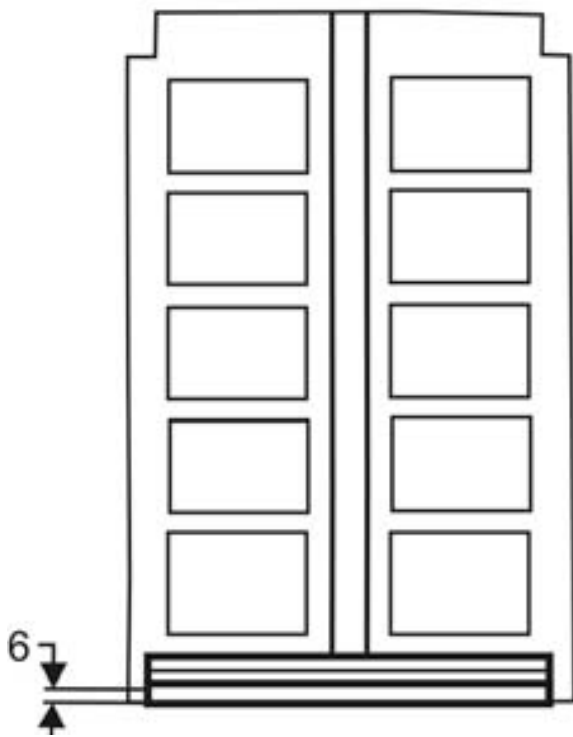
PAN TILE



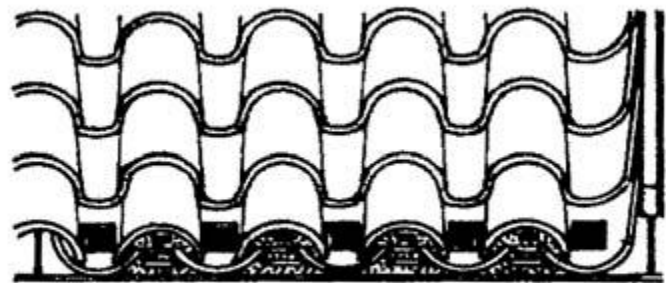
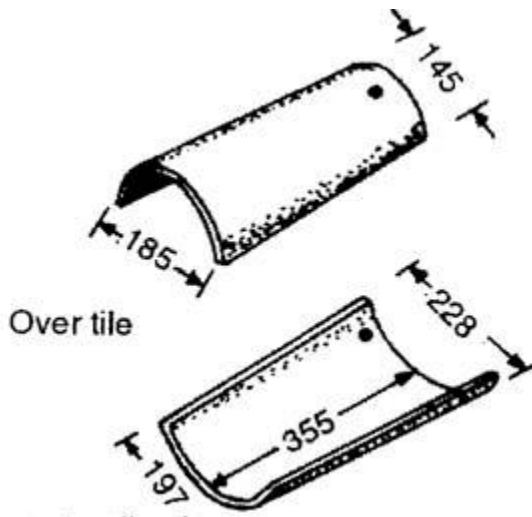


SPANISH TILE

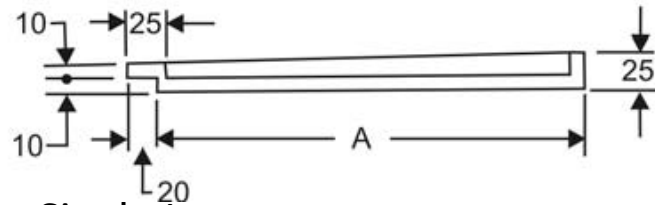
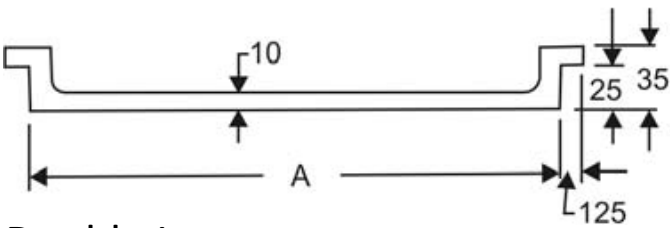
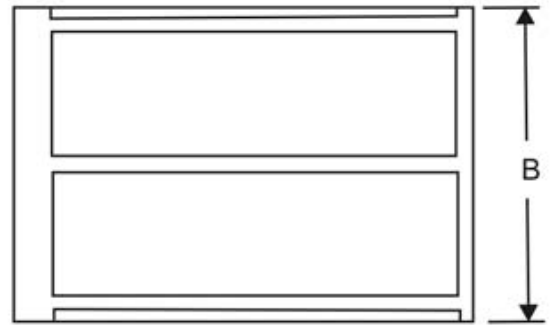




RIDGE TILE



ITALIAN TILE



Double Lug type

Single Lug type



MANUFACTURING OF TILES: Tiles are made in the same manner as bricks, but are thinner and lighter, so require greater care.

These are manufactured from a clay mass with or without admixtures of colouring impurities by moulding and subsequent burning until baked, up to about 1300 °C.

These are moulded in machines and are commonly burned in continues kilns.

CLAY RIDGE AND CEILING TILE

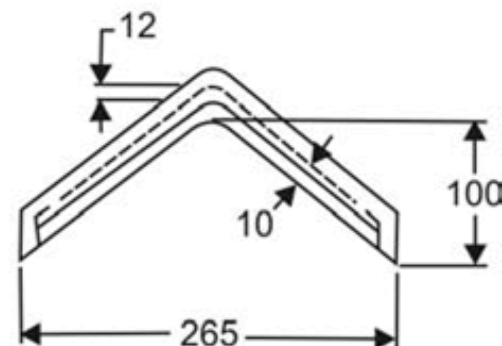
The clay ridge and ceiling tiles are grouped as class AA and also A and should fulfil the following requirements.

| | Class AA | Class A |
|-----------------------------------|--|--|
| 1. Maximum water absorption (%) | 18 | 20 |
| 2. Minimum breaking strength (kN) | 0.015 (average) 0.0125 (individual) | 0.011 (average) 0.0095 (individual) |

The length of the ridge tile measured from face to face excluding the portion containing the catch should be 375, 400 and 435 mm.

When a ridge tiles is placed on a horizontal plane the triangle formed in elevation by producing the inner faces of the tile should have a base of 265 mm and height of 100 mm.

The tiles should be not less than 100 mm thick throughout.



TERRACOTTA :

It is an Italian word, *Terra means clay and Cotta means burnt.*

Terracotta is refractory clay(*retains its strength at high temperatures*) product and is used in ornamental parts of buildings. The clay used for its manufacture should be of superior quality and should have sufficient iron and alkaline matters. By varying iron oxide in clay, desired colour can be obtained.

The clay is mixed with powdered glasses, pottery and sand ground to fine powder and pugged several times till it gets uniform and soft for moulding. Terracotta is impervious, hard and cheap. When properly made the material weathers well and because of its glazed surface can be cleaned easily. The product is burnt in special kilns (Muffle furnace).



TERRACOTTA

PREPARATION :The clay is mixed thoroughly with water in a tub. Powdered pottery, glass and white sand are added to it in sufficient proportions. It is then intimately mixed with spades. The intimate mix is then placed in wooden boxes with joints. This allows the surplus water to drain off. Thereafter the mix is passed several times through pug mills.

MOULDING AND DRYING :Special porous moulds are made of Plaster of Paris or of zinc. The pugged clay is pressed into moulds. The dried articles are taken out of the moulds after a few days and then dried slowly.

BURNING : Terracotta is burned with care to get uniform colour in muffle furnace between 1100–1200°C.

USES

1. Hollow blocks of terracotta are used for masonry.
2. Cornices and arches.
3. Statuettes.
4. Ornamental works.
5. Being fire proof, terracotta is most suitable as casing for steel columns and beams.
6. Porous terracotta is used for sound insulation.

Terracotta is of two types, the porous and the polished.



POROUS TERRACOTTA : It is manufactured by mixing sawdust or finely fragmented cork in the clay and has the following characteristics.

1. Light weight.
2. Resistant to weathering action.
3. Fire resistant.
4. Can be nailed and sawn to various shapes.
5. Sound proof.
6. Poor strength—used only for ornamental works.



POLISHED TERRACOTTA is highly glazed architectural terracotta with relatively coarse body. These are made from refractory clays with addition of quartz sand and fusing agents such as chalk. The polished terracotta is also called terracotta twice burnt. The 1st burning is called biscuiting and is done at 650°C . Then, this product is coated with glazed solution which imparts texture and colour. Thereafter it is dried and fired at 1200°C .

The material :

1. is hard, strong and durable.
2. can be given different colours.
3. is leak proof and can be easily cleaned.
4. is resistant to chemical action.
5. is resistant to weathering action of atmosphere.
6. is fire proof.



PORCELAIN

A high grade ceramic ware having white colour, zero water absorption and glazed surface which can be soft or hard, consists of finely dispersed clay, kaolin, quartz and felspar, baked at high temperature and covered with a coloured or transparent glaze.

The glazing material is applied before firing. At high temperatures, the felspar particles fuse and bind the other constituents into a hard, dense, and vitreous mass. High temperature ensures non-porosity and a better product.



Because of white colour, it is also called *whiteware* ,which is of two types:

SOFT PORCELAIN is made from white clay to which flint(form of mineral quartz)is added.

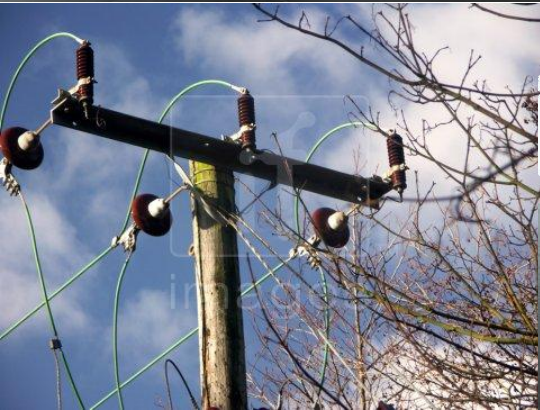
HARD PORCELAIN is made form china clay or kaolin with quartz and felspar are added as filler.

CHARACTERISTICS

1. Low (zero) water absorption.
2. Hard and glazed.
3. Good refractory material.
4. Good electric insulator.

USES

Porcelain is used for manufacturing sanitary wares, containers and crucibles, reactor chambers and electric insulators.



STONEWARE

A hard ceramic material resembling porcelain with a different colour, usually grey or brownish is made from refractory clay mixed with crushed pottery, stones and sand burned at high temperatures and cooled slowly. The clay used for making stoneware consists of about 75 per cent silica and 25 per cent alumina. Iron oxide is added to give colour.

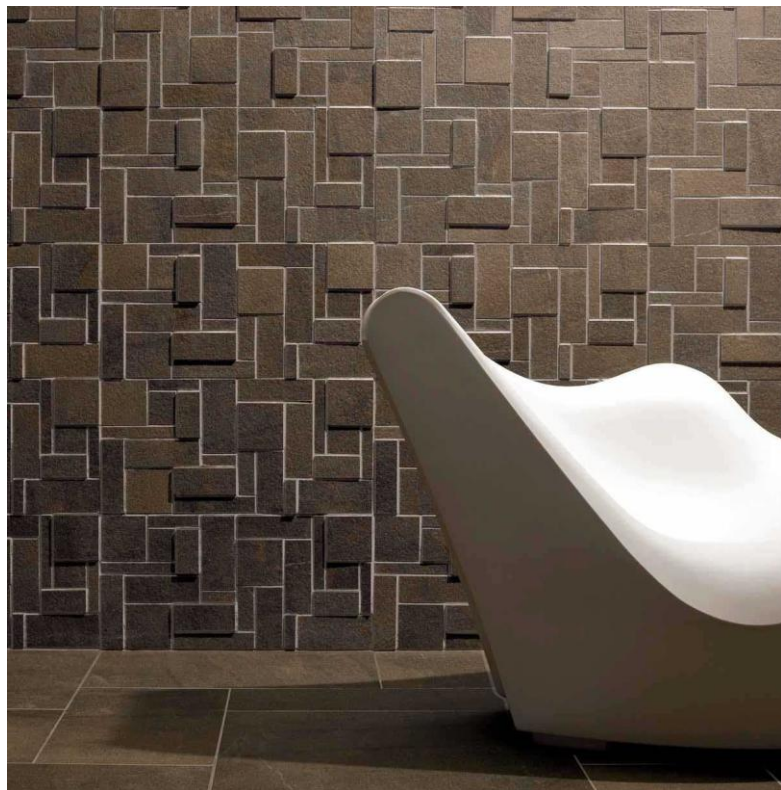


CHARACTERISTICS

1. Hard, compact, strong and durable material.
2. Gives ringing sound when struck.
3. Glazed stoneware becomes resistant to chemical and weathering action.
4. Gives good finish and appearance.

USES

1. Light sanitary wares, e.g. wash basins, water closets, etc.
2. Drain pipes and fittings.
3. Road paving materials.
4. Flooring tiles and wall tiles in toilets and kitchens.



EARTHENWARE

These are made by burning the ordinary clay at low temperature and cooling slowly. To check shrinkage, sand and crushed pottery are mixed with clay. This also increases the toughness, hardness and strength of the ware.

CHARACTERISTICS

1. Soft, porous and weak.
2. Glazed earthenware becomes resistant to weathering action.

USES

Earthenware is used for manufacturing drain pipes, lavatory fittings and light weight partition walls.



GLAZING

Bricks, tiles, earthenwares and stonewares are glazed by an impervious film to protect the surface from chemical attack and other weathering agencies. The different types of glazing in use are as to follow.

TRANSPARENT GLAZING

There are many methods for imparting transparent glazing, but salt glazing is most commonly used, since this makes the items impermeable.

It consists of throwing sodium chloride in the kiln when burning is at peak (1200° – 1300°C). The heat of the kiln volatilises the salt, which enters into the pores of the burning item and combines with the silica in clay to make soda silicate. The soda silicate so formed combines with alumina, lime and iron in the clay to form a permanent thin, transparent surface coating.

LEAD GLAZING

Clay items are burned thoroughly and then dipped in a solution of lead oxide and tin oxide.

The particles of lead and tin adhere to the surface of clay items. After this, the articles are returned in potter's kiln where these adhered particles melt and form a thin transparent layer on the outer surface. This method of glazing is used for items of inferior clay which cannot withstand high temperature required for salt glazing.



OPAQUE GLAZING

This is also known as enamelling. Borax, kaolin, chalk and colouring matter is fired with total or a part of felspar, flint, and lead oxide.

The resulting molten glass is poured into water to give shattered frit. The frit is then ground with remaining materials and water and is made of the consistency of cream known as slip.

Fully burnt earthenware known as biscuits are dipped in the slip. The biscuits absorb water and form thin layer of glaze on the surfaces. After drying the products, these are once again fired to a lower temperature so as to fuse the glaze.



APPLICATION OF CLAY PRODUCTS

The high strength and durability of clay products underlie their wide use in the various elements of buildings, such as walls, wall and floor facing materials, lining materials for chemical industry apparatus, chimney, light porous aggregates for roofing, and sewer pipes. The various applications of clay products in the building industry are as follows.

1. Wall materials. The examples are common clay brick, perforated clay brick, porous and perforated stiff-mud brick, hollow clay dry-press brick. Perforated plastic moulded ceramic stones and light weight building brick.

Structural properties of hollow clay products and low heat losses through air-filled voids (particularly at subzero temperatures) provide great possibilities for reducing the thickness and the weight of exterior walls.

2. Brick for special purposes. The example are curved clay brick, stones for sewage installations (underground sewer pipes) brick for road surface.

3. Hollow clay products for floors. The examples are stones for close-ribbed floors (prefabricated or monolithic), stones for reinforced ceramic beams, sub flooring stones (fillers between beams).

4. Facade decoration. The examples are glazed or non-glazed varieties subdivided in to facing brick and ceramic stones, floor ceramics, small-size ceramic tiles, ceramic plates for facades and window-sill drip stones.

5. Clay products for interior decoration. The examples are tiles for facing walls, built-in parts, large floor tiles and mosaic floor tiles.

6. Roof materials. The examples are common clay roof tiles for covering slopes of roofs, ridge tiles for covering ridges and ribs, valley tiles for covering valleys, end tiles for closing row of tiles, special tiles.

7. Acid-resistant lining items. The examples are common acid-resistant brick, acid-resistant and heat-and-acid-resistant ceramic shaped tiles for special purposes, ceramic acid resistant pipes and companion shapes.

8. Sanitary clay items. Sanitary ware items are manufactured mainly from white-burning refractory clay, kaolins, quartz and feldspar.

There are three groups of sanitary ceramics: **faience, semi-porcelain and porcelain**, which differ in degree of caking and, as a consequence, in porosity.

Items from faience have a porous shell, and items from porcelain, a solid shell, while those from semi-porcelain are of intermediate densities. The various degrees of caking of faience, porcelain and semi-porcelain, made of the same raw materials, are due to the latter's different proportions in the working mass.

Solid faience is used mainly to **manufacture toilet bowls, wash basins, toilet tanks and bath tubs**. Items are glazed, since unglazed faience is water permeable. Semi-porcelain items feature excellent hygienic and mechanical properties being intermediate between those of faience and porcelain. Porcelain outer shell is impervious to water and gases and possesses high mechanical strength and resistance to heat and chemical agent. **Porcelain is used to manufacture insulators for power transmission lines, chemical laboratory vessels, etc.**

Ceramic :

A **ceramic** is an inorganic, nonmetallic solid prepared by the action of heat and subsequent cooling. Ceramic materials may have a crystalline or partly crystalline structure, or may be amorphous .

Glazed tiles : Glazed tiles in general are tiles with sheen on the surface.

The liquid glass or glaze is usually baked into the surface of the clay at very high temperatures of more than 2000 degrees Fahrenheit.

Glazed tiles allow manufacturers to produce an unlimited assortment of colors, hues, and designs.

The glazing also protects the tile from staining from dirt, grime, and water. They are easier to clean and any liquid on its surface will drain faster.

Since most glazed tiles are slippery especially when wet, tile suppliers offer non-slip finishing for ceramic floors.

Smaller glazed tiles used for mosaics are less slippery due to the numerous grout lines.



Vitrified Tiles

Vitrified tile is a tile produced using vitrification. By this process the tiles created have very low porosity, making it stain-resistant and strong. It is an alternative to marble and granite flooring.

Vitrified Tile is made by baking fine minerals like clay and silica, at extreme high temperatures where the individual grains or particles melt and fuse to make a vitreous surface. Thus creating a single mass making them extremely hard with low porosity.

Porcelain tiles are also vitrified tiles and generally fall in the category of full vitrified tiles. It means that a porcelain tile has the water absorption of less than 0.5 percent.

