stone is naturally available construction material used for various Engineering structures. considering their durability strength etc. Almost all the important structures viz> Buildings, Bridges, Dams weirs, canal drops, roads, CD works etc are being executed with the utility of stones.

Ancient days, various kings, Emperors were executed heavy structures like forts, mosques, temples with maximum utility of stones even with out binding material for joints. the sculpture of the stone items in their constructions even today is undisturbed. they sculptured in the stone work (ie) enchiseling single heavy work in the shape of "Basavaswara" and Lord "Gomateswara" etc are appreciable. the Tajmahal at Agra, Redfort, Jumma masjid, parliament house, central secretariat, Rastrapathi Bhavan in Delhi. charminar and makka masjid in Hyderabad and other prominent structures spreaded all over India are the examples of construction of stones as a construction material. It clearly establishes the top most importance of a stones in construction in ancient regions and also in present regions.

the British Engineers were also utilized the stones to the possible extent for walls, floorings, columns, Road dams, C.D works, Arches etc. the present Engineers in the advanced technological constructions also, stones are being used for various masonary items with different type of dressing in addition to flooring, paving etc. the stones like

marble etc are being used for ornamental items in the structure.

→ Rock and stone:-

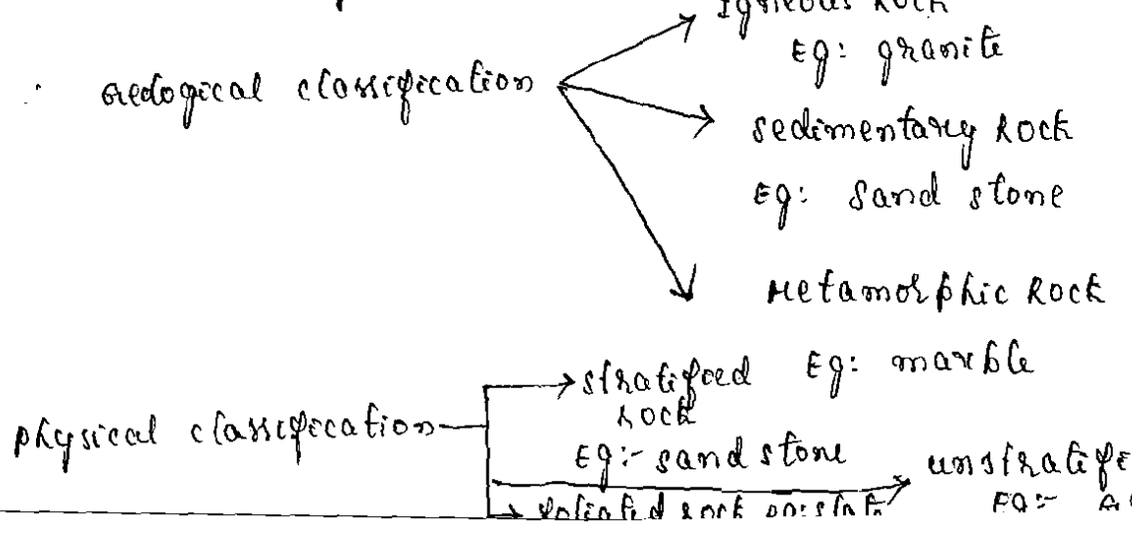
(a) Rock:- A solid mass containing of consisting of different types of miner which form the earth crust is known as rock. These minerals are not homogeneous. The position of the earth up to 20km depth below its surface is known as earth crust. Rock forming minerals, naturally occurs in inorganic substances which consists of different chemical composition and atomic structure. It has no definite shape and struct

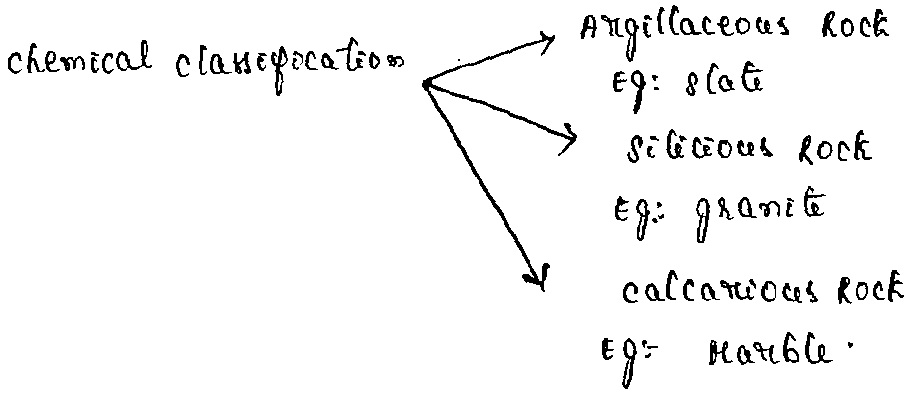
stone:- It is naturally available construction material. It is quarried and extracted from the rock. The properties of stones depends upon the mother rock from which it is extracted. The extracted stones can be make in different sizes and shapes to fulfill the needs of the structu stones when extracted from rock are very irregular in shape and and size. Hence they require cutting in to sizes dressing before used in construction.

→ classification of rocks:-

The Rocks may be classfied on the basis of theier

① Geological formation
② physical characteristics
③ chemical composition





→ Quarrying of stones:-

The only process of extracting out the stones from the natural rock bed is known as quarrying. The open part of the natural rock from which useful stones are obtained is known as quarry.

While selecting the site of quarry the following points are kept in mind for suitable selection

① Availability of suffecient quantity and required quality of stones

② proper transportation facility

③ Easy drainage of rainwater from the quarry pit at low cost

④ Easy availability of local labour.

⑤ Availability of cleanwater in suffecient quantity for a longer period.

⑥ For quarry by blasting, absence of permanant structures near by

⑦ Availability of site for dumping refuse.

⑧ Availability of required power station and required machinery for cutting, crushing etc.

→ Methods of quarrying:-

The following are the three methods of quarrying:-

① quarrying with hand tools

② quarrying with chanelling machine.

③ quarrying by blasting.

① quarrying with hand tools:-

the following are the three different ways of doing quarrying by the use of hand tools:-

ⓐ digging (or) excavating

ⓑ Heating

ⓒ wedging

ⓐ digging or Excavating:-

the stones are merely excavated with the help of suitable instruments such as pick axis, hammers, shovels, chisels etc useful for soft ston

ⓑ Heating:-

the total surface of the rock is heated. It is usually done by placing of wood or piling a heap of fuel over the surface and setting a steady fire to them for some hours. due to unequal expansion upper layer of rock separates out. It is ~~indicating~~ indicated by dull bursting noise. the detailed portion of rock is then removed by suitable instruments such as pick axes, crowbars etc.

ⓒ wedging:-

this method of quarrying is suitable for costly, soft and stratified rocks such as sandstone, limestone, laterite, marble and slate. In this method, if the rock surface contains cracks or fissures steel wedges or points ~~are~~ are driven through such cracks

by means of hammers. The blocks of stones are then shifted and they are removed with the help of suitable instruments. ⑤

Quarrying by channeling machine:-

In this method, the channeling machines driven by stream, compressed air or electricity are used to make vertical or oblique grooves or channels on the rock mass. The machines make rapid the grooves having length of about 24mm width about 50mm to 75 and depth about 240cms to 370cms.

The process consists of the following steps

① The channels are cut around the stone block, which is to be removed from the rock mass.

② The horizontal holes are drilled beneath the blocks.

③ The wedges are driven in to the holes and the block is then broken loose from its bed.

The process of separation of stone from the rock mass is almost invariably employed incase of marbles, lime stones and other soft sand stone. very large blocks of stones can be separated from the rocks by the application of this method.

Quarrying by blasting:-

In this method, the explosives are used to convert rocks in to small pieces of stones.

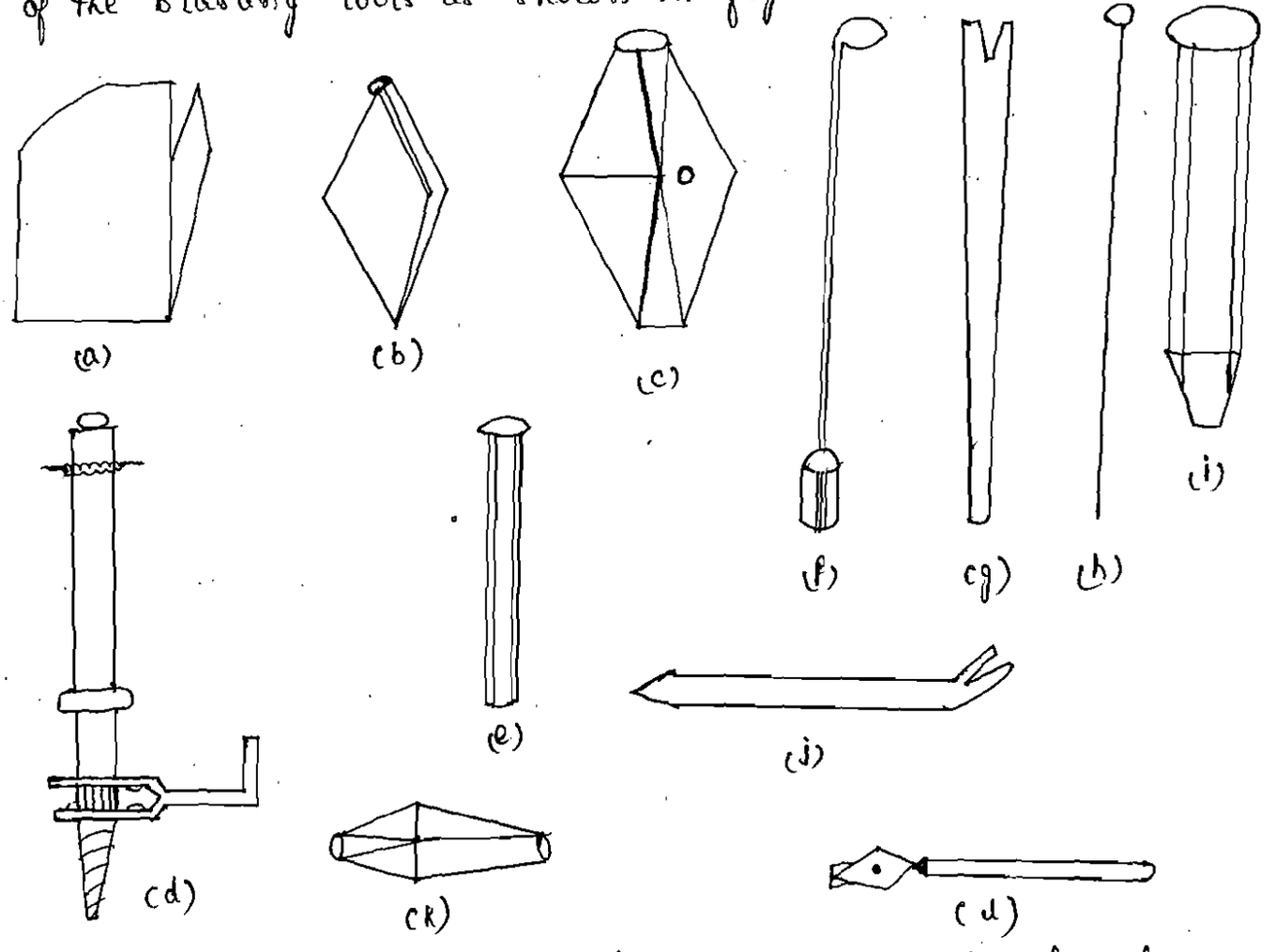
purpose:- The main purpose of quarrying stones by blasting is to loosen large masses of rocks and not to violently blow

up to the whole mass so as to convert it in to very small pieces of practically no use.

This method is adopted for quarrying hard stones, having no fissures or cracks. The stones obtained by blasting are usually of small size and they are used as ballast in railways, aggregal for concrete, road metal etc. The process of blasting is important with respect to stone quarrying.

→ Tools for blasting:-

Some of the blasting tools as shown in fig:



(a) wedge
(b) pin
(c) Hammer
(d) Ratchet boring machine
(e) Drill
(f) Dipper
(g) Ramping bar
(h) Probing needle
(i) Jumper
(j) Crow bar
(k) chisel pointing wedge
(l) Claying Iron

Machines for quarrying

NO	Machine	use
1.	cable ways and rope ways	To hoist and transport stone
2.	channellers	To form long narrow channel in rock.
3.	crusher	To break large stones in to small sizes.
4.	Drilling machine	To drill blast holes.
5.	Moulding machine	To form moulding on stones
6.	polishing stone	To polish the surface of stones
7.	pulley block and cranes	To lift stones
8.	saws	To cut stones in to desired shapes and sizes.
9.	screens	To sort stones according to size and geodes.

→ Explosives used in blasting :-

The common explosives used in blasting are:-

1. Blasting powder.
2. Dynamite
3. Gun cotton
4. Blasting gelatine
5. Rock-a- rock
6. cordite
7. Gelinite

→ precautions in Blasting :-

Accidents may takes place during blasting. following are the some of the points ~~oto~~ which should be taken note of

① Blasting should not be carried out in late evening or early morning hours. the blasting hours should be made public and a siren should warn the workmen and nearby public timely to retire to a safe distance.

② the danger zone, an area of about 200m radius, should be marked with red flags

③ First aid should be available.

④ the number of charges fired, the number of charges exploded and the misfires should be recorded.

⑤ Explosives should be stored and handled carefully.

⑥ detonators and explosives should not be kept together.

⑦ cartridges should be handled with rubber or polythene gloves

⑧ A maximum of 10 bore holes are exploded at a time and that also successively and not simultaneously.

→ characteristics of a Good Building stone :-

A good building stone should have the following qualities.

① Appearance :- A good building stone should be uniform in colour and texture. In case of a stone work the stones used for a face work, where the appearance is a primary factor, its colour and ability to receive polish and to preserve its colour for a longer period. this stones should also be capable to resist the atmospheric weathering.

(2) strength:- A good building stone should have sufficient crushing strength to with stand the loads to which they are subjected to the crushing strength of stones is greater than 1000 kg/cm². Depend upon the type of structure, suitable variety of stones will be select to achieve economy.

(3) structure:- It indicates the manner in which the particles and mass forming stones are arranged. They should be uniform textur and free from cavities, cracks, patches etc. A Igneous Rock will have uniform structure, which takes more loads and it is more suitable for construction works.

(4) texture:- The texture of stones indicates the arrangements of its mineral constituents. The stones with homogeneous and crystalline structure are hard and compact and hence these stones will be selected for construction works.

(5) Durability:- A good building stone should be durable enough to resist the effect of atmospheric agencies like wind, rain, temp-erature etc. The durability depends upon its chemical composit physical structure and its location in the construction structure

(6) Hardness:- The Hardness is the property of stones which resist abrasive forces developed due to wear and tear and friction. Hardness is to be considered when the stones are subjected to considerable wear and friction ~~— Hardness is to be considered~~ as in case of floors and pavements. It is expressed in number and it varies from 1 to 10. More the number and harder the stone.

7) toughness:- A good building stone should be tough enough to with stand the stresses developed due to vibrations of machinery and moving loads over them. The stones used for construction of road should be hard and tough.

8) porosity and absorption:- A good building stone should be less porous. If it is more porous it absorbs more water. High porosity reduces the life of the structure. The stone should not absorb water more than 5% either in volume (or) in weight, when it was immersed in water for 24 hours.

9) specific gravity:- The stones used for heavy Engineering structure like dams, bridges, piers where more stresses developed should be of heavier variety of more specific gravity. In case of dams, roof covers etc lighter varies of less specific gravity are preferred the specific gravity ranges between 2.4 to 2.8.

10) workability:- Stones used for construction should be economical so that the operations like cutting, dressing and bring it to them to required shape should not costly.

11) dressing:- Stones extracted from quarry or irregular shape and they are not useful for construction with out dressing. The stones used for purpose such as Arches, sills and ornamental work requires proper dressing and the stones required should be of good and easy and dressing property. Stones possesing dressing properties are weak in strength and durability.

12) seasoning:- Stone quarried from the parent rock contains moisture

in the body called quarry sap. This moisture makes the stone soft an damage. Hence the stones quarrying and dressing should be kept f a period of 6 to 12 months under open sheds for proper seasoning, before using for construction. The seasoning is effectively achieved presence of air and sunlight. A good building stone required effective seasoning.

(13) Resistance to fire:- A good stone constitutes minerals having equal coefficient of thermal expansion for better resistance to fire. such stone is preferred for construction.

(14) cost:- The cost of a good building stone is not uneconomical. The cost depends upon type of quarrying distance from quarry to site transportation facilities available and cost of dressing. These operation are economical.

→ Dressing of stone:-

The freshly quarried stones are irregular in shape and rough in surface and as it is they are not useful for construction. Depending upon the type of stone masonary and also for special purposes like arches, sills, columns etc. the stones are cut in to suitable size and required shape and surface. This process is known as "Dressing" of stones.

→ Bricks when compared to stone on the basis of structural requirements:

The natural construction material known as stone. The following observations are made.

① the quarried stones are huge in size and irregular in shape and as it is they are not useful for construction the operations like cutting, dressing etc. needed for made them use. it is difficult in handling due to heavy weight, costlier, time consumption factor in performance.

② the quarries of the stone are generally exists in hilly area from where the transportation to the nearest highway or railway is difficult and uneconomical

③ the stones are not useful for multistoried buildings in view of heavy weight and also there is a waste of site in urban areas in view of more thickness of stone masonary walls.

④ During quarrying when hard rocks met with, it essentially needed the operation like blasting which is difficult and causing dangers in the near by locality.

to overcome the problems with stone it is necessary to mould the artificial clay blocks of rectangular size, uniform surface and sharp edges known as bricks to make them use in construction after suitable burning.

Hence bricks are being used as best construction material, since ancient days and even today.

→ Definition and composition:-

the bricks are defined as artificially moulded clay blocks, with mass of natural clay with uniform size and shape. Bricks are moulded in rectangular shape of suitable size with plastic clay,

when it is in semi solid condition. the bricks are suitably dried and burnt to attain strength durability etc to made them useful for construction works.

→ chemical composition of Brick Earth : [Ingredients in Brick Earth]

For preparation of bricks, clay and other suitable ~~work~~ earth is moulded to the desired shape and size after subjecting it to several processes after drying it should not shrink and no cracks should develop.

Sl.no	Ingredient	proportion	Functions
1.	clay (Alumina)	20 to 30%. by weight	It absorbs water and render clay plastic. Excess Alumin produces cracks on drying.
2.	silt	20 to 35%. by weight	It supports the sharp edges of bricks and helps to remai intact during drying and burning of bricks.
3.	Silica (sand)	50 to 60%.	It retains its shape and imparts durability and prever cracking and warping. Exce of silica makes the bricks brittle and weak on burning.
4.	other Ingredients a) Lime ($CaCO_3$)	1 to 2%. by weight for a good brick earth 10%.	It prevents shrinkage of on drying and makes the bricks hard. Excess lime caused bri to melt and hence its shape will los

S.no	Ingredient	proportion	Functions
(b)	Ferricoxide (FeO)	< 7%.	It gives good red colour strength and durability.
(c)	Magnesia (MgO)	< 1%.	Excess presence of manganese make the bricks darken.
(e)	Sodium potash etc		Little Excess of these ingredients decolours the bricks.

Note:- ① The total content of clay silt shall not be less than 50% by weight.

② The total soluble material shall not be more than 1% by weight.

→ Requirements of good brick Earth:-

① It should be homogeneous and contain desired proportions of ingradients (clay, silt, silica etc)

② It should be free from pebbles, grits etc

③ It should also be free from lumps of lime

④ It must be free from alkaline salts and chlorides

⑤ It should not contain vegetable and organic matters.

→ Characteristics of a good brick: [IS] ...

(a) Standard size:- 19 x 9 x 9 and ... 200 mm x 100mm x 100mm [nominal size of the module size]

(b) Appearance:- well burnt, uniform and bright copper colour.

(c) Shape:- smooth rectangular faces, sharp corners, free from cracks and nodules [small grains]

(d) Texture:- uniform texture, fractured surface should not show fissures, holes etc. [fissures means line of breakage made by cracking]

(e) Hardness:- sufficient hard, when scratched with finger nail no impression is made on surface

(f) compressive strength:- strength not less than 10.5 N/mm² (1st class) 7.0 N/mm² (2nd class), 4.0 N/mm² (3rd class)

(g) soundness:- Give metallic sound when two bricks struck togeth

(h) water absorption:- water absorption of brick by dry weight sho not exceed 15% (1st class), 20% (second class), 25% (3rd class) br

→ classification of bricks:-

① Based on field practices — ① First class bricks
② second class bricks
③ third class bricks
④ fourth class bricks

② Based on strength — ① Heavy durable bricks
② light durable bricks

③ Based on shape — (a) sub class A
(b) sub class B

④ Based on uses — ① common bricks
② Facing bricks
③ Engineering bricks.

⑤ Based on finishing — ① sand faced
② Rustic faced

⑥ Based on manufacture — ① Hand moulded
② Machine moulded

⑦ Based on burning — ① pale Bricks ② Body Bricks ③ Arch bric

→ Based on field practices :-

① First class Bricks :-

properties :- ① These are thoroughly burnt with deep red, cherry or copper colour.

② The surface should be smooth and rectangular with parallel sharp and straight edges.

③ They should be free from flaws, cracks and stones.

④ They should have uniform texture.

⑤ The water absorption should be in about 15% of its weight when immersed in water for 24 hours.

⑥ A ringing sound should come when two bricks struck each other.

⑦ The crushing strength should not be less than 10.5 N/mm²

uses :-

① For heavy Engineering works for masonary items.

② For exposed face work of structures.

③ For flooring and reinforced brick work.

② second class bricks :-

properties :- ① small cracks and minor distortions are allowable.

② A little more water absorption (i.e) about 20% of its weight is allowed

③ The crushing strength should not be less than 7.0 N/mm²

uses :- second class bricks are recommended for all important or unimportant masonary works, centering for reinforced brick works.

(3) third class bricks:-

These are burnt bricks. they are soft and light coloured produces a dull sound when struck with another bricks. the water absorp is about 25% of its weight.

uses:- these bricks are used for temporary building structure.

(4) fourth class bricks:-

these are over burnt bricks and badly distorted in size and shap and brittle in nature.

uses:- the pieces of these bricks are used for foundation and floor in lime concrete.

Note:- composition of various ingradients of good brick earth the proportions of various ingradients and functions are as follows

silica	–	50 - 60%.
Alumina	–	20 - 30%.
Lime	–	10%.
Magnesia	–	< 1%.
Ferric oxide	–	< 7%.
Alkalis	–	< 10%.

carbondioxide, sulphur trioxide, water – very small percenta

→ Functions of various ingradients:-

(1) silica:- A good brick earth should contain 50% to 60% of silic the presence of silica constituent prevents cracking, shrinkage in bricks thus imparts from uniform shape to the bricks. Excess of silica

makes the brick brittle and weak on burning. The durability of bricks depends on the proper proportion of silica in brick earth.

② Alumina:- A good brick earth should contain about 20 to 30% of alu If alumina is present in excess, with inadequate quantity of sand th raw bricks ~~sink~~ shrink and it produces cracks during and burni and become too hard when burnt.

③ Lime (calcium):- A small quantity of lime not exceeding 10% is desirable in good brick earth. The excess of lime causes the bric to melt and hence its shape is lost and also results in splitting of bricks in to peeces.

④ Magnesia:- If exceeds 1%, affects the color and makes the brick yellow. Excess of magnesia content leads to the decay of bricks.

⑤ Iron oxide:- usually constitutes < 7%. It imparts the following proper

① Gives red colour on burning when excess of oxygen is available and dark brown or even black colour when oxygen available is insufficient however excess of ferric oxide makes the brick dark blu

② Improves impermeability and durability.

③ Tends to lower the fusion point of the clay, especially if present as ferrous oxide

④ Gives strength and hardness.

→ Harmful substances in Brick Earth

Following are the ingradients which are undesirable in the brick Eart

① Lime:- when lime is present in lumps, it absorbs moisture, swells and causes disintegration of bricks.

② pebbeles, gravels:- the presence of pebbles of any kind is undesirab in brick earth because it will not allow the clay to be mixed uniformly and thoroughly which will result in weak and porous br Also the brick containing pebbles will not break regularly as desire

③ Alkalies:- these are mainly in the form of soda and potash. when alkalies present in excess, the bricks become unsymmetrical / loose their shape. further, the presence of excess alkalies content absorb moisture from the atmosphere. such moisture, when en evaporated, leave behind grey or white deposits on the wall surface and the appearance of the building as a whole is then seriously spoiled.

④ organic matter:- the presence of organic matter in the brick earth, which is not burnt in case, the bricks become porous and the streng is reduced.

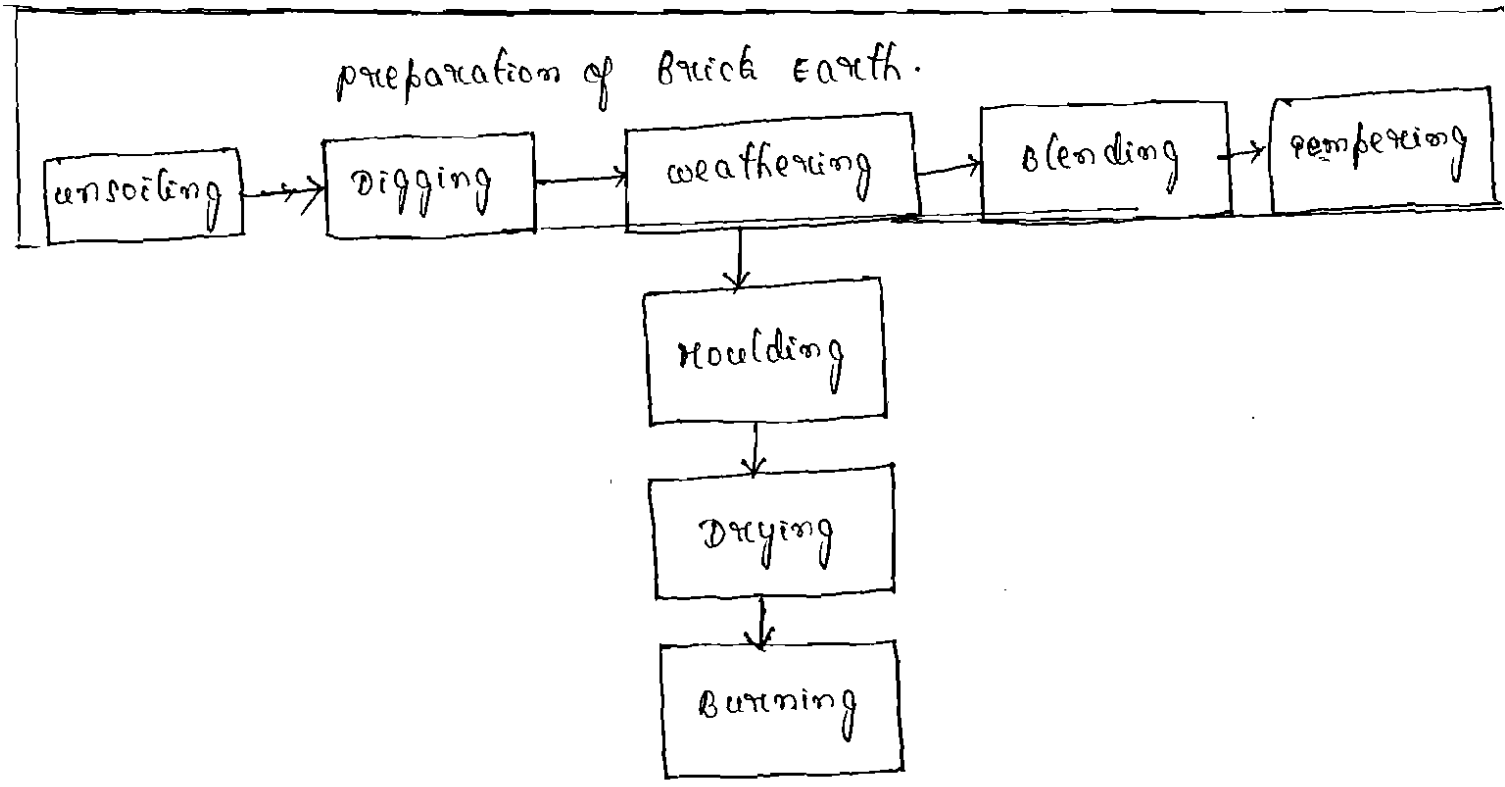
⑤ sulphur and carbon:- sulphur is usually found in clay as the sulpha of calcium [$CaSO_4$], magnesium [$MgSO_4$], sodium [$NaSO_4$] potassium [K_2SO_4] and iron sulphides [FeS_2]. if however there is carbon in th clay and insufficient time is given during burning for proper oxidat of carbon and sulphur later it will cause the formation of a spong swollen structure in the brick.

⑥ water:- A large proportion of free water generally causes clay to shrink considerably during drying where as combined water cause shrinkage during burning. the use of water containing small quantities of magnesium or calcium carbonates, together with a sulphurous fuel often causes similar effects as those by sulphur.

① iron pyrites:- tend to oxidize and decompose the brick during burni the brick may split in to preces. pyrites decolourise the bricks.

→ manufacturing of bricks:-

the operations involved in the manufacture of clay bricks are represented diagramatically in the figure below.



→ Tiles:- the first and foremost need of the inhabitant is a shelter (i.e) a structure for the residential needs of a human called house) to protect the effects of weathering agents such as rain, heat, wind etc for the suitable lively hood of generation of the earth. the oldest and effective method of covering structures permanantly is a tiled roofing. this is best suitable for resistance to atmospheric agencies. the tiles places suitable role, in the roofing item of the structures.

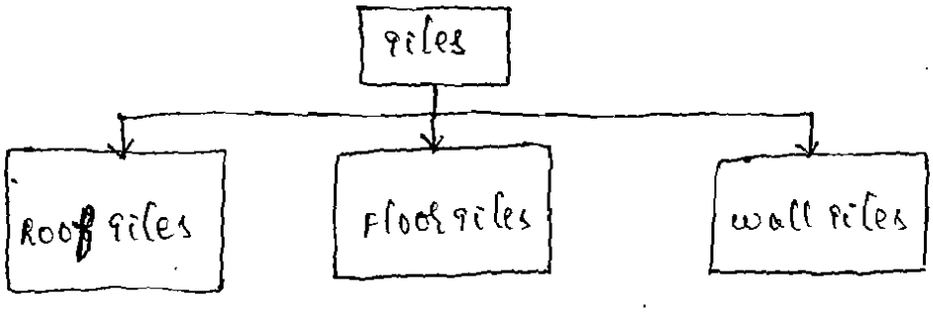
the roofing with tiles in different angles and shapes gives, good appearance and keep the structure cool.

Ex:- Sri krishna Devarayalu constructed at a Gagan vihar at panukond

with pan tiles and pot tiles and be used it as a summer palace. The British emperors constructed almost all the official buildings with pitched [sloped] roof coverings, with flat tiles embedded in cement mortar or lime mortar over at inter locked tiles viz mangalore tiles. All these structures are leaked proof and good appearance with coolness, even in summer.

→ Tiles:- The tiles may be defined as the thin slabs of low melting clays and they used in the various purposes in the Engineering constructions, these gives pleasing appearance and good service to the properties.

→ Classification of tiles:-



The tiles are classified in to following three types depending upon the purpose of use.

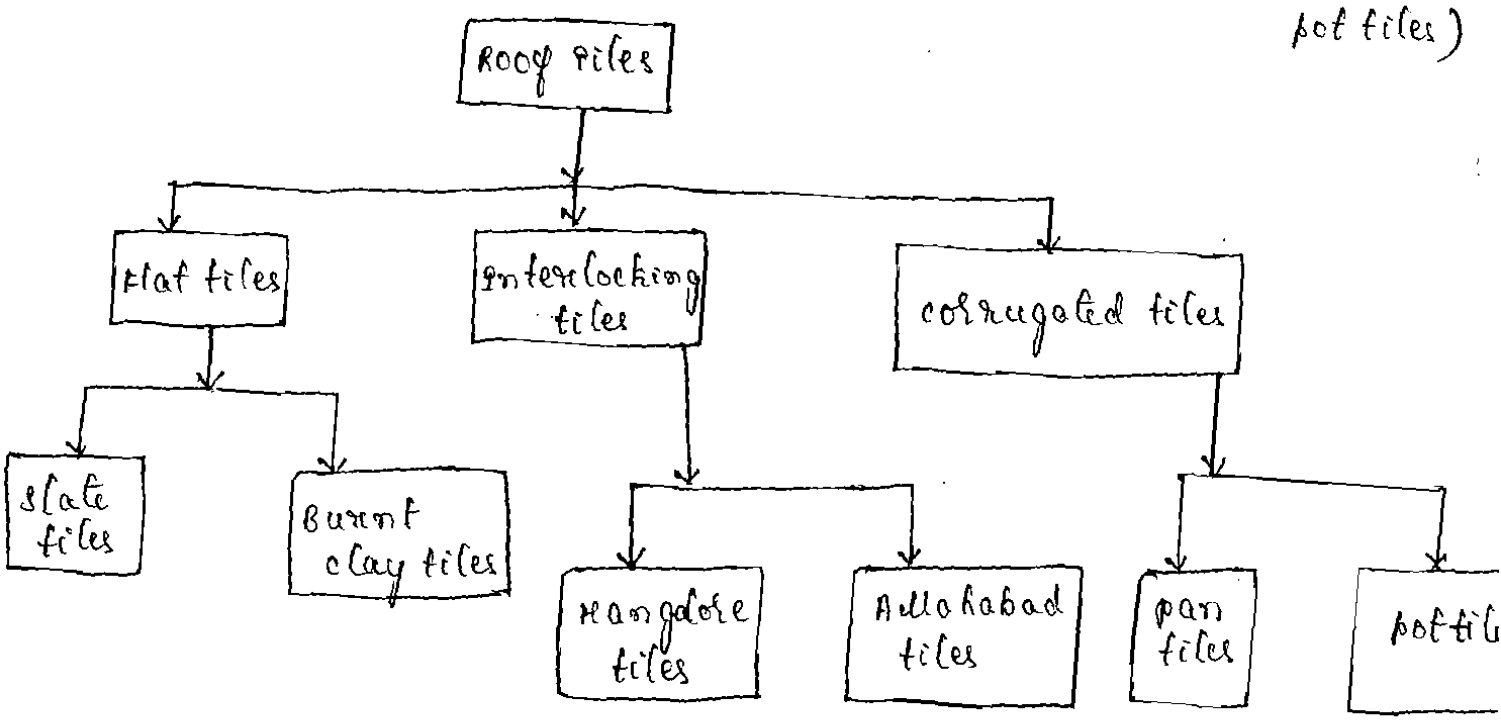
Roofing tiles:-

① ~~Roofing tiles~~ ② ~~Flooring tiles~~ ③ ~~wall tiles~~

These tiles are used for covering the roofs of houses or buildings. These tiles have the quality of water resistance and other adver atmospheric agents such as wind, heat etc. They are made in differ shapes and sizes to suit the requirements.

→ Classification of Roofing tiles:- The roofing tiles are divided in to the following types according to their shape.

(a) Flat tiles (b) Interlocking tiles (c) curved tiles (pan tiles or pot tiles)



(a) Flat tiles:- these tiles are flat. these tiles exists either in rectangular or square shape in various dimensions. these are laid in one or two layers in cement or lime mortar. these are used ~~as~~ for flat as well as ~~slopf~~ sloped roof below the mangalore tiles or pan tiles or pot tiles.

Types of flat tiles:-

the flat tiles are further divided in to following types

① slate tiles

② Burnt clay flat tiles.

Slate tiles:- these are thus slab of slate. there are uniform in colour texture free from cracks ~~fibres etc~~ etc. water absorption is not more than 20%.

Burnt clay flat tiles:- these tiles made with good clay, uniform texture and uniform burnt. uniform size, shape, free from ben cracks, pebbeles etc. they are used below the mangalore tiles, pot

tiles, pan tiles etc.

Normal sizes:- Length 25 to 15cms in stages of 2.5cms

width 20 to 10cms in stages of 2.5cms

Thickness 20mm to 15mm

Tolerance is ± 2%.

(b) Interlocking tiles:-

These tiles are generally rectangular in plan, with surface corrug so arranged that the corrugations of one tile fit or lock in to th of the other. These corrugations will form as gutters from the ridg of the roof to the eaves board to draw of the rainwater, quick and safely. These tiles have interlocking system - These are mostly Machine make. Mangalore tiles and allahabad tiles are some of the Interlocking tiles.

(a) Mangalore tiles are first manufactured in Mangalore city in Karnataka. These tiles are with corrugations to draw of rainwate and corrugation are suitable for overlapping of tiles safely. These are red in colour. Mangalore tiles are available for hip, ridge & valley positions of roof and also for ventilation, chimney etc. fig. [3-17] shows the Mangalore tiles and their arrangements. As per Bureau of Indian standards the mangalore tiles are divided in to two classes namely class AA and class A. The characteristics of both the classes are mentioned in the table.

[Note:- the sharp edge of a roof from the ridge to the eaves where the two sides meet]

Sl No	property	class A	class AA
1.	Maximum water absorption By weight	19	24
2.	Minimum average breaking load	1.02 KN	0.82 KN
3.	Minimum individual breaking load	0.91 KN	0.68 kN

specification of mangalore tiles:-

① the size of mangalore tiles 41 X 23.5 cms, 42 X 25 cms, 42 X 26 cm

② the thickness of mangalore tiles 3 to 5 cms

③ the life of mangalore tiles 25 years.

(b) Allahabad tiles:-

these tiles are made are selected clay. the moulding of clay is done under pressure in machines. the burning of these tiles is done in such away that they attain more strength. the tiles are provided with projections so that they interlock with each other when place in position. these tiles ~~are of special types~~ of special shapes are mad for hip, ridge and valley positions of the roof. these tiles of special shapes are extensively used in north western India.

(c) corrugated tiles:-

these tiles have corrugations and when they are placed in position a side lap of one or two corrugations are formed. the placing of

such tiles on a roof gives appearance of corrugated galvanised iron sheets. these tiles are good in appearance, but they can easily blow due to violent wind.

(c) curved tiles:-

pan tiles:- the pan tiles are short and heavy when compared to pot tiles. they are less curved than pot tiles. they are moulded flat first as the bent to the required curvature by ~~moving~~ moulding in suitable forms. the drying and burning of the tiles are done carefully to get better quality of tiles. these tiles are of length 33 to 38 cms and of width of 23cms to 28 cms.

pot tiles:- pot tiles are made by hand on a potter's wheel. they are hallow half round and tampering in shape. pot tiles are laid on sloped roofs along with the concave side up and longer end towards the ridge. then another row of same tiles convex side up and smaller end towards the ridge is laid covering the adjoining edges of every pair of tiles as shown in fig. pot tiles are generally porous and not quite strong.

(2) Flooring tiles:-

these tiles are used for flooring just like polished stones, cuddapah slabs etc in the building works. these are also used for finishing the surface of floors of water closets, bath rooms, kitchens, hospitals and other such places where cleanliness is of prime importance.

the top surface of the tile is glazed and the underside is left ungla for proper adhesion to the subsurface. they are vitrified to pr water absorption. these tiles can be made in any colour and of any Geometrical shape. Floor tiles can be made in any colour and of an Geometrical shape. Floor tiles are available in the following common sizes ① 15 X 15 X 1.8 cms

② 20 X 20 X 2.00 cms

③ 22.5 X 22.5 X 2.2 cms

requirements of flooring tiles:-

① they should be free from pebbles, grit, lime or other foreign materials either on the surface or on a fractured surface.

② when broken, the fractured surface should be clean dense and sharp at all edges.

③ they should be ringing sound, when struck each other.

④ should not absorb water more than 20% by their weight when immersed in water for 24hours.

⑤ they should resist maximum to impact.

③ wall tiles:-

these tiles are can be manufactured from dry or wet clay. these a also called as pressed tiles, these are almost all smilar to the flor tiles, except for their design and degree of burning. wall tiles are burnt again at low temperatures, glazed and burnt again at a still lower temperature. they can be made to any size. coded tiles are obtained by mixing colouring figments (generally metallic oxides) in the glaze solution.

→ Manufacturing of Roof tiles:-

The thickness of these tiles is thin compared to bricks and therefore requires better care and attention at all stages of manufacture of mangalore and allahabad tiles. These tiles being better type of roofti and are made in the ways as pressed bricks.

The clay is of stiff consistency and is pressed in the moulded carrying the necessary identification for the purpose of drainage and interlocking when load in position. The burning of these tile is same as described for clay building bricks except that they are burnt hard to have strength. Roofing tiles must have a very low absorption of about less than 5 to 7% in boiling water for fivehou

→ Manufacturing of wall tiles and flooring tiles:-

preparation of clay :- for this preparation of floor and wall tiles rich variety of clay is required. Kaolin or china clay which is whit in colour is best suited for the purpose. sometimes a mixture of several clays such as fire clay, shale and kaolin may be made in the required proportion. some water is to be added to it to prepa slurry. The slurry is then allowed to settle down in a tank. The to water is taken out by decondition and the bottom deposit is first drained in the filter press and dried over the evens. The dried day mixture is then regrocund to a fine powder.

Moulding:- The crushed powder is moistened, preferring by steam to consistency wet for powder to facilitate moulding. The moulding is

done in dry process and moulded green tiles are directly sent in to a kiln for burning.

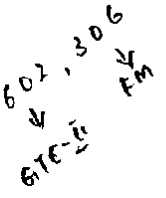
Burning:- The burning is done in two stages. In the first stage the gree tiles are burnt to a low temperatures of about 700°c to be taken out a for a dip in the glaze solution for the quarried colour. After this t tiles are again sent in to the kiln for the second stage of burning to a temperature of 1250°c to fuse to glaze.

Note:- A glaze is applied to a surface of clay articles for

① for improving the surface.

② To make them non-absorbent

③ To impart durability.



→ Characteristics of a good tiles:-

① It should be free from any cracks, flaws or bends.

② It should be regular in shape and size.

③ It should be well burnt and have uniform colour.

④ It should be sound, hard and durable.

⑤ It should give a clear ringing sound when struck with each other.

⑥ It should fit properly when placed in position

⑦ It should have compact granular structure.

⑧ It should not be slippery, it should have resistance to dampne

⑨ water absorption of less than 15%.

⑩ Resistance to Atmospheric conditions

Greater care is required for laying of tiles over the concrete ba

a 25-30 mm thick layer of lime mortar 1:3 (1lime : 3sand) is spread to serve as bedding / bedding. This bedding mortar is allowe to harden for 12-24 hours. Before laying the tiles, cement slurry is spread over the mortar and the tiles are laid over it by gently pressing. The tile flooring is cured for 7 days.

Comparision of burning bricks:-

→ comparision between clamp burning and kiln burning:-

S.no	point of comparision	clamp burning	Kiln burning
1.	Nature of structure	Temporary	permanant.
2.	Initial cost	Low	High
3.	Final cost	Low as grass, straw, cow dung litter, fire wood etc are used.	Generally high as coal dust is used.
4.	capacity	About 30,000 to 1 lakh bricks at a time in a period of 3 to 6 months.	Average 20,000 bric per day.
5.	Mode of supply	supply of bricks not continuous	supply of bricks continuous
6.	Time of burning and cooling	About 3 to 6 months for burning and cooling	Time of burning one chamber : 24hours Time of cooling : 12hour
7.	Regulation of fire.	No regulation of fire. only perfectly dry bricks should to put to fire, otherwise sudden	Fire regulation throughout even raw bricks can be put in

S.no	point of comparision	clamp Burning	Kiln Burning
8.	supervision	skilled supervision is not required.	skilled supervision is required.
9.	suitability	suitable only for small scale manufacture of bricks	suitable for large scale manufacture of br
10.	wastage of heat	considerable	less
11.	Quality of bricks	the good bricks are 60% of the total.	the good bricks are 90% of the total.
12.	Effect of atmospheric agent	working affected by atmospheric agents	working not affects by atmospheric agents.
13.	pollution problems	Gives out lot of smoke in the begening, thus polluting the atmosphere	No smoke. No pollution of the atmosphere.

→ comparision Between Bull's trench kiln and Hoffman's kiln

S.no	point of comparision	Bull's trench kiln	Hoffman's kiln
1.	type or nature	semi continuous	perfectly continuous.
2.	initial cost	less	High
3.	consumption of fuel	more	less
4.	continuity of working	since it is not provided with a permanant roof it stops functioning during monsoon.	It is provided with a perma roof and hence it functio all the year round.
5.	Drying space	Requires more drying	Requires less drying space.

6.	Burning capacity	About 10000 bricks daily and about 18 lakh bricks per session.	About 20000 bricks daily and about 60 lakh bricks per year.
7.	popularity	more popular because of less initial cost	Less popular because of high initial cost
8.	suitability	suitable when demand of bricks in monsoon is not substantial	suitable when deman of bricks is continuo
9.	Quality of bricks	Moderate	quite high.

→ Manufacturing methods of brick Earth :-

① preparation of a brick Earth:-

preparation of brick Earth consists of the following operations

(a) unsoiling (b) Digging (c) cleaning (d) weathering (e) Blending (f) tampering

(a) unsoiling:- the top soil contains full of impurities like roots of grass, bushes, vegetables, dried leaves and other organic matter Hence the top surface of clay is not suitable for preparation of a bricks. Hence the top layer of soil about 20cms in depth is to be removed and thrown away.

(b) Digging:- the clay is then dug from the ground. It is then spread on the adjacent levelled ground, just a little deeper than the general level of the ground. the height of the heaps of clay

is about 60cms to 120cms. the operation should be done before monso to avoid wasting away of soil during excepted rains.

(c) cleaning:- the clay, as obtained in the process of digging shoul be cleaned of stones, pebbeles, vegetable matter etc. if these particles are in excess, the clay is to be washed and screened. this process is seems to be trouble some and expansive. Hence the dumps of clay should be converted in to powder form in the earth crushing rollers

(d) weathering:- the clay is then exposed to ~~atom~~ atmosphere for softening and mellowing the period of weathering varies from few weeks to full season. the period of weathering depends upon the quantity and quality of soil used for preparation of bricks.

(e) Blending:- the weathered soil is then loosened and deposited in heaps. the ingredients of the heap are checked to the standard if any ingredients required it should be placed in layers on the heap and blended. Blending is process of thorough mixing up of all ingredients to form homogeneity. it is carried out by taking small position of clay every time and by ~~turni~~ turning it up and down in ~~vertcle~~ vertical direction. the blending makes clay to fit to the next stage of tampering.

(f) Tempering:- In the process of tempering, the clay is brought to a proper degree of hardness and it is made it fit for the next operation of moulding. the required quantity of water is added to

clay and then the whole mass is pressed under the feet of men and cattle. The tempering should be done to obtain homogeneous mass of clay of uniform character.

For manufacturing good bricks on a large scale the tampering is usually done in a pugmill. A typical pugmill capable of ~~to~~ tempering sufficient earth for a daily out put of about 15000 to 20000 bricks. The process of grinding clay with water and making it plastic is known as pugging. (continuation in pg-18 on back side

→ classification of Rocks :- [Based on geological formation)

This classification is based on the mode of formation

Igneous Rocks :- These Rocks are known as primary rocks. are of volcanic origin and are formed as a result of solidification of molten mass lying below or above the earth surface.

① The inner layers of the earth are at a very high temperature causing the masses of silicates to melt. This molten mass called magma is forced up in as volcanic erruptions and spreads over the surface of earth where it solidifies forming forming basalt and trap. These are known as effusive rocks.

② If the magma solidifies below the earth surface itself the solid crystaline ~~structure~~ rock is termed as deep-seated plutonic rock.

Eg:- Granite, syenite, diorite & gabbro.

③ If the magma solidifies at a relatively shallow depth, the resultan rock posses a finally grained crystalline structure and is term

as hypabyssal

Example:- Dolerite

④ Magma cools rapidly, its mass expands due to rapid cooling of swollen dumps of magma gives rise to glossy porous rock known as pumice.

⑤ pumice used as aggregate for light weight concrete & mineral admixture to lime and cement.

Sedimentary Rocks:- sedimentary rocks are also known as aqueous or stratified rocks. The various weathering agencies eg:- rain, sun air, frost etc. breaks up the surface of earth. Rain water carries down these broken pieces to rivers.

① The principal stones from sedimentary rocks are sand stone, lime stone and laterite.

② sedimentary rocks resulting from the accumulation of plants or animal remains

Metamorphic Rocks:- The rocks are formed from Igneous or sedimentary rocks as a result of the action of the earth movements, temperature changes, liquid pressures etc. The resultant mass may have a foliated structure eg:- gneiss, schist . for a non foliated structure eg:- marble, quartzite and serpentine.

Based on physical characteristics of rocks:-

Stratified rocks:- shows distinct layers along which the rocks can be split the examples are sandstone, limestone, shale, slate marble etc.

unstratified rocks:- do not show any stratification and cannot be easily split in to thin layers. the examples of such rocks are granite, basalt trap etc.

Foliated Rocks:- have a tendency to split up only in a definite direct most of the metamorphic rocks have a foliated structure except fo quartzite and marble which have granular structure.

Based on chemical characteristics:-

the rocks may be classified as Argillaceous, silicious and calcario

Argillaceous:- the principal constituent of is clay [Al_2O_3] the rocks are hard and brittle eg:- slate, laterite etc.

siliceous:- the principal constituent ~~of clay~~ is silica (SiO_2) i.e) sand. the rocks are very hard and durable eg:- granite, basalt, trap quartzite, gneiss, syenite etc.

calcarious:- the principal constituent is lime eg:- limestone, marbl dolomite etc.

→ Dressing of stones for various purposes:-

(a) stones for facing:- All the stones should be chisel dressed on all the four sides except at the back. the faces shall be fine tooled. All the visible angles and edges shall be true to right angles and free from unsightly chipping.

(b) stones for Arches, Domes of circular moulded works:- the stones should be chisel dressed on all the beds and joints to the required faces and fine tooled. this makes the stones free from any welding and gives truly radial joints for proper bonding.

c) stones for sills and lintels :- these stones can be finished at any type finishing as required in local market as per purchasers for constr

d) stones for flooring:- the stone slabs should be cut by chisel in plane parallel to the natural bed. the edges are chiselled true straight and square. In the case of rough stone following the surfaces are rough chiselled. In case of a dressed stone flooring the surface are fine chise dressed or rough tools as specified.

→ Manufacturing of Bricks:- ① preparation of brick Earth :- pgno 16

② Moulding:- It is a process of giving a required shape to the brie from the prepared clay, soil and brick Earth. Moulding may be carried out by hand or by machines.

a) Hand Moulding:- In this process, the bricks are moulded by hand (ie) manually. It is adopted where man power is cheap and for producing a small quantity of bricks. A typical wooden mould shoul be prepared from well seasoned wood for making bricks.

the bricks prepared by hand moulding are of two types:-

i) Ground-moulded bricks.

ii) Table-moulded bricks.

i) Ground moulded bricks:- In this process, the ground is levelled an sand is sprinkled on it. the moulded bricks are left on the groun for drying such bricks do not have fog and the lower brick surface becomes too rough. To overcome these defects, moulding blo or boards are used at the base of the mould. the process consists of shaping in hands a lump of well pugged Earth, slightly more than tha

of the brick volume. It is then rolled in to the sand and with a jerk it is dashed in to the mould. The moulder then gives blows with his fists and presses the earth properly in the corners of the mould with his thumb. The surplus clay on the top surface is remo with a sharp edge metal plate called strike or with a thine wire stretched over the mould. After this the mould is given gentle slop and is lifted leaving the brick on the ground to dry.

(ii) Table moulded bricks:- The bricks are moulded on stock boards nailed on the moulding table. Stock boards have the projection for forming the ~~fog~~ frog. The process of filling clay in the mould is the same as explained above. After this, a thin board called pallet is placed over the mould. The mould containing the brick is then smartly lifted off the stock board and inverted so that the moulded clay along with the mould rests on the pallet. The mould is then removed and the brick is carried to the drying site.

(b) Machine moulding:- The moulding may be done by machines. It proves to be economical when bricks in huge quantity are to be manufactured at the same spot in a short time. Machine moulding can be done by either of the following process.

(a) plastic method (plastic clay machine):- The pugged clay is placed in the machine through a rectangular opening by means of an auger. clay comes out of the opening in the form of a bar. The bricks are cut

from the bar by a frame consisting of several wires at a distance of brick size and this is a quick and economical process. this process is also known as wire cut bricks.

(b) Dry press method:- In these machines the strong clay is first conver in to powder form. A small quantity of water is added to form a stiff plastic plate. such paste is placed in mould and pressed ~~in~~ by machine to form hard and well shaped bricks. these bricks are also known as pressed bricks. they can be sent directly for the next proce of burning.

③ Drying:- For drying, the bricks are laid longitudinally in stacks of width equal to two bricks. A stack consists of 8 or 10 tiers or courses. the bricks are laid along and across the stack in alternate layers. All bricks are placed on edge. the bricks in stakes should be arranged in such away that sufficient air space is left between them. the bricks should be allowed to dry till they become hard or the moisture content is brought down to about 3%. under exposed conditions with in 3 to 4 days. for the drying ~~pe~~ purpose, drying yards should be prepared. the drying yards should be slightly on a higher level and it is desirable to cover it wit Sand. such an arrangement would prevent the accumulation of rainwat

④ Burning:- this is a very important operation in the manufacture of bricks. the burning of clay may be divided in to three main stages.

(a) Dehydration stage (400 - 650°c):- this is also known as water smoking stage. During Dehydration:-

i) the water which has been retained in the pores of the clay after dryi

is driven off.

(ii) some of the carbonaceous matter is burnt.

(iii) carbonated minerals are more or less decarbonated.

(iv) too rapid heating causes cracking or bursting of the bricks.

(b) oxidation period:- [650 – 900°c] During the oxidation period, the remaining carbon is eliminated and the ferrous ~~ion~~ iron is oxidize to the ferric form. Removal of sulphur is completed only after the carbon has been eliminated.

(c) vitrification [900 – 1250°c] :- to convert the mass in to the glass like substance, the temperature ranges from 900 – 1100°c for low melting clay and 1000 – 1250°c for high melting clay. Great care is required in cooling the bricks below the cherry red heat in order to avoid checking and cracking.

vitrification period may further be divided in to (a) incipient vitrification, at which clay has softened sufficiently to cause adherence but not enough to close the pores or cause loss of space on cooling the material cannot be scratched by the knife (b) complete vitrification more or less well-marked by maximum shrinkage (c) viscous vitrification produced by a further increase in temperature which results in a soft molten mass, a gradual loss in shape and a glassy structure after cooling. Generally clay products are vitrified to the point of viscosity. However, paving bricks are burnt to the stage of complete vitrification to achieve maximum hardness as well as toughness.

→ Different shapes of clay bricks with their uses:-

SI NO	title	shape	uses.
1.	Bull nose bricks	Round angle termed as bull nose	Moulding for queens [turning of walls]
2.	channel bricks	gutters and channels	For construction of drains.
3.	coping bricks	to suit the thickness of walls.	For copings of compound walls and parapet walls
4.	curved bricks	curved shape	For circular tanks, pillars chimneys etc.
5.	Hallow bricks	Hallow: light weight special homogeneous	For partition walls
6.	paving bricks (checkered bricks)	moulds with higher percentage of iron	For garden walls, street pavement etc.
7.	perforated bricks	moulds with cylindrical holes through out the ~~light~~ thickness (light weight)	For brick panels of light weight structures multistore frame works.
8.	Arch bricks	wedge shape to keep mortar	For Arch work
9.	Fire clay bricks	moulded to resist high temperatures with out loosing shape	For lining materials of furnaces.

uses of Aluminium:-

① pure Aluminium is very soft and is unsuitable for structural purposes.

② satisfactory properties are ~~derwi~~ derived by alloying copper, mangan zinc, silicon, nickel with aluminium.

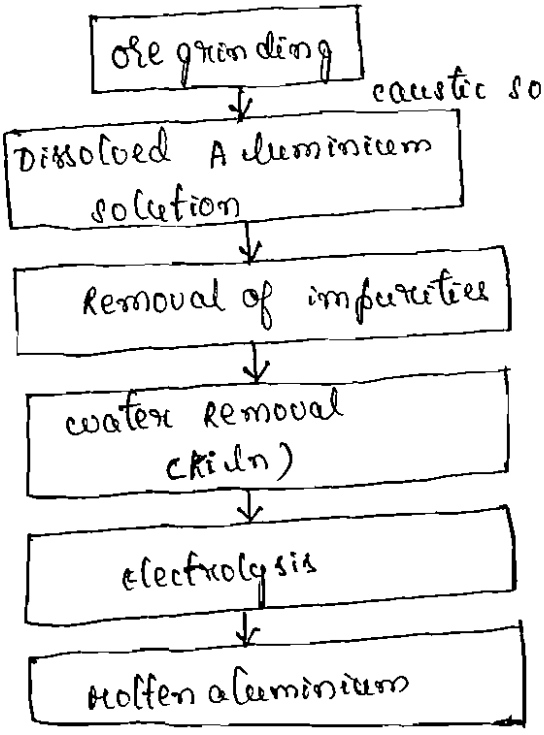
③ It is most suitable for making door and window frames, railin of shops and corrugated sheets for roofing system.

④ Aluminium sheets are used over doors in bathrooms to protect them from getting rot and for stamping in to a variety of shap

⑤ Aluminium powder is used for making paint.

⑥ Aluminium is extensively used in making parts of internal combus engine, airplanes, utensils and packings for medicines, choclates etc.

⑦ Aluminium alloys are widely used for the manufacture of rolled sections, such as angles, channels, I-sections, round and rectangul pipes, rivets and bolts.



→ Glass:-

Glass is a mixture of a number of metallic silicates one of which is usually that of an alkali metal. The varieties of glass are being used in building industry for various purposes such as walls, ceilings [hollow glass blocks] windows, doors, bathroom fittings, glazing etc.

properties of glass:-

① It is basically a hard, brittle, transparent or translucent material

② The properties such as hardness, fusibility, refractive powder etc can be changed according to the requirements.

③ It is not affected by ordinary chemical reagents, air or water.

④ It is possible to weld pieces of glass by fusion.

⑤ It is effected by alkalies but can take up high polish.

⑥ It provides excellent electric insulation due to uncertain crystalline structure

⑦ It absorbs refracts or transmits light depending upon the variety for a particular use.

⑧ It is available in beautiful colours.

⑨ It has no sharp melting point.

⑩ As it can be changed to desired viscosity by heating and cooling, so can be fabricated in to desired sizes and shapes.

uses of Different varieties of glass for Different purposes:-

Glass and Allied products	uses of Glass and Allied products for Different purposes
1. crown glass or soda lime glass — cheapest quality of glass.	1. Glass tubes, windows, panes, glass, electric bulbs, bottles etc.
2. Flint glass or potash lead glass	2. Electric bulbs, optical lenses, radiovalve table ware etc.
3. Hard glass or Bohemian glass or potash lime glass.	3. Glass articles subjected to high temperature such as combustion tubes.
4. pyrex glass or boro silicate glass	4. High quality laboratory apparatus and cooking utensils.

(5) common Glass or Bottle Glass
(6) Flat drawn sheet Glass
(7) Fluted sheet glass [when one side of sheet fluted]
(8) plate glass [stronger than sheet glass and more transparent]
(9) wired glass [wire mesh embeded inside the glass]
(10) Heat Insulating Glass [glass sheet separated by air gap]
(11) obscurred glass [vision is obscurred out but light passes - types - figured, ground chipped and corrugated]
(12) tinted glass such as ultra-violet ray glass decorative glasses.
(13) Glass blocks
(14) Bullet-proof Glass [layers of plate glass joined by vinyl resin]
(15) Fibre glass [composed of glass rods]
(16) Foam glass [ground glass and carbon]
(17) shielding glass
(18) structural glass [made by joining two halves and pressing]

(5) Medicine bottles.
(6) most common for all Engineering purposes.
(7) Glazing, high grade work such as cabinet glazing etc.
(8) show cases, shop fronts, shelves, dang mirrors etc.
(9) Fire resisting doors and windows, sky lights and roofs.
(10) windows of railway coaches, hospital laboratories etc.
(11) used where privacy is required with out obstructing light such as office doors, partitions and public toilets etc
(12) used for decoration and light exclusi purposes such as windows of schools, hospit etc.
(13) partitions up to 6m and for Insulati purposes.
(14) showcases, jewellery stores, glazing bank teller, cashier boothe.
(15) Air filters to remove dust.
(16) substitute for cork in air condition and refrigeration Industries.
(17) windows subject to high radiation
(18) Different sizes and shapes used for Insulation panel walls, partitionwo Facings, day light openings, stairway enclosures etc.

→ Gypsum:-

① It is a combination of calcium sulphate with water of crystallization [i.e chemically $CaSO_4 \cdot 2H_2O$] and it is white colour substance found in the form of rock in nature. Gypsum containing up to 70% of $CaSO_4 2H_2O$ can be used as a building material. It is mainly used in the manufacture of cement to incr its setting time.

② plaster of paris and Hardwall plaster:-

when finely ground gypsum rock is heated to a temperature between 100°c to 140°c three fourth of the combined water passes off as steam. The remaining product is known as plaster of paris. If pure gypsum has been used and 'Hardwall plaster' if the gypsum rock containing impurities is used.

③ Gypsum Anhydrite:- If we heat gypsum rock further up to a temperature of abou 200°c then entire water of crystalligation is driven off and the resultant product is known as "Gypsum Anhydrite". or "hard burnt plaster".

④ proprietary plasters :-

some hard burnt plasters are double burnt. The hard burnt plaster is impregnated with a chemical solution and burnt again. some important varieti of such plaster are ① keene's cement – Gypsum calcined with alum.

② parian's cement – Gypsum calcined with borax.

③ martins cement – Gypsum calcined with pearlash.

④ mack's cement – Gypsum calcined with Glauber's salt.

⑤ Sirapite – Gypsum slaked in petroleum.

uses:- ① As Insulating material to protect wood or metal columns and beams from high temperature.

② For finishings corners and angles as they have high resistance to wear.

③ They are ~~available~~ valuable for repair work.

④ For hard water-proof coatings on the walls of bath rooms, kitchens and laundries.

⑤ plastering of interior walls, followed by a polish etc.

5. plaster Board:-

It is a large sheet of gypsum plaster faced on both sides with stout paper o a reinforcement. Depending upon the nature of facing paper, the plaster boards are of two types

① Gypsum lath board:- when facing paper is rough and meant to provide an adhesive grip for plaster finish.

② plaster wall board:- when facing paper is of self finish type of meant for decoration such as a wood veneer.

uses:- these plaster boards, varying in thickness from 9.5mm to 12.5mm, posse good insulation properties and are being used for ceilings for internal lining of walls and for partition walls.

6. pyrocell:- It consists of finally ground gypsum powder, and such an admixt which on being mixed with water forms a gas and expands the mixture to 3 or 4 times its volume. this gas inflated paste hardens in to a product known as pyrocell. this pyrocell is light, cellular, fire resistant mass which can be used for Acoustical and insulating purposes in Buildings.

→ Bitumen:-

It is obtained by fractional distillation from crude petroleum as an end produ Bitumen is available in various forms

(a) straight run bitumen:- It is a bitumen distilled to a definite viscosity or penetration with out further treatment.

(b) Blown Bitumen:- It is that properties of which has been modified by passing the air under pressure and at a higher temperature. Based on softening point and penetration value, it is available in ten grades. single grade or combination are used for general purposes viz for manufacturing roofin and damp proofing felts and also plastic bitumen for teak steps. fixing of heat Insulation materials for buildings, manufacture of water proof packing paper, pipe asphalts, joint fillers, bituminous filling compounds etc and fixing of roofs and damp proofing felts.

(c) cut back Bitumen:- It is obtained by fluxing asphaltic bitumens with suitable liquid distillates of petroleum or coal tar.

d) plastic Bitumen:- It consists of a bitumen, thinner and suitable inert fillers such as asbestors fibre/powder. The amount of inert fillers used is about 40 to 45%. It is used for the purpose of stopping leaks and fillers cracks in masonary struct for water proofing.

e) Bitumen emulsion:- It is a liquid product in which large amount of bitumen is suspended in finely divided condition [i.e) globules] in an aqueous medium and stabilized by means of one or more suitable agents.

4. When thus the clamp is built only one third its full size, it is fired at the lower end, while the loading is still continuing. The object of this is to burn the lower part, while the spaces for an upward draught are still open.

5. When the loading is completed, the clamp is plastered over with mud to prevent escape of heat and left to burn itself out and cool.

Wood or coal may also be used as fuel for clamp. Each clamp will burn from 30,000 to 1,00,000 bricks and take from three to six months to burn and cool. The clamp is temporary structure for burning and it is build again for the next burning of bricks.

Advantages of clamp burning:

The advantages of clamp burning are as follows:

1. The burning and cooling of bricks are gradual in clamps. Hence bricks produced are tough and strong.
2. The burning of bricks by clamps proves to be cheap and economical.
3. No. skilled labour and supervision are required for the construction and working of clamps.
4. The clamp is not liable to injury from high wind or rain.
5. There is considerable savings of fuel.

Disadvantages of clamp burning:

The disadvantages of clamp burning are as follows.

1. The shape of bricks are not uniform.
2. It is very slow process and it is not suited for large quantity.
3. It is not possible to regulate fire in clamps, once it starts burning and the bricks are liable to uneven burning.
4. The quality of bricks is not uniform. The bricks near the bottom are over burnt and those rear sides and top are unburnt.

Burning of bricks in kilns:

A kiln is a large oven which is used to burn, bricks. This kilns which are used in the manufacture of bricks are of the following two types.

(a) Intermittent kilns.

(b) Continuous kilns.

(a) Intermittent kilns:

The figure 3.8 shows the plan and elevation of typical over ground intermittent kiln. The structure of the kiln is of permanent nature, but the process is discontinuous. After loading the kiln, it is burnt, cooled and unloaded. And then it is ready for the next loading. Thus there is wastage of fuel in these kilns as the side walls and the floor get cooled by the time the kiln is reloaded. These kilns have to be heated again at the time of subsequent firing. Though the bricks are more evenly burnt as compared with clamp, still, those at the top are underburnt, and a certain amount at bottom is over burnt.

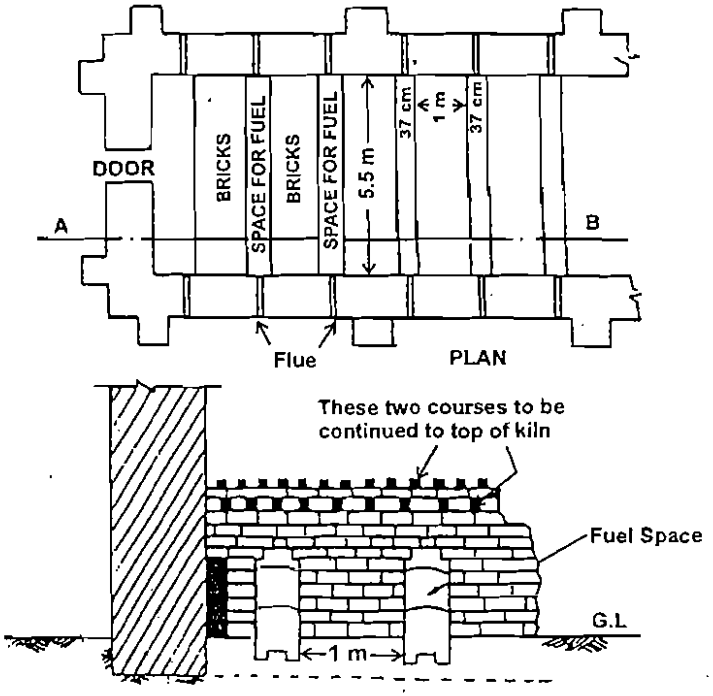


Fig. 3.8

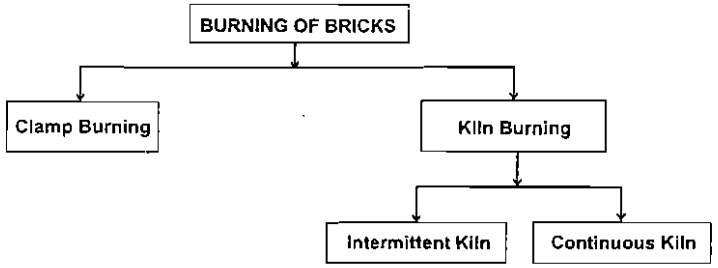
Continuous kilns:

In the continuous kilns, while the bricks in one set of chambers are being fired, the bricks is the next set of chambers are getting dried out and preheated, the bricks in the other set of chambers being loaded and in the last being cooled.

It is not desirable to dry the bricks directly exposed to sun. But suitable screens are to be provided.

3.14. BURNING OF BRICKS:

It is very important operation in the manufacture of bricks.



Types of Burning of Bricks

The functions of burning of bricks:

1. It imparts hardness and strength to bricks.
2. It makes dense and durable to bricks.

Note:

1. The bricks are to be burnt properly to achieve strength and durability.
2. If the bricks are over burnt, they will be brittle and hence break easily.
3. If the bricks are unburnt, they will be soft and hence can not carry loads.

The burning of clay bricks may be divided into three main stages.

(a) Dehydration, (b) Oxidation period, (c) Vitrification.

(a) Dehydration: (It is also known as water smoking stage) In this stage of burning, when the temperature of dull heat is attained (about 650°C) the organic matter contained in the brick is oxidized and also the water of crystallization is driven away. Further heating of bricks is continued for the next stage.

(b) Oxidation period: (650°C to 1100°C): The further heating of bricks continued due to the following purposes.

1. If the bricks are cooled after attaining the temperature of about 650°C, the bricks formed will absorb moisture from the air and get rehydrated.
2. The reaction between the mineral constituents of clay are achieved at higher temperature and these reactions are necessary to give new properties such as strength hardness, less moisture absorption etc. to the bricks.

3. When the temperature about 1100°C, the particles of two important constituents of brick clay namely Alumina and sand, bind themselves together resulting in the increase of strength and density of bricks.

(c) Vitrification: After the stage of oxidation period, further heating is not desirable and if the temperature raised beyond 1100°C a great amount of fusible glassy mass is formed and the bricks are said to be vitrified. The bricks begin to loose their shape beyond a certain limit of vitrification.

The burning of bricks is done either in clamp or in kilns. The clamps are temporary structures and they are adopted to manufacture bricks on a small scale to serve the local demands or a specific purpose. The kilns are permanent structures and they are adopted to manufacture of bricks on a large scale. They have arrangements for interducing fuel during the burning period.

Burning of bricks by clamp:

A clamp is a stock of raw bricks protected temperarly around the sides and top to minimise the loss of heat and arranged so that it will burn. A cross section of typical clamp is shown in figure 3.7.

Procedure:

1. In clamp burning a layer of fuel consenting of grass, cow dung and litter about 0.75 m thick in first laid.
2. Above it a layer of four or five courses of bricks are laid on edge with small spaces between them.
3. A second layer of fuel is then laid followed by another layer of five courses of bricks on edge and so on the proposition of fuel gradually diminishing towards the top.

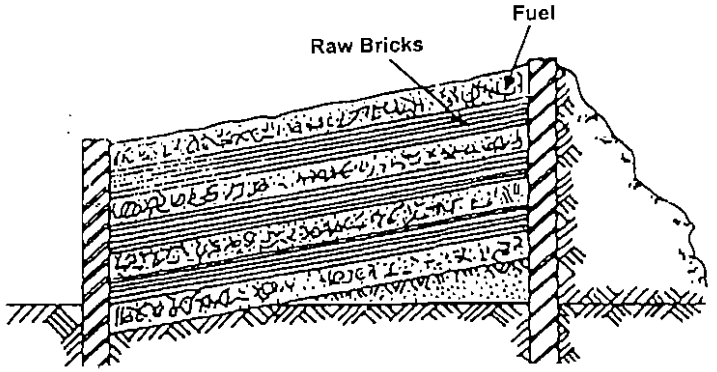


Fig. 3.7: Section of clamp burning

The arrangements in such that air enters through the loading chambers and passed through the stacks of bricks being cooled and gets preheated. The preheated air enters the burning zone and the hot gasses of combustion from the burning zone have to passes through the dried bricks for preheated before entering the chimney. Thus cool air is preheated by cooling the burnt bricks and hot gasses lose their heat to the bricks which are to be burnt. This saves fuel and makes it an economical process more over the supply of bricks is ensured throughout the year. Bull's trench kiln and Hoffman's kiln belong to this class of kilns.

(a) Bull's Trench Kiln:

Bricks are stocked in sections of about 5.0 m length, 4.5 to 9 m in width and 2.25 m in height, each section being separated by bricks of about 15 cm over which two chimneys are placed. The outgoing gasses from one section which is being fired, is led to the next section for warning the stock brick, before they escape out of the chimney.

As the burning in one section is completed, the fuel holes of this section are closed by cooling the burnit bricks. This kiln stops working in mansons. Though less economical in fuel cost as compared to Haffman's kiln, it has the advantage of being more economical in the initial cost. See fig. 3.9.

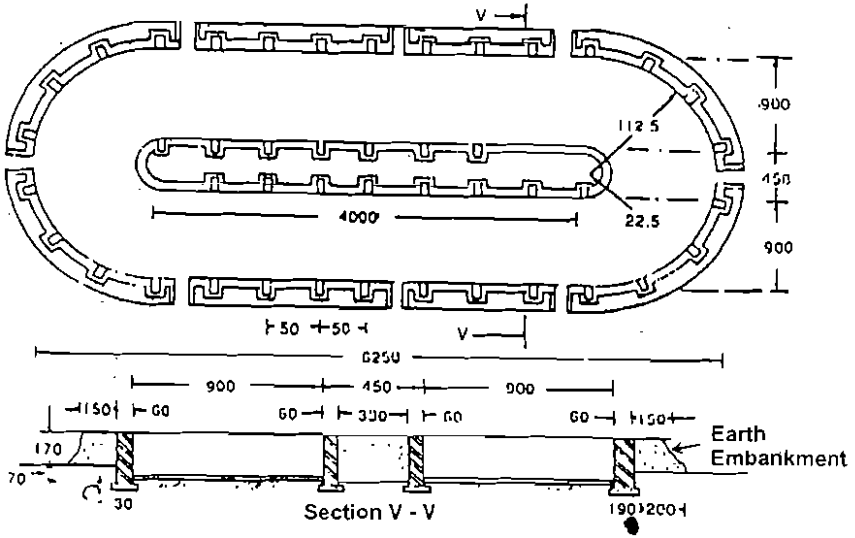


Fig. 3.9: Bull's Trench Kiln

(b) Haffman's Kiln:

This type of kiln has a chimney at the centre ground which there are twelve chambers in the form of a ring. Every chamber has a door opening outside, which can be cooled or opened when required by using the relevant damper. The operation of loading, preheating of bricks, burning of bricks, cooling of burnt bricks and unloading of bricks are carried on simultaneously in the kiln.

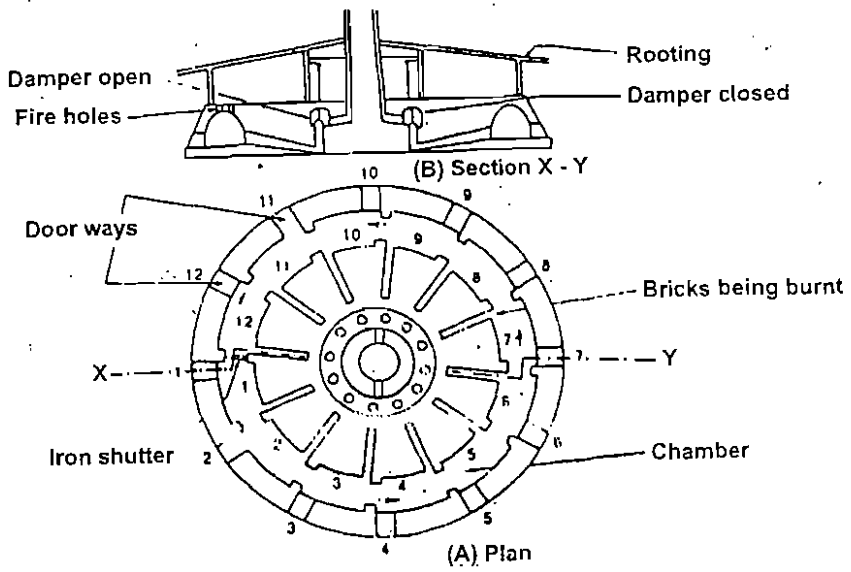
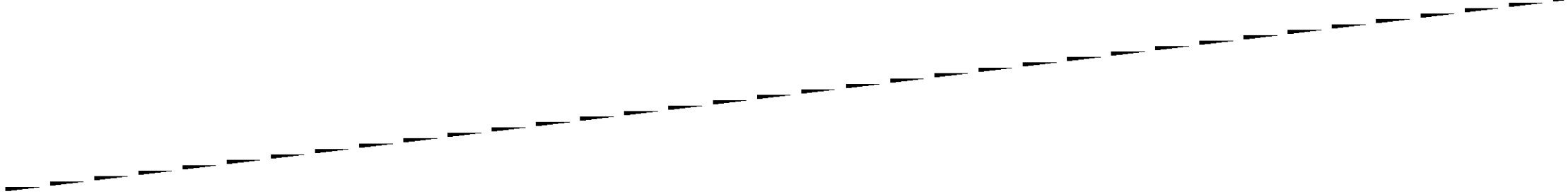


Fig. 3.10: Haffman's Kiln

The Kiln can be work out throughout the year and can manufacture 20,000 bricks per day. (Fig. 3.10) shows the plan and section of Haffman's Kiln.

Table 3.1: Comparison of Burning of Bricks (Clamp Burning and Kiln Burning)

Sl.No.	Property / Item	Clamp burning	Kiln burning
1.	Manufacturing capacity	About 20,000 to 1,00,000 bricks at a time.	Average 25,000 bricks per day.
2.	Cost of fuel	Low (cheap type fuels, grass, cow dung etc.)	High, (coal dust etc.)
3.	Initial cost	Low (no structures are to be built)	More (permanent structure are to be constructed.)



t. These tiles exists either in rectangular or square shape
There are laid in one or two layers in cement or lime
for flat as well as sloped roof below the mangalore tiles

he flat tiles are further divided into the following Types:

tiles.

e thus slabs of slate. There are uniform in colour texture
ers etc. Water absorption is not more than 20%.

al roofing tile.

es: The tiles made with good clay, uniform texture and uniform
, shape, free from bend, cracks, pebbles etc. They are used
e Tiles, pot tiles, pan tiles etc.

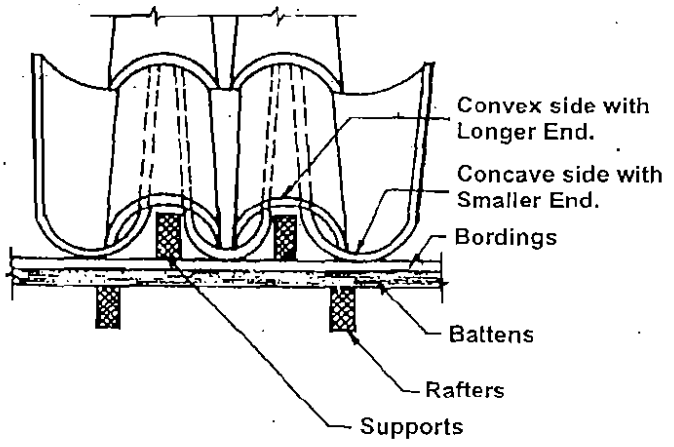
: Length 25 to 15 cms in stages of 2.5 cms.

10 cms in stages of 2.5 cms

0 mm to 15 mm,

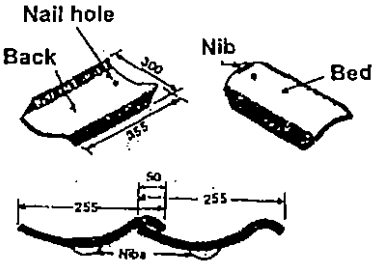
s ± 2%

tile

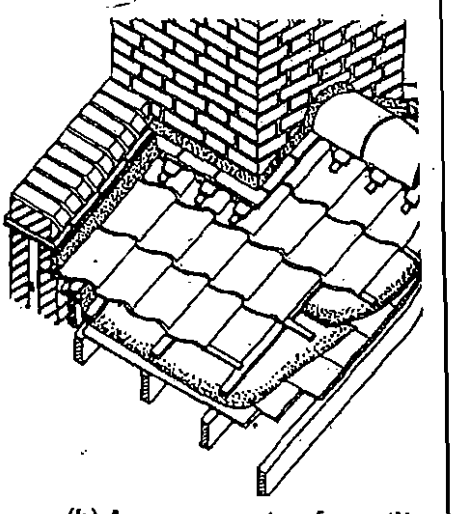


(b) Arrange of Pot tile

Fig. 3.15

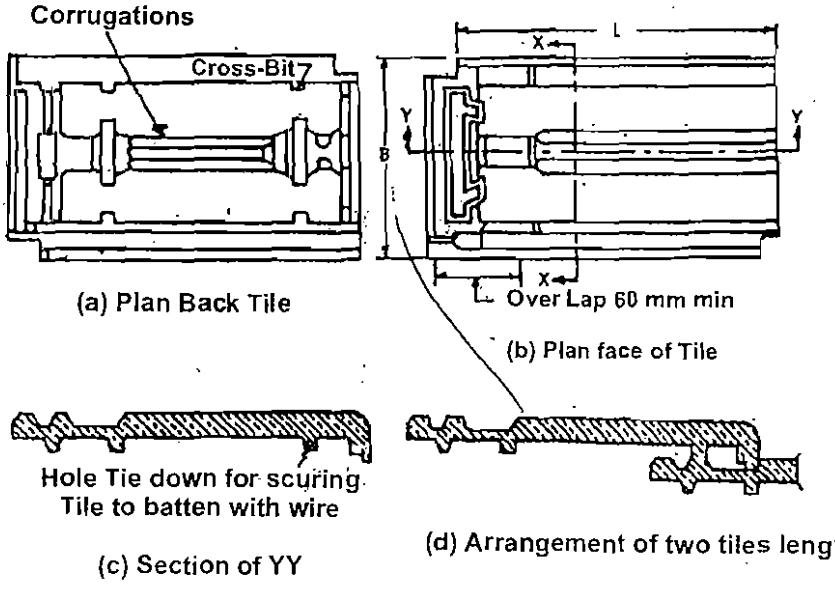


(a) Section through two pan tiles



(b) Arrangements of pan tile

Fig. 3.16



(a) Plan Back Tile

(b) Plan face of Tile

(c) Section of YY

(d) Arrangement of two tiles length wise

Fig. 3.17: Mangalore Tiles