STONES

Date:-15/07/1

CLASSIFICATION OF ROCKS

The rocks are classified in the following three types:-

1. Geological classification
2. physical classification
3. chemical classification

1. Geological classification

According to this classification, the rocks are of the following three types:

(i) Igneous Rocks;
(ii) Sedimentary Rocks; and
(iii) Metamorphic Rocks.

(i) Igneous Rocks: In inside portion of the earth's surface has high temperature so as to cause fusion by heat at even ordinary pressures. The molten or pasty rocky material is known as the magma and this magma occasionally tries to come out to the earth's surface through cracks or weak portions. The rocks

(2)

Which are formed by the cooling of Magma is known as Igneous rocks.

This are further classified into three types:-

① Plutonic Rocks: This rocks are formed due to cooling of Magma at a considerable depth from the earth's surface. The cooling is slow and the rocks possess coarsely grained crystalline structure. Ex:- Granite

② Hypabyssal Rocks: Such rocks are formed due to cooling of Magma at a relatively shallow depth from the earth's surface. The cooling is quick and rocks possess finely grained crystalline structure.

Ex:- Dolerite

③ Volcanic Rocks: Such rocks are formed due to pouring of Magma at earth's surface. The cooling is very rapid as compared to the previous two cases.

Ex:- Basalt

(ii) Sedimentary Rocks: These rocks are formed by the deposition of products of weathering on the pre-existing rocks. All the products of weathering are ultimately carried away from their place of origin by the agents of transport like frost, rain, wind, flowing water etc.

Ex:- Gravel, sandstone, limestone, gypsom, lignite, etc.

(iii) Metamorphic Rocks: The igneous as well as sedimentary rocks are changed in character when they are subject to great heat and pressure by this metamorphic rocks are formed.

(2) Physical classification

This classification is based on general structure of rocks.

(i) stratified Rocks;

(ii) Unstratified Rocks; and

(iii) Foliated Rocks.

(3) Chemical classification

This classification is known as the scientific or engineering classification and according to this classification the rocks of the following three types : (i) Silicious Rocks;
(ii) Argillaceous Rocks; and
(iii) calcareous Rocks.

(i) Silicious Rocks : It contains silica predominates. The rocks are hard & durable. Ex :- Granite, quartzites, etc.

(ii) Argillaceous Rocks : It contains argil or clay predominates, such rocks May be soft. These stones are hard and durable but brittle. Ex :- Slates, laterites, etc.

(iii) Calcareous Rocks : In these rocks, the calcium carbonate predominates. The durability of these rocks will depend upon the constituent present in the surrounding atmosphere.

Ex :- Limestones, Marbles, etc.

(5) Date:- 17/07/19

NATURAL BED OF STONES

The building stones are obtained from rocks. These rocks have a distinct plane of division along which stones can easily be split. This plane is known as natural bed of stone and it thus indicates the plane or bed on which the sedimentary stone was originally deposited.

STONE QUARRYING

The process of taking out stones from natural rock beds is known as the quarrying.

Methods of quarrying

1. Quarrying by hand tools
2. Quarrying by channelling machine
3. Quarrying by blasting

(1) Quarrying by hand tools

(i) Digging / excavating: In this method, the stones are excavated with the help of suitable instruments like

hammers, showels, chisels, etc. This method is useful when soft stones occur in the form of large or small blocks.

(ii) Heating: In this method, the top surface is the rock is heated. This is usually done by placing pieces of wood or by piling of a heap of fuel over the rock surface and setting or steady fire to them for some hours. Due to unequal expansion, the upper layer of rock separates out.

(iii) Wedging: In this method, if rock surface contains cracks, the steel wedges are driven through such cracks by means of hammers. The blocks of stone are then shifted and they are removed with the help of suitable instruments.

2 Quarrying with channelling machine

In this method, the channelling machines driven by steam and electricity are used to make vertical grooves or channels on the rock mass.

→ These machines make rapidly the grooves having length of about 24 m, width of about 50mm-75mm and depth of about 2.40 m.

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

→ The horizontal holes are drilled beneath the block.

→ The wedges are driven into the holes and the block is then brocken loose from its bed.

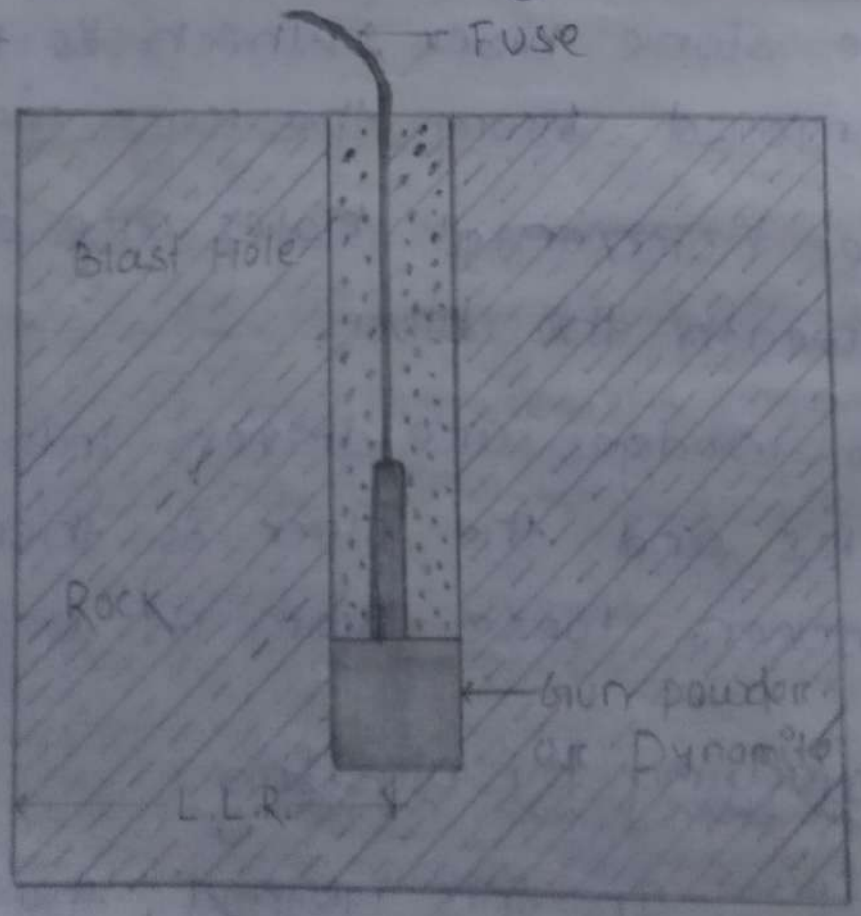
3 Quarrying by blasting

In this method, the explosive are used to converet rocks into small pieces of stones.

→ The main purpose of quarrying stones by blasting is to convert it into very small pieces.

Tools for blasting: Following tools are required in the process of blasting :- Dipper, Jumper, priming needle, scraping spoon, tamping bar.

Materials for blasting: Following materials are required in the process of blasting :



PROCESS OF BLASTING

QUALITIES OF A GOOD BUILDING STONES

(1) Crushing strength: For a good structural stone the crushing strength should be greater than $100 N/mm^2$.

(2) Appearance: The stones which are to be used for face work should be decent in appearance and they should be capable of preserving their colour uniformly for a long time.

(3) Durability: A good building stone should be durable. The various factors contributing to durability of a stone are its chemical composition, texture, resistance to atmospheric and other influences, location in structure, etc.

(4) Facility of dressing: The stones should be such that they can be easily carved, moulded, cut and dressed.

(5) Fracture: For a good building stone its fracture should be sharp, even, bright and clear with grains well cemented together.

(6) Hardness: The co-efficient of hardness, as worked out in hardness test, should be greater than 17 for a stone to be used in road work.

→ If it is between 14 and 17, the stone is said to be of medium hardness.

(7) percentage Wear: In attrition test, if wear is more than 3%, the stone is not satisfactory.

→ If it is equal to 3%, the stone is just tolerable.

(8) Resistance to fire: The minerals composing stone should be such that shape of stone is preserved when a fire occurs.

(9) Seasoning:- The stones should be

(11)

well seasoned before putting into use.

(10) Specific gravity: For a good building stone, its specific gravity should be greater than 2.7.

(11) Texture: A good building stone should have compact fine crystalline structure free from cavities, cracks or soft or loose material. The stone with such texture are strong and durable.

(12) Toughness - Index: In impact test, if the value of toughness - index comes below 13, the stone is tough. If the toughness - index comes between 13 and 19, the stone is said to be moderately tough.

→ If it exceeds 19, the toughness of stone is said to be high.

(13) Water absorption: All the stones are more or less porous, but for a good stone, percentage absorption

by weight after 24 hours should not exceed 0.60.

(14) Weathering: A good building stone should possess better weathering qualities. It should be capable of withstanding adverse effects of various atmospheric and external agencies such as rain, frost, wind, etc.

DRESSING OF STONE Date :- 20/07/2019

The stones, after being quarried, are to be cut into suitable sizes and suitable surface. This process is known as the dressing of stones.

(i) To get the desired appearance from stone work,

(ii) To make the transport from quarry easy and economical,

(iii) To suit to the requirements of stone masonry,

(iv) To take advantages of local men near quarry who are trained for such type of work, etc.

COMMON BUILDING STONES OF INDIA

No.	Stone	Classification	Qualities	Uses	Localities
1.	Basalt and trap	Igneous	Hard and tough; difficult to work. Its compressive strength varies from 18 to 29 KN per m^3.	Road metal, for rubble masonry, foundation work, etc.	Maharashtra, bihar, Gujarat, Bengal & M.P.
2.	Chalk	Sedimentary	Pure white limestone; soft and easy to form powder.	In preparing glazier's putty; as colouring material for portland cement.	Same as limestone
3.	Gneiss	Metamorphic	splits into thin slabs; easy to work. compressive strength is 206 N/mm^2.	Street paving, rough stone masonry work, etc.	Madras, Mysore, bihar, Kerala & gujarat.
4.	Granite	Igneous	Hard, durable and available in different colours, highly resistant to natural forces. compressive strength from 75 to 127 N/mm^2.	Steps, sills, facing work, walls, bridge piers, columns, road metal, ballast, etc. It is unsuitable for carving.	Kashmir, Madras, Punjab, U.P, M.P, Orissa, Assam, Maharashtra.
5.	Kankar	Sedimentary	Impure limestone.	Road metal, manufacture of hydraulic lime, etc.	North and central india
6.	Laterite	Metamorphic	Porous & spongy structure and available in different colours. strength 1.80 - 3.10 N/mm^2.	Building stone, road metal, rough stone masonry work, etc.	Bihar, Orissa, A.P, Madras and mysore Maharastra.

No.	Stone	Classification	Qualities	Uses	Localities
7.	Lime-stone	sedimentary	consists of carbonate of lime; easy to work. compressive strength is 54 N/mm².	Floors, steps, walls, road metal, manufacture of lime in blast furnaces, etc.	Maharashtra, Punjab, Bihar, Himachal Pradesh, M.P & U.P.
8.	Marble	Metamorphic	Can take good polish and available in different colours. Strength ~~colour~~ is 71 N/mm².	Flooring, facing work, steps, ornamental work, etc. It can easily be sawn and carved.	Rajastan, Gujarat, Mysore, M.P & U.P, Maharashtra.
9.	Murum	Metamorphic	Decomposed laterite, deep brown or red in colour.	Blindage for metal roads and garden walls	Same as laterite.
10.	Sand-stone	sedimentary	consists of quartz & other minerals, easy to work. Varies from 2.65 to 2.95 & strength is 64 N/mm². Its weight is about 20 to 22 KN per m³.	Steps, facing work, columns, flooring, walls, road metal, ornamental carving, etc.	A.P, M.P, Punjab, Gujarat, Andaman Islands, Kashmir, Madras and U.P, Maharashtra.
11.	Slate	Metamorphic	Black colour & splits along natural bedding planes; non absorbent. strength varies from 75 to 207 N/mm².	Roofing work, sills, damp-proof courses, etc.	U.P, M.P, Bihar, Madras, Rajasthan and Mysore.

BRICK

INTRODUCTION

Brick is a civil Engineering material, which is used for building construction. The brick is the oldest and basic building material.

→ It is used because it is durable, low cost and easily available.

→ The use of brick is very simple compared to stone.

→ The size of bricks are uniform therefore it should be easily handled, transported and use.

→ The bricks are obtained by moulding clay in rectangular blocks of uniform size, after drying and burning these rectangular block.

COMPOSITION OF BRICK

1. Alumina
2. Silica
3. Lime
4. Oxide of iron
5. Magnesia

① Alumina :- A good brick should contain about 20% to 30% of alumina.

→ This constituent imparts plasticity to the earth so that it can be moulded.

→ The excess of alumina causes shrink and warp during drying and burning.

② Silica :- A good brick should contain 50-60% of silica.

→ The presence of this constituent in brick earth prevents the defect in brick.

→ The durability of a bricks depend on the proper proportion of silica in the brick earth.

→ The excess amount of silica destroys the cohesion between particles.

③ Lime :- A small quantity of lime that is not exceeding to 5% is desirable in good brick earth.

→ The lime prevents shrinkage of raw bricks.

→ The excess of lime causes the brick too soft which melts easily and quickly.

(4) Magnesia:- A small quantity of magnesia in brick earth gives less shrinkage of bricks.

(5) Oxide of iron:- A small quantity of Oxide of iron is desirable a good brick earth.

→ It should not be extent 5-6%.

→ It provides red colour to the bricks.

→ If excess of oxide of iron is used then it will be blank in colour, If less the bricks will be yellow in colour.

MANUFACTURING PROCESS OF BRICKS

In the process of manufacturing bricks, the following four distinct operations are involved:

(1) preparation of clay
(2) Moulding
(3) Drying
(4) Burning

(1) Preparation of clay:- The clay for bricks is prepared in the following order:

(i) unsoiling
(ii) Digging
(iii) cleaning
(iv) Weathering
(v) Blending
(vi) Tempering.

(i) unsoiling:- The top layer of soil, about 200 mm in depth, is remove out because the clay in the top soil it is full impurities.

→ This impurities are to be rejected for purpose of preparing bricks such process is known as unsoiling.

(ii) Digging:- After the process of unsoiling the digging process is to be carried out.

→ In this process the clay is dug out from the ground then it is spred on the level ground just a little deep general level of the ground.

(iii) Cleaning:- In this process the clay should be cleaned of stones, vegetable matter

(iv) Weathering:- In this process the clay is exposed to atmosphere for softening.

→ For a large project, the process is carried out just before monsoon.

(v) Blending:- In this process after the process of weathering the next process is blending.

→ In this process the clay is made loose and some ingredient added to it.

(vi) Tempering:- In this process the clay is brought to make bet for the next process of moulding.

→ The water is required quantity is to be added in clay then the whole mass placed under the feet of men or cattle or pugmil (Machine).

(2) Moulding: It is the process where bricks are moulded into desired shape. Their are two types of moulding:-

(i) Hand Moulding
(ii) Machine Moulding

(i) Hand Moulding:- In hand moulding the bricks are moulded by hand.

→ It is adopted in which the manpower is cheap or low in price.

→ The moulds are rectangular in shape which are open at top and bottom.

→ The moulds may be made up wood or steel.

→ The steel mould is prepared from the combination of steel plates.

→ The steel moulds are more durable as compare to wooden mould and this gives uniform shape to the brick.

Hand Moulding are two types:-

(a) Ground - moulded bricks

(b) Table - moulded bricks.

(a) Ground - Moulded bricks:- The ground is first made level.

→ A small amount of water and fine sand is sprinkled on it. The mould is deeped in water and placed over

the ground.

→ The clay is placed in the mould that in such way it covers all the corners of mould.

→ The extra clay is remove either by wooden or metal spetula.

→ The mould is then lifted up and the raw brick is left on the ground.

→ A brick moulder can mould about 750 bricks per day with working period of 8 hours.

(b) Table - Moulded bricks :- The process of moulding these bricks is just similar to the previous process.

→ In this process to moulder stands near table a size about 2m x 1m. The clay, mould, water pots, stock board are placed on the above table.

→ The bricks are moulded on the table and then sent for the further process of drying.

→ The cost of remoulding increases

when the table moulded is adopted

(ii) Machine Moulding :- when machine is used for moulding bricks is known as machine moulding.

These are 2 types :-

(a) plastic clay machines

(b) Dry clay machines.

(a) Plastic clay machines :- such machine contain a rectangular opening of size is equal to the length and width of a brick.

→ The prepared clay is placed in the machine and as it comes out through the opening.

→ It is cut into strips by wires fixed in the frames as the bricks are cut by wires the process is known as wire cut bricks.

(b) Dry clay Machines :- In these machines the strong clay is first converted into powder form.

→ A small quantity of water is added

to form a stiff plastic paste. This paste is placed in mould & placed by machine to form hard and well shaped bricks.

→ These bricks don't requeire the process of drying.

→ They can be sent the process before the process of burning. as the bricks are form by machine is known as pressed bricks.

(3) Drying:- The damp bricks are likely to be cracked when it is burnt.

→ Hence the moulded bricks are dried before they are to be burnt.

→ For a drying bricks the longitudinally stacks are provided.

→ The stack consist of 8 to 10 layers of plates.

→ The bricks are laid along and across the stack in alternative layers.

→ The brick should be allowed to dry till they become hard.

Some important points to be remem-

bered in connection with drying of bricks:

(i) Artificial drying:- When the bricks are to be rapidly dry on the large scale, the artificial drying should be adopted.

→ In such a case, the moulded bricks are allowed to pass through or to dry through the special dryers.

→ In this system the temperature usually less than 120°C.

(ii) Drying yard:- For the drying process special drying yard should be prepared.

→ It should be slightly on a higher level, such arrangment would prevent the rain water.

(iii) Period for drying:- The time required by moulded bricks to dry depends upon weathering conditions.

→ usually it takes about 3 to 10 days for drying the bricks.

(iv) Circulation of Air :- The bricks should be arranged in such a way that sufficient air space is left between them for the good circulation of air.

(v) Screens :- It is to be seen that the bricks are not directly exposed to the wind or sun for drying.

→ Suitable screens, if nesessary, may be provided to avoid such situations.

④ Burning

→ This is very important operation in manufacturing of bricks.

→ It gives hardness or imparts and strength to the bricks and makes them dense and durable.

→ The brick should be burnt properly otherwise it will be brittle and hence break easily.

→ There are two types of burning process :- ① Clamp (small scale)
② Kiln (large scale)

(i) Clamp :- A piece of ground is selected. Its shape in plan is generally trapezodical / trapezoidal.

→ The brick wall in mud is constructed on the short end and a layer of fuel is laid on the prepared floor.

→ The fuel may be consist of grass, litter, husks of rice, cow dung, etc.

→ The thickness of this layer is about 700mm to 800mm.

→ The wood, coal dust may also used as fuel.

→ A layer consist of 4 or 5 courses of row bricks, is then put up.

→ A second layer fuel is then placed over it and another layer of row bricks are put up.

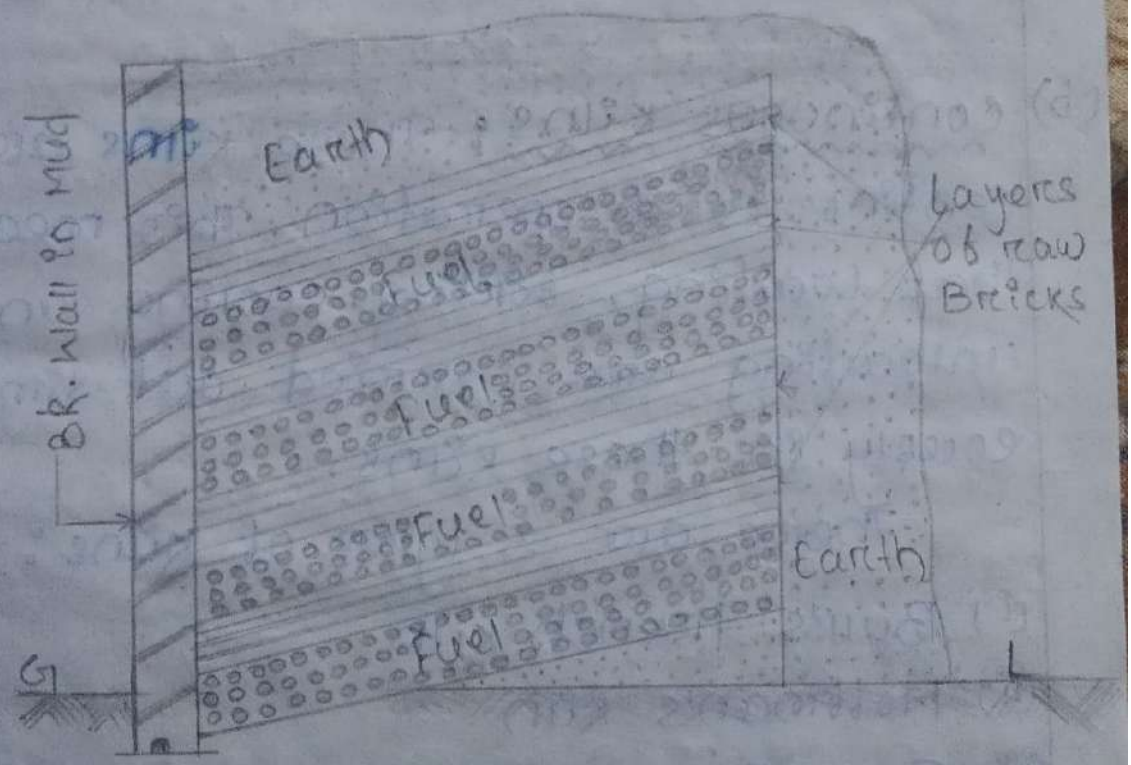
→ The total height of a clamp is about 3m to 4m. When the clamp is completely constructed, it is plastered with mud on sides and top and filled with earth to prevent the escape of

heat.

→ The clamp is allowed to burn for a period of about one to two months.

→ Then allowed to cool for more or less the same period as burning.

→ The burn bricks are then taken out from the clamp.



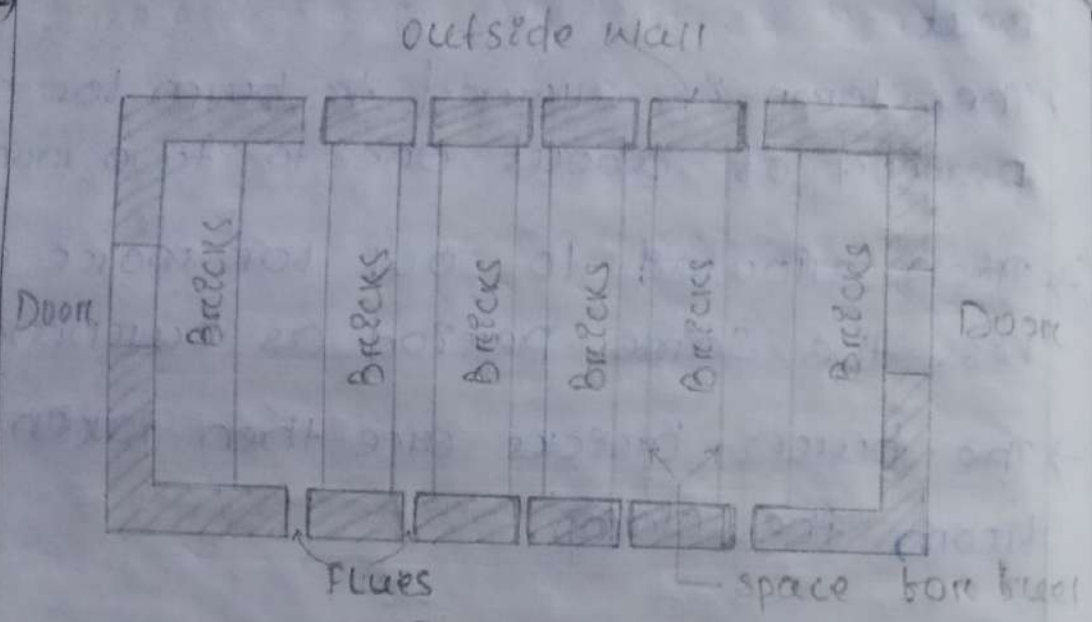
CLAMP

(ii) Kiln :- A kiln is a large oven which is used to burn bricks. They are classified in two types :-

(a) Intermittent kilns

(b) continuous kilns.

(a)



Intermittent Kiln

(b) Continuous Kilns :- These kilns are continuous in operation. This means that loading, firing, cooling and unloading are carried out simultaneously in these kilns.

There are 3 types of kilns :-

(i) Bull's trench kiln
(ii) Hoffman's kiln
(iii) Tunnel kiln.

(i) Bull's trench kiln :- This kiln may be rectangular, circular, or oval shape. As the name sugest, the kiln is constructed in a trench excavated in ground.

It may be fully underground or partly

projecting above ground.

→ The outer and inner walls are to be constructed of bricks. The openings are generally provided in the outer walls to act as flue holes.

→ The dampers are in the form of iron plates and they are used to divide the kilns in suitable sections.

→ This is the most widely used kiln in India and it gives countenuous supply of bricks.

→ The bricks are arranged in sections. They are arranged in such a way that flues are formed.

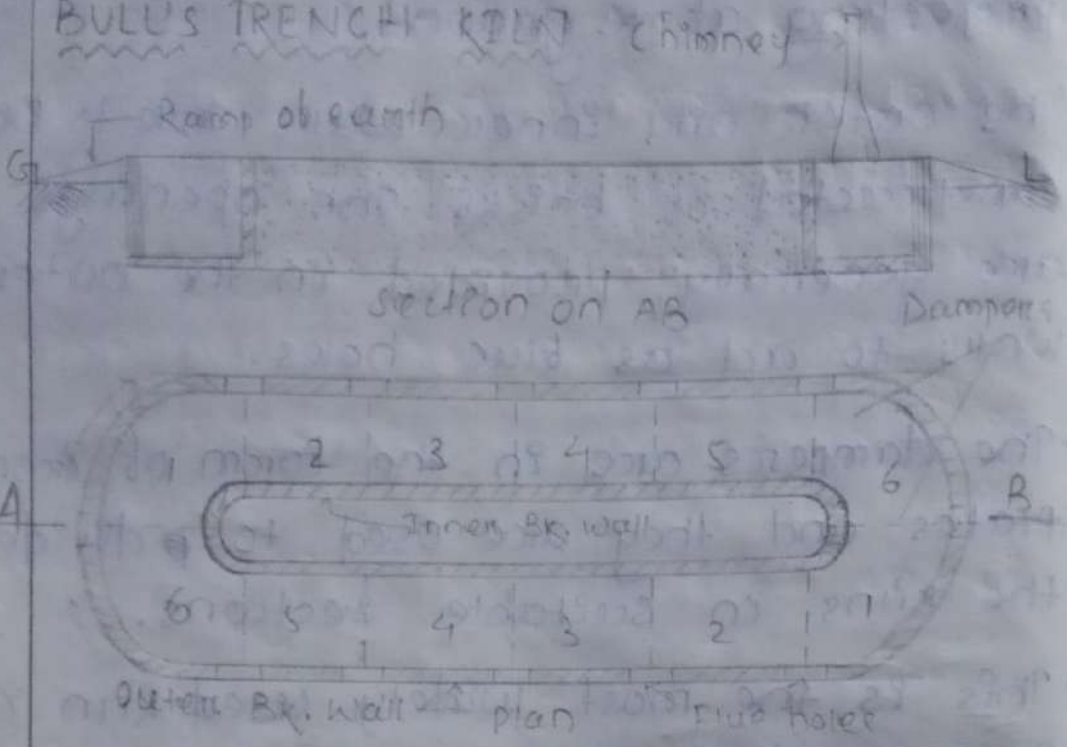
→ The fuel is placed in flues and it is ignited through flue holes after covering top surface with earth.

→ Each section requires about one day to burn.

→ when a section has been burnt, the flue holes are closed and it is allowed to cool down gradually.

Date:- 31/07/2019

BULL'S TRENCH KILN

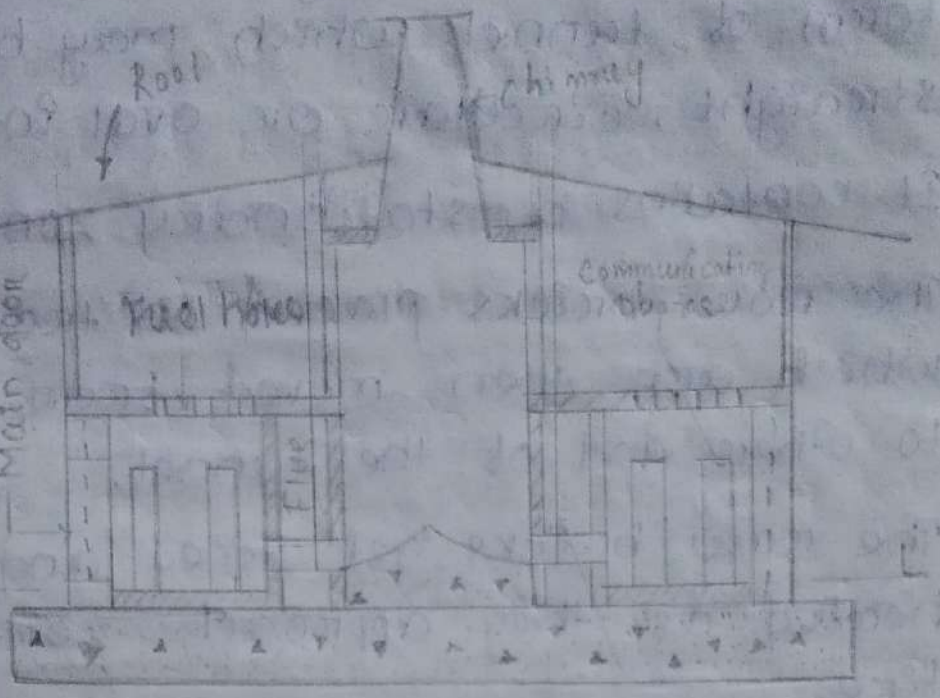


(22) Hoffman's Kiln :- The kiln is constructed overground and hence it is sometimes known as the flame kiln.

→ It shape is circular in plan and it is divided into a number of compartments or chambers.

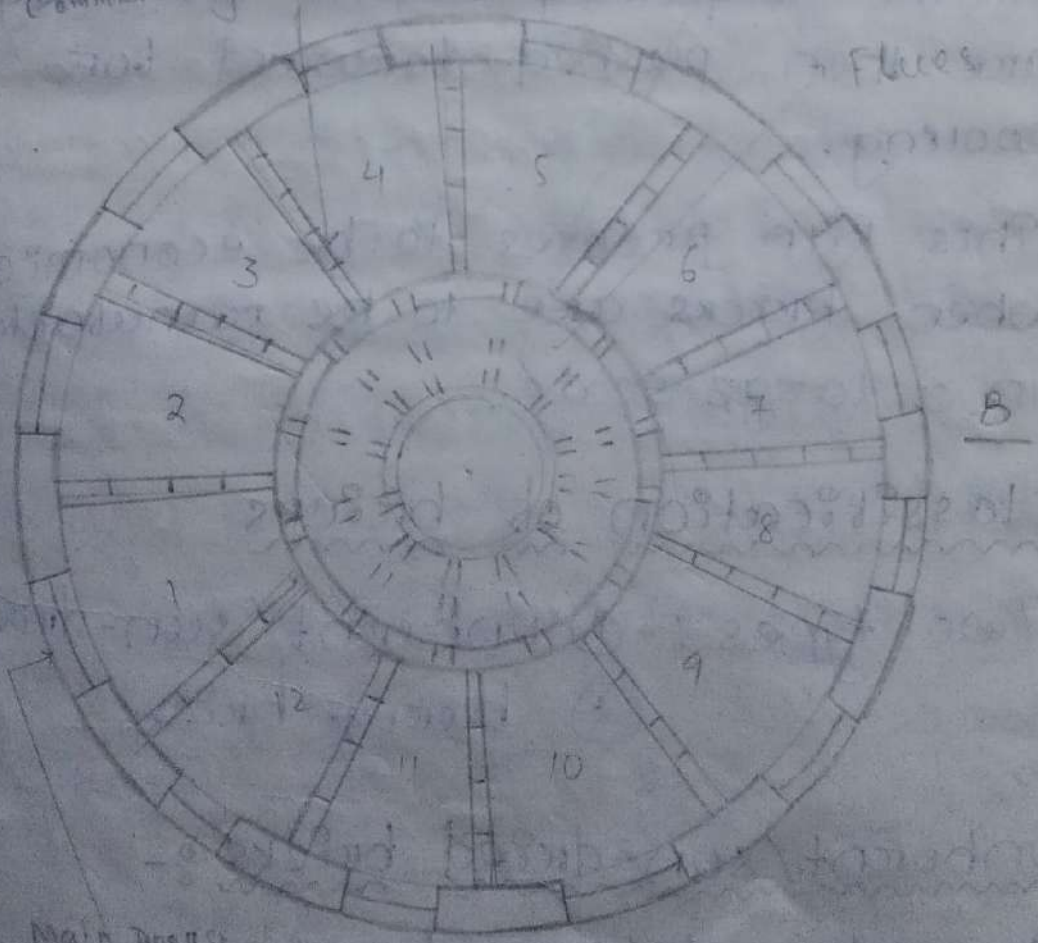
→ As a permanent roof is provided, the kiln can even function during rainy season.

→ In this type of kiln, each chamber performs various functions in succession, namely, loading, drying, burning, cooling and unloading.



Section on AB

Damper



Plan

HOFFMAN'S KILN

(iii) Tunnel Kiln :- This type of kiln in the form of tunnel which may be straight, circular or oval in shape.

→ It contains a stationary zone of fire.

→ The row bricks placed on trolleys which are then moved from one end to other end of the tunnel.

→ The raw bricks get dried and pre-heated as they approach zone of fire.

→ In zone of fire, the bricks are burnt to the required degree and they are then pushed forward for cooling.

→ This kiln proves to be economical when bricks are to be manufactured on a large scale.

Classification of bricks

Two types :- ① unburnt/sun-dried
② burnt bricks.

① unburnt/sun-dried bricks :-

→ The unburnt/sun-dried bricks are dried with the help of heat received

from sun.

→ These bricks can only be used in the construction of temporary and cheap structures.

→ Such bricks should not be used at places exposed to heavy rains.

(2) burnt bricks :- burnt bricks are classified into 4 categories :-

(a) First class bricks :- These bricks are table - moulded and of standard shape and they are burnt in kilns.

→ The surfaces and edges of the bricks are sharp, smooth, square and straight.

→ These bricks are used for superior work of permanent nature.

(b) Second class bricks :- These bricks are ground-moulded and burnt in kilns.

→ The surface of these bricks in somewhat rough and shape is also slightly irregular.

→ These bricks are commonly used at places where brickwork is to be

provided with a coat of plaster.

(c) Third class bricks :- These bricks are ground-moulded and they are burnt in clamps.

→ These bricks are not hard and they have rough surfaces with irregular in shape.

→ They are used for unimportant and temporary structures and at places where rainfall is not heavy.

(d) Fourth class bricks :- These are over-burnt bricks with irregular shape and dark colour.

→ These bricks are used as aggregate for concrete in foundations, roads, floors, etc.

Qualities of good bricks

→ The bricks should be table-moulded, well-burnt in kilns, copper coloured, free from cracks and with sharp and square edges. The colour should be uniform and bright.

→ The bricks should be uniform in shape and should be of standard size.

→ The bricks should give a clear metallic ringing sound when struck with each other.

→ The brick should not absorb water more than 20% by weight for first class bricks and 22% by weight for second class bricks, when soaked in cold water for a period of 24 hours.

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CHAPTER = 3

CEMENT, MORTAR AND CONCRETE

CEMENT

Cement is a civil engineering material which is used for various purposes such as in making of concrete, Mortar.

Composition of cement

(i) Lime – 62%
(ii) Silica – 22%
(iii) Alumina – 5%
(iv) Calcium Sulphate – 4%
(v) Iron Oxide – 3%
(vi) Magnesia – 2%
(vii) Sulphur – 1%
(viii) Alkalies – 1%

Types of cement

① Acid resistance cement

→ An acid resistance cement is composed of following ingredient:-
(i) Acid resistance aggregate
(ii) Sodium fluosilicate
(iii) Sodium Silicate
The sodium fluosilicate increased

the resistic power of cement. The acid resistance cement is not water resistance cement. It fell attacked with water.

→ The cement is used as acid resistance and heat resistance putting, coating for insulation in chemical industry.

(2) Blast furnace cement

For this cement the slag which is obtained from blast furnace is used.

→ properties of this cement is less as compare to ordinary portland cement.

→ The structure constructed from the blast furnace cement gives less strength.

(3) Colocered cement

when some colocering material is mixed with ordinary cement the cement is known as colocer cement.

→ The amocent of colocering material varies from 5 to 10 percent. It this

percent exceeds the strength of cement is affected.

→ chromicem oxide gives green colour.

→ cobalt gives blue colour.

→ Iron oxide gives red colour.

→ Manganese dioxide is used to produce blackies or brown colour cement.

→ The coloured cement is widely used for finishing of floor, external surfaces of building, artificial marble.

(4) Expanding cement

This type of cement is produced by addition of expanding ingredients like sulphur aluminate to the ordinary cement hence the cement is tends to expands.

→ This types of cement is used for construction water retaining structure & also for repairing the damaged concrete structure.

(5) High - Alumina cement

This cement is produce by

grinding clinkers formed by calcinating bacexite and lime.

→ The percentage of alumina content should not be less than 42% in this cement.

→ The ratio by weight of alumina to the lime should be between 1.15 to 1.30.

→ This cement can absorb high temperature.

→ The price of the cement is high. It cannot be used in mass construction.

⑥ Hydrophobic cement

This cement contains admixtures which decrease the weighting ability of cement grains.

→ The hydrophobic admixture like acidol, oxides, petroleum, etc form a thin layer around cement grain.

⑦ Low heat cement

→ The considerable heat is produced during the setting action of cement. In order to reduce the amount of

heat, this type of cement is used.

→ This cement possesses less compressive strength.

⑧ Pozzuolana cement

→ The pozzuolana is a volcanic powder. It is resembles surkhi which is prepared by burning bricks made from ordinary soils.

→ The percentage of pozzuolana material should be between 10 to 30.

→ This cement is used to prepare mass concrete of lean mix and for marine structures.

→ It is also used in sewage works and for laying concrete under water.

⑨ Quick setting cement

→ This cement is produced by adding a small percentage of aluminium sulphate & by finely grinding the cement.

→ The percentage of gypsum for setting action is also greatly reduced.

→ The addition of aluminium sulphate is responsible for accelerating the setting action of cement.

→ The setting action of cement starts within 5 minutes after addition of water and becomes hard like stone in less than 30 minutes or so.

(10) Rapid Hardening cement

→ It attains high strength in early days. It contains high percentage of tricalcium silicate (C_3S) to the extent of about 56%.

→ This cement is slightly costlier than ordinary cement.

→ As it sets rapidly, the construction work may be carried out speedily.

→ It obtains strength in a short period.

→ It is light in weight.

→ This cement requires short period of curing.

(11) Sulphate resisting cement

→ In this cement, the percentage of

tricalcicem aluminate (C_3A) is kept below 5 percent and it results in the increase in resisting power against sulphates.

→ This cement is used for structures which are likely to be damaged by severe alkaline conditions such as canal linings, culverts.

(12) White cement

→ This is just a variety of ordinary cement and it is prepared from such raw materials which are practically free from colouring oxides of iron, manganese or chromicem.

→ For burning of this cement, the oil fuel is used instead of coal.

→ It is quick drying, possesses high strength.

→ It is used for moulding sculptures and statues for painting garden furniture.

Properties of cement

→ Following are the important properties

of a good cement which primarily depend upon its chemical composition, fineness of grinding.

→ It gives strength to the masonry.

→ It is an excellent binding material.

→ It is easily workable.

→ It offers good resistance to the moisture.

→ It stiffens or hardens early against moisture attack.

Manufacturing of cement

The entire manufacturing process in a modern plant is now controlled through a microprocessor based programmable logic control system to maintain a consistently uniform quality of cement and a high rate of production.

Following 3 operations are involved in the manufacture of ordinary or portland cement:

① Mixing of raw materials :- The raw materials such as limestone or chalk and shale or clay may be

mixed either in dry condition or in wet condition.

→ The process is accordingly known as the dry process or the wet process of mixing.

Dry process :- In this process, the raw materials are first reduced in size of about 25 mm.

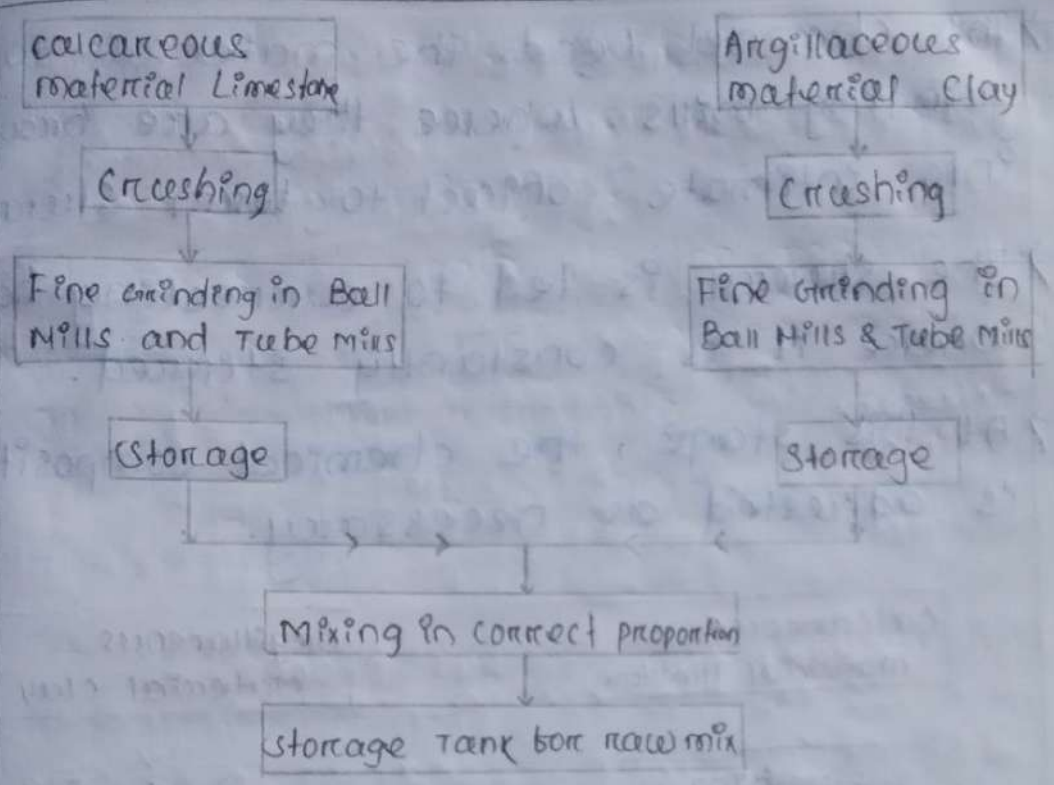
→ A current of dry air is then passed over these dried materials.

→ These dried materials are then pulverised into fine powder in tube mills and ball mills.

→ The raw materials are stored in hoppers.

→ They are then mixed in correct proportions and made ready for the feed of rotary kiln.

→ This finely ground powder of raw materials is known as the raw mix and it is stored in storage tank.



Flow diagram of dry process

Wet process :- In this process the calcareous materials such as lime-stone are crushed and stored in silos or storage tanks.

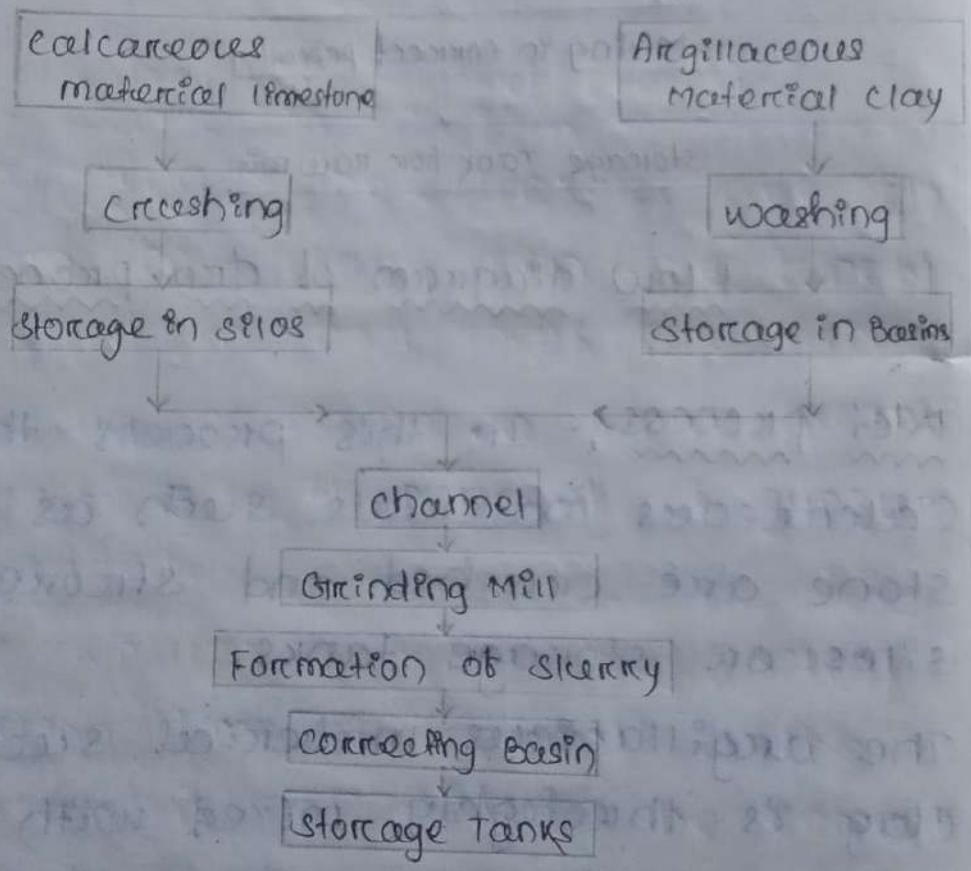
→ The argillaceous material such as clay is throughly mixed with water in a container known as the wash mill. This washed clay is stored in basins.

→ The crused limestone from silos and wet clay from the basins are allowed to fall in a channel in correct proportions.

→ This channel leads the materials to grinding mills where they are brought into intimate contact to form slurry.

→ The slurry is led to correcting basin where it is constantly stirred.

→ At this stage, the chemical composition is adjusted as necessary.



Flow diagram of Wet process

(2) Burning process :- The slurry is injected at the upper end of kiln. The hot gases or flames are forced through the lower end of kiln.

→ The portion of the kiln near its upper end is known as the dry zone and in this zone, the water of slurry is evaporated.

→ As the slurry gradually descends, there is rise in temperature and the next section of kiln, the carbon dioxide from slurry is evaporated.

→ The small lumps, known as the nodules, are formed at this stage.

→ These nodules then gradually roll down passing through zones of rising temperature and ultimately reach to the burning zone, where the temperature is about 1400°C to 1500°C.

→ In burning zone, the nodules are converted into small hard dark greenish blue balls which is known as clinkers.

Rotary Kiln For Wet process

(3) Grinding :- The clinkers are obtained from the rotary kiln are finely ground in ball mills and tube mills.

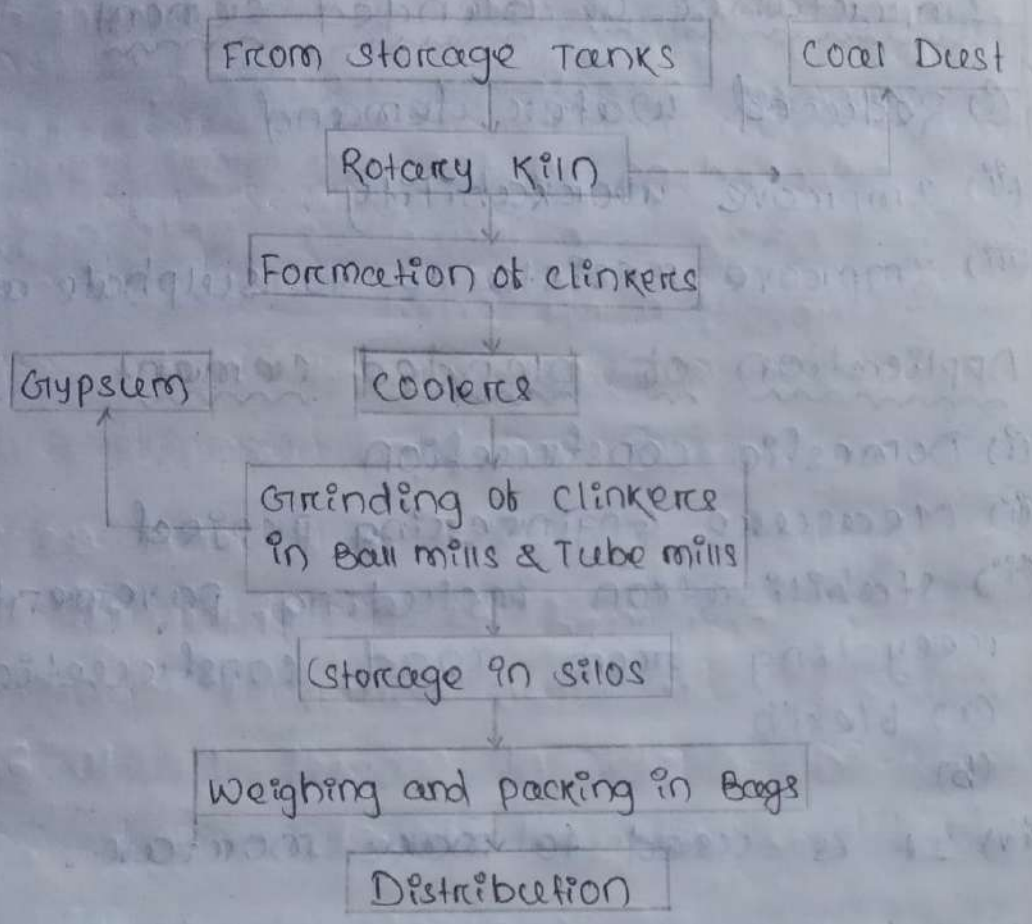
→ During grinding, a small quantity about 3 to 4 percent of gypsum is added.

→ The gypsum controls the initial setting time of cement if the gypsum is not added, the cement would set as soon as water is added.

→ The grinding of clinkers in modern plants is carried out in the cement mill which contains chromium steel balls of various sizes.

→ These balls roll within the mill &

grind the mixture which is collected in a hopper & taken in the bucket elevator for storage in silos.



Flow diagram of burning & grinding operations of cement

Importance & Application blended cement with Fly ash & blast furnace slag

Blended cement :- Blended cement can be defined as uniform mix of ordinary portland cement and blending

materials such as fliers and slag to enhances it is properties for different uses.

Importance of Blended cement

(i) Reduced water demand

(ii) Improve workability

(iii) Improve resistance to sulphate attack

Application of blended cement

(i) Domestic construction

(ii) Measure Engineering project

(iii) stabilisation including pavement recycling from road construction

(a) flexib

(b)

(iv) It is used to make mortar.

Mortar :- The term mortar is a mixture or paste prepared by required quantity of water and binding material like cement or lime & fine aggregate like sand.

Types of mortar

(i) Lime mortar :- The lime mortar is prepared either by pounding or grinding the pounding is adopted from preparing small quantities of

mortar.

→ The Grinding is adopted for preparing large amount of mortar.

pounding :- In this method the peates are found in handground & they are provided with limiting of bricks an stones at they side and water.

→ The lime & sand are mixed in dry state & the mixture is than place in pipes.

→ A small quantity of water is added & 4 to 5% with heavy wooden pounders on beaters work on mortar.

(ii) Surkhi mortar :- The mix of fat lime & surkhi or fat lime, surkhi & sand is decided & it is converted into a good paste by grinding in of mortar bill on by pounding.

(iii) Cement mortar :- This mortar doesn't required pounding or grinding. The cement & sand are mixed in required proportion & dry state on a water type platform.

(iv) Gauged Mortar :- In lime mortar if we add required quantity of cement then it is said to be gauged mortar.

Sources of sand

The sand particles consist of small grains of silica. It is formed by the decomposition of sandstones due to various effects of weather.

According to the natural sources from which the sand is obtained, it is 3 types :- ① pit sand
② River sand
③ Sea sand

① **Pit sand** :- This sand is found as deposits in soil and it is obtained by forming pits into soils. It is excavated from a depth of about 1 m to 2m from the ground level.

→ The pit sand consists of sharp angular grains which are free from salts and it proves to be excellent material for mortar or concrete work.

② **River Sand** :- This sand is obtained from banks of rivers.

→ The river sand consists of fine rounded grains probably due to mutual attrition under the action water or current.

→ The colour of river sand is almost white.

→ As river sand is usually available in clean condition, it is widely used for all purposes.

③ Sea sand :- This sand is obtained from sea shores.

→ The sea sand, like river sand consists of fine rounded grains.

→ The colour of sea sand is light brown.

→ The sea sand contains salts. These salts attract moisture from the atmosphere.

→ Such absorption causes dampness.

→ The sea sand retards the setting action of cement for this reason we should not use sea sand for engineering purposes except for filling of basement.

Classification of sand

According to the size of grains, the sand is classified as fine, coarse and gravelly.

→ The sand passing through a screen with clear openings of 1.5875 mm

is known as fine sand. It is used for plastering work.

→ The sand passing through a screen with clear opening of 3.175 mm is known as coarse sand. It is used for mortar for masonry work.

→ The sand passing through a screen with clear opening of 7.62 mm is known as gravelly sand. It is used for concrete work.

Bulking of Sand

The presence of moisture in sand increases the volume of sand.

→ This is due to the fact that moisture causes film of water around sand particles which results in the increase of volume of sand.

→ This phenomena is known as bulking of sand and it can be represented in a graphical way.

Uses of Gravel

Gravel is a loose aggregation of rock fragments. It is classified by particle size range and includes size classes from granular to builder

size fragments.

→ Gravel is an important commercial product with a number of applications.

→ Many road ways surfaced with gravel especially in rural areas when their is little traffic.

→ Small gravel are also important for manufacture of concrete, concrete blocks and bricks.

Uses of Murrum

It is the soil which is particularly used for road pavement. It is reddish soil they are good material for building huts and paths as they can be compacted easily to form even surfaces.

Uses of Fly ash

The fly ash is a fairly divided residue which results from the of powdered bituminous coal.

→ Ground or powder bituminous or sub bituminous coal like lignite.

→ It is a by-product of many thermal power stations and other plants using

coal or lignite as a source of heat for boilers.

uses :- (i) Addition to mass concrete
(ii) Cellular concrete blocks
(iii) Fly ash bricks.

Concrete

Concrete is a mixture of binding material like cement, fine aggregate (sand), coarse aggregate and portable water.

→ Generally it is used for various purposes like in making of slab, beam, column, foundation, etc.

properties of cement concrete

→ It has a high compressive strength.

→ It is free from corrosion & there is no appreciable effect of atmospheric agents on it.

→ It is proved to be more economical than steel.

→ It binds rapidly with steel & as it is weak is tension the steel reinforcement is placed in cement concrete at suitable places to take up the tensile stresses.

→ This is termed as RCC (Reinforced cement concrete).

Water cement ratio

The water enters into chemical action with cement and this action causes the seting & hardening of concrete.

→ The water lubricates the aggregates and it facilitates the passage of cement through voids of aggregates. This means that water makes workable.

→ This ratio of the amount of water to the amount of cement by weight is termed as the water-cement ratio.

→ The strength & quality of concrete primarily depends upon water cement ratio.

→ The quantity of water is usually expressed in litres per bag of cement & hence the water cement ratio reduces to the quantity of water required in the quantity of water required in litres per kg of cement as one litre of water weighs

1 kg.

→ For instance, if water required for 1 bag of cement is 30 litres.

Grading of Aggregates

In order to obtain concrete to denser quality, the fine & coarse aggregates are properly graded.

→ The grading of fine aggregates is expressed in terms of BIS (Bureau of indian standard) sieves numbers 480, 240, 120, 60, 30 and 15.

→ The grading of fine aggregates has a marked effect on the uniformity, workability and finishing qualities of concrete.

BIS Sieve	Percentage by weight passing through sieve	
	Natural or crushed gravel sand	Crushed stone sand
NO. 480	95 - 100	90 - 100
NO. 240	70 - 95	60 - 90
NO. 120	45 - 85	40 - 80
NO. 60	25 - 60	20 - 50
NO. 30	5 - 30	5 - 30
NO. 15	0 - 10	0 - 15

Workability

The term workability is used to describe the ease or difficulty with which the concrete is handled, transported, and place between the forms with minimum loss of homogeneity.

The important facts in connection with workability :-

→ If more water is added to attain the required degree of workmanship, it results into concrete of low strength & poor durability.

→ The workability of concrete is affected mainly by water content, water cement ratio & aggregate cement ratio.

Slump Test

→ The standard slump cone, is placed on the ground. The operator holds the cone firmly by standing on the foot pieces.

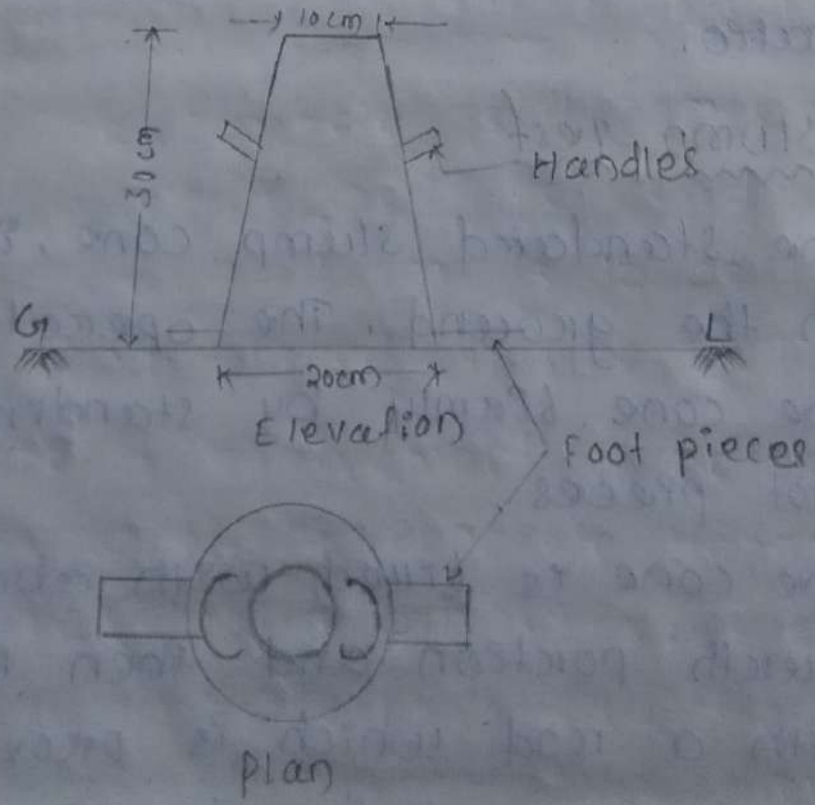
→ The cone is filled with about one-fourth portion and then rammed with a rod which is provided with bullet nose at the lower end.

→ The diameter of the rod is 16 mm, length is 60 mm.

→ The strokes to be given for tramping vary from 20 to 30. The remaining portion of the cone is filled with similar layers & then the top of the concrete surface is streek off, so that the cone is then gradually raised vertically & removed.

→ The concrete is allowed to subside & then the height of concrete is measured.

→ The slump of concrete is obtained by deducting height of concrete after subsidence from 30 cm.



Slump cone

Mixing of concrete

The process of rolling, folding and spreading of particles is known as the mixing of concrete.

→ The materials of concrete should be mixed thoroughly so that their is uniform distribution of materials in the mass of concrete.

There are 2 types of mixing :-

① Hand mixing
② Machine mixing

① **Hand Mixing** :- For hand mixing, the materials are stacked on a water-tight platform, which may be either of wood, brick & steel.

→ The materials should be thoroughly mixed, atleast 3 times in dry condition before water is added.

→ The prepared mixed should be consumed in 30 minutes after adding water.

→ The mixing by hand is allowed in case of small works where small quantity of concrete is required.

② Machine Mixing :- For machine mixing, all the materials of concrete including water are collected in a revolving drum & then the drum is rotated for a certain period. The resulting mix is may taken out from the drum.

→ It is used for major construction work where more amount of concrete is required.

→ It takes less time as compared to hand mixing.

→ The concrete discharged by the mixture should be consumed within 30 minutes.

Transporting & placing of concrete

The concrete as it comes out of the mixture as it is ready for use of the platform is to be transported and placed on the formwork.

→ The type of equivement to be used for transport of concrete depends upon the nature of work, height above ground level & distance between the points of preparation & placing of concrete.

→ For ordinary building works the human ladder is formed & concrete is conveyed in pans from hand to hand.

→ For important works various mechanical devices such as truck mixture, belt conveyors, buckets, pumps may be used.

Consolidation of Concrete

The term consolidation of concrete is used to mean the compaction between aggregate and aggregate, between aggregate and reinforcement, and between aggregate and forms.

Types of consolidation

Hand consolidation:- For unimportant works, the consolidation of concrete is carried out by hand methods which include ramming, tamping, spading & slicing with suitable tools.

Vibrators:- These are the mechanical devices which are used to compact concrete in the formwork. The advantages of vibrators over hand methods are:-

→ The quality of concrete can be improved by use of vibrators as less water will be required or in other way, economy can be achieved by adopting a leaner mix when vibrators are used.

→ With the help of vibrators, it is possible to deposit concrete in small openings or places where it will be difficult to deposit concrete by hand methods.

Following are the four types of vibrators :- ① Internal or immersion
② surface vibrators
③ Form or shutter vibrators
④ vibrating tables

① Internal or immersion vibrators

These vibrators consist of a steel tube which is inserted in fresh concrete. This steel tube is called the poker and it is connected to an electric motor or a petrol engine through a flexible tube.

→ The frequency of vibration is about 3000 to 6000 r.p.m (Revolution per minute).

→ These vibrators are more efficient than other types of vibrators & hence they

are most commonly used.

(2) Surface vibrators :- These vibrators are mounted on platform.

→ They are used to finish concrete surfaces such as bridge floors, road slabs, station platform, etc.

→ These vibrators are found to be more effective for compacting very dry concrete mixes.

(3) Form or shutter vibrators :- These vibrators are attached to the formwork and external centering of walls, columns, etc.

→ This vibrating action is conveyed to the concrete through the formwork during transmission of vibrations.

(4) Vibrating Tables :- These are in the form of a rigidly built steel platform mounted on flexible springs and they are operated by electromagnetic action or electric motors.

→ The frequency of vibration varies from 3000 to 7200 vibrations per minute.

Curing of concrete

The concrete surfaces are kept wet for a certain period after placing of concrete so as to promote the hardening of cement.

→ In other words a curing of concrete is define as spraying or sprinkle on the concrete surfaces.

Purposes

→ The curing protects the concrete surfaces from sun and wind.

→ The strength of concrete gradually increases with age, if curing is efficient.

→ By proper curing, the durability and impermeability of concrete are increased and shrinkage is reduced.

period of curing

This depends on the type of cement and nature of work. Generally it takes 7 to 14 days for ordinary portland cement.

→ If rapid hardening cement is used, the curing period can be considerably reduced.

Types of curing

(i) ponding with water

(ii) covering concrete with wet jute bags.

(iii) covering concrete with water.

(iv) covering concrete with waterproof paper or polythene sheets.

(v) Intermittents spraying with water and continuous sprinkling of water.

(vi) Applying curing compounds like resin and wax.

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TIMBER

The word "timber" is derived from an old english word "timbrian" which means to build. The timber thus denotes wood which is suitable for building or carpentry or various other engineering purposes. Following 3 terms are to be noted in connection with the timber :-

(i) Converted timber :- This indicates timber which is sawn and cut into suitable commercial sizes.

(ii) Rough timber :- This indicates timber which is obtained after felling of tree.

(iii) Standing timber :- This indicates timber contained in a living tree.

Classification of trees

For engineering purposes, the trees are classified according to their mode of growth.

- Trees
  - Exgenous
    - Conifers → Soft woods
    - Deciduous → Hard woods
  - Endogenous

(1) Exogenous trees :- These trees increase in bulk by growing outwards and distinct consecutive rings are formed in the horizontal section of such a tree.

→ The timber which is mostly used for engineering purposes belongs to this categories.

(i) Conifers :- The conifers are also known as the ever-green trees & leaves of these trees do not fall till new ones are grown.

→ These trees provides soft woods, light coloured, resinous, light in weight and weak.

(ii) Deciduous :- The deciduous trees are known as the broad-leaf trees & leaves of these trees fall in autumn and new ones appear in spring season.

→ These trees provide hard wood and which are strong, heavy, dark coloured durable and non-resinous.

The examples of soft woods are deodar, Kail, pine, etc.

→ Hard woods are babul, mahogany, oak, shal, teak, etc.

② Endogenous trees :- These trees grow inwards and fibrous mass is seen in their longitudinal sections.

→ The examples of endogenous trees are bamboo, cane, palm, etc.

Structure of a tree

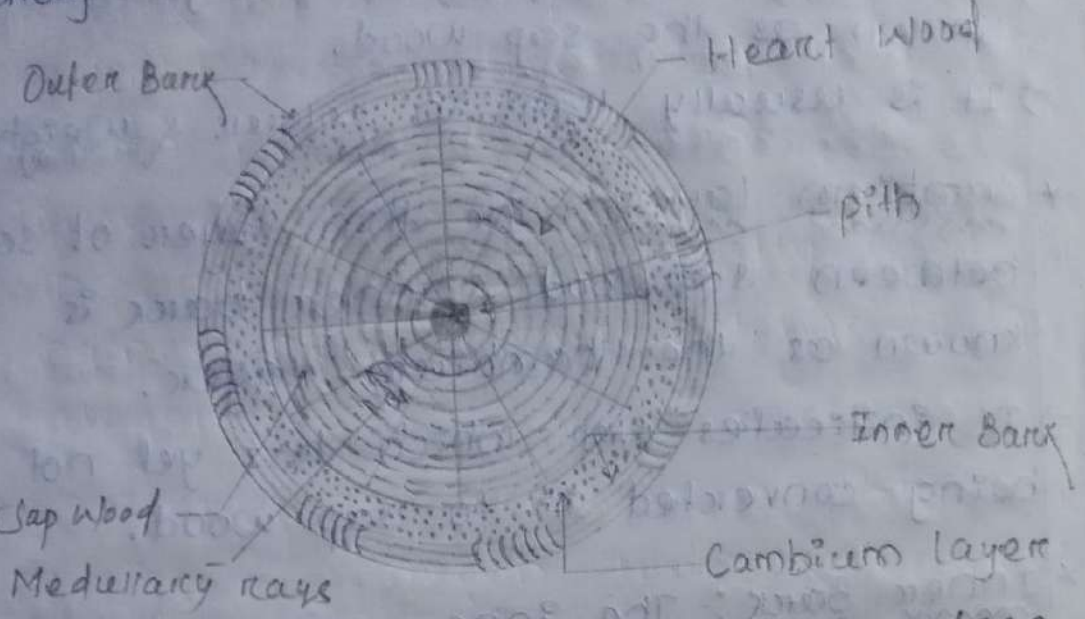
A tree basically consists of three parts namely trunk, crown and roots. The function of the trunk is to support the crown and to supply water and nutrients from the roots to the leaves through branches and from the leaves back to the roots.

From the visibility aspect, the structure of a tree is divided into 2 types :- ① Macrostructure
② Microstructure

① Macrostructure :- The structure of wood visible to the naked eye or at a small magnification is called the macrostructure.

→ The transverse section of the trunk

of an exogenous tree is shown in the diagram.



Cross-section of an exogenous tree

* **pith**:- The innermost central portion or core of the tree is called the pith or medulla.

→ It varies in size and shape for different types of trees.

→ It consists of cellular tissues and it nourishes the plant in its young age.

* **Heart wood**:- The inner annual rings surrounding the pith constituent the heart wood.

→ It is usually dark in colour. As a matter of fact, it indicates dead portion of tree.

→ It doesn't take active part in the growth of tree.

* Sap Wood :- The outer annual rings between heart wood and cambium layer is known as the sap wood.

→ It is usually light in colour & weight.

* Cambium layer :- The thin layer of sap between sapwood & inner bark is known as the cambium layer.

→ It indicates sap which has yet not being converted in to sap wood.

* Inner Bark :- The inner skin or layer covering the cambium layer is known as inner bark.

→ It gives protection to the cambium layer from any injury.

* Outer Bark :- The outer skin or cover of the tree is known as outer bark.

→ It is the outermost protective layer and it sometimes contains cracks.

* Medullary rays :- The thin radial fibers extending from pith to cambium layer are known as the medullary rays.

② Microstructure

The structure of wood apparent only at great magnification is known as microstructure.

→ A living cells consists of four parts namely membrane, protoplasm, sap and core.

→ The cell membrane consists mainly of cellular tissue and cellulose.

→ The protoplasm is a granular, transparent, viscous vegetable protein composed of carbon, hydrogen, oxygen, nitrogen and sulphur.

→ The core of cell differs from protoplasm merely the presence of phosphorus and it is generally oval.

Seasoning of timber

When a tree is newly felled, it contains about 50 percent or more of its own dry weight as water.

→ This water is in the form of sap or moisture.

→ The water is to be removed before the timber can be used for any engineering purpose.

→ In other words, the timber is to be dried.

→ This process of drying of timber is known as seasoning of timber.

Objects

→ To allow timber to burn readily, if used as fuel.

→ To decrease the weight of timber & thereby to lower the cost of transport and handling.

→ To impart hardness, stiffness, strength and better electrical resistance to timber.

The methods of seasoning can be divided into 2 categories:-

① Natural seasoning

② Artificial seasoning.

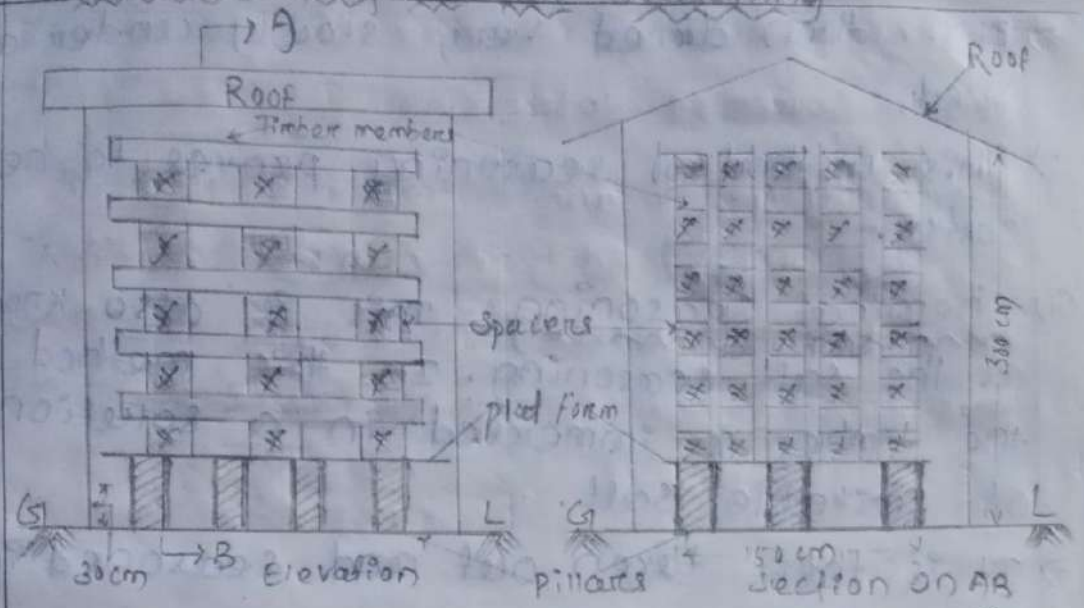
① Natural Seasoning:- In this method, the seasoning of timber is carried out by natural air and hence it is also sometimes referred to as air seasoning.

Procedure

→ The timber in log form it is not usually fit for the process of seasoning. so it cut and sawn into suitable sections.

→ The timber pieces can either be stacked horizontally or vertically for the formal arrangement being very common.

Horizontal stack for air seasoning



(2) Artificial Seasoning :- The drying is controlled and there are practically no chances for the attack of fungi and insects.

→ The defects such as shrinkage, warping are minimized.

→ It considerably reduces the period of seasoning.

→ The wood becomes more suitable for painting and glueing, etc.

The various methods of artificial seasoning are :-

(i) Boiling :- In this method of artificial seasoning the timber is immersed in water and water is then boiled.

→ This is a very quick method.

→ The timber is thus boiled with water for about 3 to 4 hours.

→ It is then dried very slowly under a shed.

→ This method of seasoning proves to be costly.

(ii) Chemical seasoning:- This is also known as the salt seasoning. In this method the timber is immersed in a solution of suitable salt.

→ It is then taken out and seasoned in the ordinary way.

(iii) Electrical seasoning:- In this method the used is made of high frequency alternating current.

→ The timber, when it is green, offers less resistance to the flow of electric current.

→ The resistance increases as the wood dries internally which also results the production of heat.

→ This is the most rapid method of seasoning.

(iv) Kiln seasoning:- In this method, the drying of timber is carried out in airtight chamber or oven.

→ The kiln seasoning gives well seasoned timber as it controls 3 important conditions namely, circulating air,

relative humidity and temperature.

(v) Water seasoning :- The timber is cut into pieces of suitable sizes.

→ These pieces are immersed wholly in water, preferably in running water of a stream.

→ The care should be taken to see that the timber is not partly immersed.

→ The thicker or larger end of timber is kept pointing on the upstream side.

→ The timber is taken out after a period of 2 to 4 weeks.

→ During time period the sap contained in timber is washed away.

→ The timber is then taken out of water and allowed to dry under a shed having free circulation of air.

Characteristics of good timber

Following are the characteristics or qualities of good timber :-

① Appearance :- A freshly cut surface of timber should have hard and shining appearance.

② Colour :- The colour of timber should preferably be dark.

③ Defects :- A good timber should be free from serious defects.

④ Durability :- A good timber should be durable it should be capable of resisting the action of fungi insects, chemicals, physical agencies and mechanical agencies.

⑤ Elasticity :- This is the property by which timber returns to its original shape when load causing its deformation is removed.

⑥ Fibres :- The timber should have straight fibres.

⑦ Fire resistance :- The timber is a bad conductor of heat. A dense wood offers good resistance to the fire and it requires sufficient heat to cause a flame.

⑧ Hardness :- A good timber should be hard.

→ It should offer resistance when it is being penetrated by other body.

⑨ Shape :- A good timber should be capable of retaining its shape during conversion or seasoning.

⑩ Smell :- A good timber should have sweet

smell. An unpleasant smell indicates decayed timber.

(11) Sound :- A good timber should give out a clear ringing sound when struck.

(12) Weight :- The timber with heavy weight considered be sound and strong.

(13) Water permeability :- A good timber should have low water permeability.

(14) Working condition :- The timber should be easily workable.

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Clay products & Refractories Materials

The term ceramics is used to indicate the potter's art or articles made by the potter. The ceramics products are broadly divided into 3 categories :-

(I) Clay products :- The clay occurs plenty in nature. The clay is a distinct product of chemical weathering of igneous rocks.

→ The clay, when made wet with water possesses a high degree of plasticity.

→ such plastic clay can be moulded in desired shape it is then dried & burnt.

→ The clay products which are employed in building industry are tiles, terra-cotta, earthenwares, porcelain & bricks.

Tiles

The tiles may be defined as thin slabs which are burnt in kiln.

→ They are thinner than bricks and hence they should be carefully handled to any damage to them.

→ Tiles are classified into 2 types :-

(i) common tiles :- These tiles have different shape and sizes. They are mainly used for paving, flooring, roofing.

(ii) Encaustic tiles :- These tiles are used for decorative purposes in floors, walls, ceilings and roofs.

Characteristics of a good tile

→ It should be hard and durable.
→ It should be free from cracks & bends.
→ It should be regular in shape & size.
→ It should be well burnt.
→ It should fit in properly, when placed in position.
→ It should possess uniform colour.

Types of common tiles

Depending upon the used to which the tiles are put :- (a) drain tiles
(b) paving tiles
(c) roof tiles

(a) Drain Tiles :- These tiles are prepared in such a way that they retain porous texture after burning.
→ Hence, when such tiles are laid in the waterlogged areas they allow the subsoil water to pass through the body or skeleton.
→ These drains may be circular or

semi-circular.

→ Such drain tiles are rarely adopted in modern times.

(b) Paving tiles :- The floor or paving tiles may be square, hexagonal in shape.

→ These are flat tiles and their thickness varies from 12 mm to 50mm.

→ The floor tiles should be hard so that can resist wear and tear in a better way.

→ The floor tiles of thin section can be adopted from ceiling also.

(c) Roof Tiles :- These tiles are used to serve as covering for pitched roof.

→ The various types of roof tiles are available in the market :- (i) Allahabad
(ii) corrugated
(iii) Flat tiles
(iv) Manglore tiles

Encaustic Tiles

The encaustic tiles are manufactured from carefully prepared ordinary clays, colouring materials and sometimes with finer clays.

→ Depending upon the colouring pigment added in the clay, these tiles obtain

the desired print on colour after manufacture.

Terra-cotta

The terra means of earth and cotta means baked, hence the terra-cotta means baked earth.

→ It is a type of earthenware or porous pottery made from local clays and glazed with glazes containing with galena.

Types of terra-cotta

There are 2 types of terra-cotta:-

① porous terra-cotta
② polished terra-cotta

① porous terra-cotta

To prepare porous terra-cotta the saw dust is added in clay before the stage of moulding.

→ when articles from such clay are burnt in a kiln the organic particles are burnt and they live porous in the articles.

→ The porous terra-cotta is a fire-proof and a sound-proof material.

→ It is light in weight, but it is structurally weak.

② polished terra-cotta

This is also known as the fine terra-cotta to obtained this variety of terra-cotta the articles are burnt at a low temperature of about 650°c.

→ The first burning is known as the bisciuiting.

→ The articles brought to the biscuit stage are removed from kiln & are allowed to cool down.

→ They are then coated with glazing compound & burnt again in the kiln at a temperature about 1200°c.

→ The polished terra-cotta is available in a variety of colours & it indicates superior quality of terra-cotta.

→ It is used for ornamental purposes.

porcelain

The term porcelain is used to indicate fine earthenware which is white, thin and semi-transparent. Since the colour of porcelain is white, it is also known as whiteware.

→ It is hard, brittle and non-porous.
→ It is prepared from clay, felspar, minerals.
→ The constituents are finely ground and then they are thoroughly mixed in liquid state.
→ The mixture is desired shape & it is burnt at high temperature.
→ The various types of porcelains are available & they are adopted for various uses such as sanitarywares, electric insulators, storage vessels.
→ The porcelains are 2 types:-
① Low voltage porcelain
② High voltage porcelain

① Low voltage porcelain:- It is prepared by dry process and it is mainly used for switch block, insulating tubes, lamp sockets, if some quantity of alumina or silicate of magnesia is added, it can resist high temperature to certain extent.

② High voltage porcelain:- It is prepared by wet process. It is a refractory

material of high quality.
→ But it is oxidized at high temperature.
→ It is used for making electrodes and constructions of atomic reactor rockets.
→ It is used as electrical insulator for high intensity electric current, vacuum tubes, etc.

Glazing

The surface of clay products are sometimes glazed. A glaze is a glassy coat of thickness about 0.1 to 0.2 mm applied on the surface of an articles and then fused in to place by burning at high temperature.

Purposes

→ To improve the appearance.
→ To make the articles durable.
→ To provide smooth surface.
→ To protect the articles from action of atmospheric agencies, chemicals, etc.

Types of glazing

The glazing may be transparent like glass or it may be opaque like enamels.

Transparent glazing:- Transparent glazing

is also divided into 2 types :- (a) Salt glazing
(b) lead glazing

(a) Salt glazing :- In this method a small quantity of wet sodium chloride or salt is added in the kiln at a high temperature of about 1300°c.

→ The salt is vaporized at a high temperature and a glass like glaze is formed on the surface of article.

→ This method is useful for sanitary pipes and chemical stonewares.

→ The colour of articles glazed by this method is brownies.

(b) Lead glazing :- For getting of better quantity the lead glazing is preferred as compared to salt glazing.

→ In this method the article is ones burnt & it is then dipped in a bath containing oxide of lead and tin.

→ The articles is taken out from the bath and it is reburnt at a high temperature.

→ This method is used for terra-cotta, earthenwares.

Opaque glazing

This type of glazing is adopted to give better appearance than that

given by a burnt materials.

→ The superior clay is finely powdered and dried then water is added to such clay to make a plastic cream like substance known as the slip.

→ The articles to be glazed are dipped in the slip before burning and they are subsequently heated.

→ The burning of articles results into the blow of clay particles and an opaque glaze surface is formed.

→ The sanitary articles are glazed by this process.

(II) Refractories

The term refractories is used to indicate substances that are able to resist high temperatures.

Following are the properties of refractories materials:-

(i) It must possesses excellent resistance to rapid changes in temperature that is thermal shocks.

(ii) It should be strong that is it must be capable of resisting compressive, crushing and tensile forces in hot

are cold conditions.

(iii) Its melting point should be high.

(iv) It should not fall into pieces at high temperatures.

Classification of Refractory materials

The refractory materials are classified in the following 2 types:-

(a) According to the chemical properties,

(b) According to resistance to temperature

(a) According to the chemical properties:-

Again according to chemical properties the refractory materials are divided into 3 types: (i) Acidic
(ii) Neutral
(iii) Basic.

(i) Acidic

* **Fire-clay:-** Its important constituents are alumina and silica.

→ It is used for the manufacture of fire bricks, crucibles, lining material for furnaces, hollow tiles, etc.

* **Quartzite:-** It is a metamorphic stone.

→ It is hard, brittle, crystalline and compact.

→ Its melting point varies from 1650°C to 1720°C

→ It is used for making the silica bricks.

* Silica:- It is available in the form of sand with some impurities from river bed.

→ It melts at a temperature of 1730°C.

→ It is used for preparing silica bricks, coke oven, lining for glass furnaces.

(ii) Neutral

* Bauxite :- It is mixed with the clay and finely ground.

→ Its melting point is 1200°C.

→ It is used for preparing fire-bricks containing more percentage of silica.

* Carbon :- It is available in three forms- amorphous carbon, graphite, diamond.

→ Its melting point is 3500°C.

→ It is used as activated carbon and lining material for furnaces.

* Chromite :- It is the oxide of iron and chromium.

→ Its melting point is 2180°C.

→ It is used in thermal plants and it is the most powerful neutral refractory material.

(iii) Basic

* Dolomite :- It is carbonate of lime and magnesium.

→ Its melting point varies from 2300°C to 2600°C.

→ It is used for making refractory bricks.

* Magnesia :- It is available in crystalline form and its melting point 2800°C.

→ It is used for preparing magnesia bricks.

(b) According to resistance to temperature

The refractory materials are divided into two types :- (i) Low quality (ii) High quality.

(i) Low quality :- If the melting point of such materials is more than 1580°C then it is said to be low quality refractory materials.

→ It is used for fire-clay, lining for furnaces.

(ii) High quality :- The high quality refractory materials are stable in a even at high temperature and they are used in the construction of modern aeroplanes such as rockets, jets, etc.

→ The term cermet (cer from ceramics and met from metals) is used to indicate the refractory materials containing a combination of clay and metal.

→ The usual percentages are 80% clay & 20% metal.

→ The usual metals employed for cermets are aluminium, iron, chromium, cobalt, etc.

→ The cermets are widely used where shocks due to the sudden changes of temperature are to be resisted.

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IRON & STEEL

The metals are also employed for various engineering purposes such as structural members, roofing materials, damp proof courses (DPC), pipes, tanks, doors, windows, etc.

→ Out of all the metals, the iron is the most popular metal and it has been used in the construction activity since pre-historic times.

(i) **Brittle Material**:- A material which can be breaks into pieces or can be easily reduced to powder e.g. glass.

(ii) **Ductile Material**:- A material which can be converted into thin and fine wires e.g. copper, silver.

(iii) Hard Material :- which cannot be cut by a sharp tool e.g. diamond.

(iv) Malleable Material :- A material which can be beaten into thin sheets e.g. gold.

(v) Soft material :- A material which can be easily cut by a sharp weapon e.g. lead.

(vi) Tough Material :- A material which does not easily break under a hammer e.g. basalt.

Cast - iron

The cast-iron contains about 2 to 4% of carbon.

→ In addition, it contains the various impurities such as manganese, phosphorus, silicon and sulphur.

→ The cast-iron is manufactured by remelting pig-iron with coke and limestone.

→ This remelting is done in a furnace known as the cupola furnace.

properties of cast-iron

→ If placed in salt water, it becomes soft.

→ It can not be magnetised.

→ It does not rust easily.
→ It is hard but it is brittle also.
→ Its melting temperature is about 1250°c.
→ It is weak in tension but strong in compression. Average tensile strength of cast iron is 150 N/mm² and compressive strength is 600 N/mm².

Uses of Cast-iron

→ The use of cast iron is not recommended in horizontal direction either for heavy or variable loads.
→ The cast iron to be used on the work should be tough, free from air holes and with an even surface.
→ For making cisterns, water pipes, sewers, manhole covers and sanitary fittings.
→ For making ornamental castings such as gates, lamposts, spiral staircases etc.
→ For making parts of machinery which are not subject to heavy shocks.
→ For manufacturing compression members like columns in buildings, bases of columns, etc.

Wrought-iron

The wrought-iron is almost pure iron and it hardly contains carbon more than 0.15% or so.

Properties

- It is ductile, malleable and tough.
- It is moderately elastic.
- It resists corrosion in a better way.
- Tensile strength is 400 N/mm² and compressive strength is 200 N/mm².

Uses

- The wrought-iron is replaced at present to a very great extent by mild steel.
- It is used for rivets, chains, ornamental iron works, railway couplings, water pipes.
- It is used as raw material for manufacturing steel, bolts and nuts, handrails, straps for timber roof trusses, boiler tubes, roofing sheets.

STEEL

Steel is an alloy of iron & carbon and sometimes other materials.

→ Because of its high tensile strength and low cost it is a major components use in building.

→ It is also used in making of tools, ships, automobiles, machines, appliances.

Depending upon the carbon content the steel is designated as the mild steel or medium carbon steel or high carbon steel.

Mild steel

The carbon content of mild steel is about 0.05 to 0.25%.

→ Mild steel are used for making motor body, sheet metal, tin plate, etc.

→ It is also used as reinforcement in construction.

properties

→ It can be magnetised permanently.

→ It can be easily welded.

→ It is malleable and ductile.

→ It is tougher and more elastic than wrought iron.

→ It rusts easily and rapidly.

→ Its melting point is about 1400°C.

Medium carbon steel - 0.25 to 0.60%
High carbon steel - 0.60% to 1.10%
(Hard steel)

Tor steel

→ Tor is actually a brand name - Toristeg steel corporation of Luxembourg.

→ It is commonly known as cold twisted deformed (CTD) bar due to its popularity.

→ Tor steel bars are used in steel structures.

→ It has more tensile stress than the mild steel bars.

Uses

→ These bars are commonly used as reinforcement in concrete structures such as buildings, bridges, road, precast concrete, etc.

→ Ribbed tor steel bars can be bent through 180° without formation of any crack or fracture on their outside surface.

→ welding is possible in these types of bars.

Difference between

Mild steel	Tor steel
→ It contains 0.05 - 0.25% carbon.	→ Steel bars have surface deformation formed by twisting the steel after elongation.
→ It has relatively low tensile strength.	→ This impart high yield strength to steel and provide proper bondage with concrete.
→ It is easy to form & cheap.	
→ Surface hardness can be increased through carburizing.	

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