GOVT. POLYTECHNIC JAJPUR

Lecture Note

Th-3 building Materials & Construction Technology

3rd Sem. Civil Engg.

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3rd Sem (civil) Building Material. 10.8.2020

Qualities Required in Stones.

1. Strength.
2. Hardness
3. Water Absorption
4. Appearance
5. Workability.
6. Durability.

For ensuring, a durable, cost effective and a esthetically appealing construction, the following properties are deemed desirable in the stones available for selection.

1. **Strength.**
   - for construction normally any stone or brick should sufficient strength to bear usual loads.
   - The engineer must satisfy himself about all the strength parameters only after thorough testing in accordance with prescribed codes.

   i) **Compressive Strength** — It is the main quality of a building stone and may be defined as the load bearing capacity of a stone expressed as the maximum load per unit area at which the stone starts breaking.

   ii) Compressive strength property can be easily tested with a (UTM) in Laboratory selected stone or brick sample (in cube or cylinder shape) of specified dimension and loaded in machine. The sample is obtained from simple relationship

   $$P = \frac{P}{A}$$

   P = Stress P = load A = Area of cross section

   iii) Compressive strength of stones vary from 280 – 2800 kg/cm². for Brick it is (A class – 140 kg/cm²) for Concrete it is – 280 kg/cm²

2. **Transverse Strength.**
   i) It is the resistance a stone (or any other material) offers to bending under load. when a stone is required for use as a beam or a lintel.

   ii) This property is commonly determined as Modulus of Rupture "R" method.

   iii) The 'R' values for different stones vary between 20 – 300 kg/cm².

Shear Strength.

i) The stone should withstand shearing type of loads. & shearing strength.

ii) The shearing strength of common building stones lies between 70 – 160 kg/cm².

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Uses of Stone.

Three factors are generally considered by an engineer while deciding the use of a stone in the constructions Jobs.

First • The type of building and the situation where he wants to use the stone such as:

i) A residential building or a public building such as for school, departmental office, community centre.

ii) A commercial building like a cinema hall, shopping complex stadium.

iii) A monumental building such as a temple, mosque, church & fort.

Second • The precise location in the building where the stone shall give a preferential benefit in terms of cost, appearance and durability such as in foundations superstructures, arches, columns & beams plinths or in flooring, roofing or sills and cantilevers.

Third • Cost of construction with stones.

• This will depend on factors of availability of stone in nearby areas, their extraction from quarry, transport and dressing (giving proper shape) before putting them in use.

• Some times a desired quality of stone may not be available locally it may have to be imported from other states or even from other countries.

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3. The waters may get saturated with these compounds with passage of time and precipitate them.
4. Example – Lime stones, gypsum, anhydrite, rock salt
5. It is not a good building stone.

c) Organically formed Sedimentary Rocks –

1. Many sea animals have their hard parts made up of bones which are a mixture of calcium and magnesium Carbonate
2. These parts accumulate on the sea floors on the death of these animals & gradually huge thickness of such deposits get formed. is known as organically formed Sedimentary rocks.
3. Example – lime stone. ($CaCO_3$)
4. It is a good building stone.

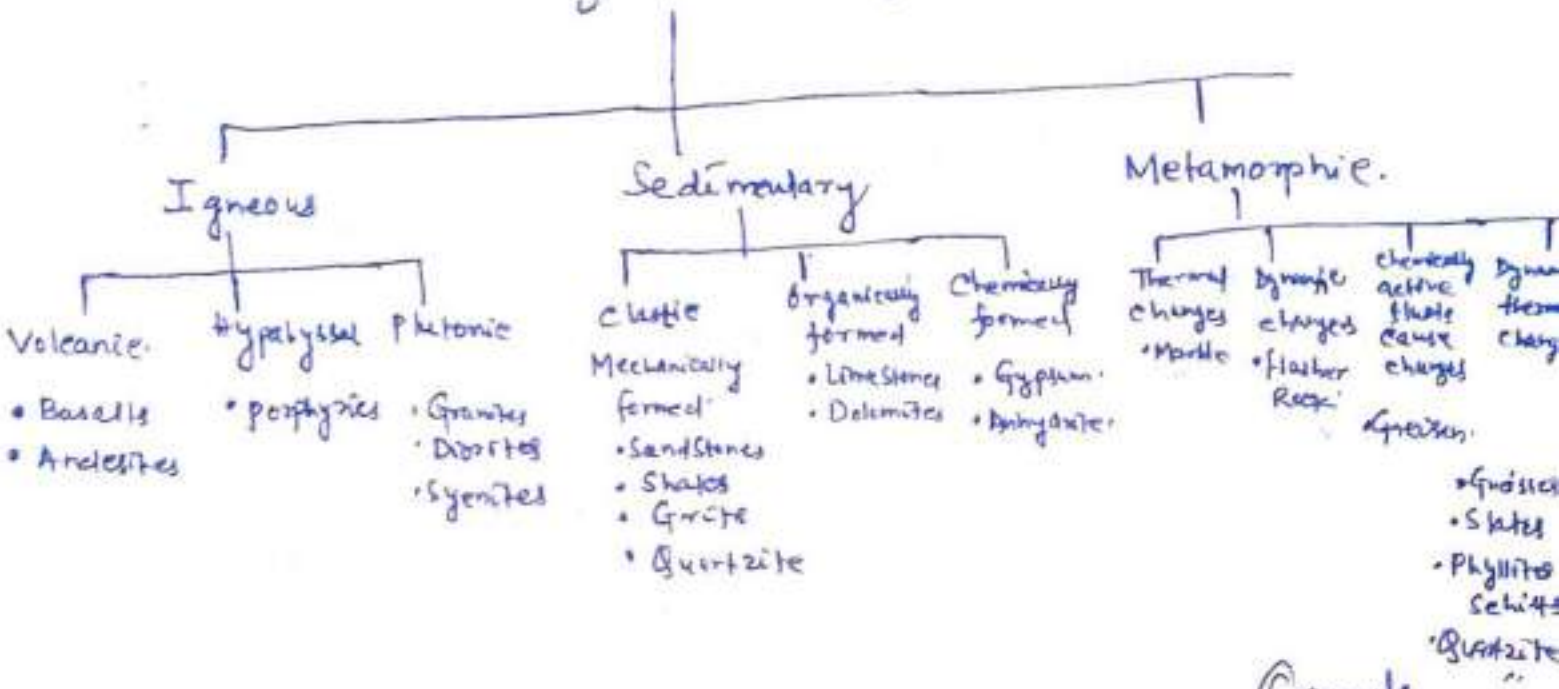
3. Metamorphic Rocks (Meta = change, Morph = form)

1. These are originally either Igneous or Sedimentary rocks.
2. The process for their change under the influence of increased temprature, pressure and chemical environment is called Metamorphism.
3. This pressure changes the original structure and chemical constitution. After changes new rock is called Metamorphic rocks.
4. Example – marble, slate, shale, Quartzite, Gneiss and schist

The nature of change of an original rock into a Metamorphic rock depends on the following factors

i) The type of agents/operating (temprature, presture fluids)
ii) The duration of operation of the ~~Original rock~~ above agents
iii) The nature and composition of the Original rock.

Geological Classificatron.



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B. Chemical classificatron.

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Chemical classification:

On the basis of dominant chemical composition, The following three main groups of rocks (stones) are commonly recognised:

1. Siliceous Rocks
   - These rocks have SILICA (SiO_2) as the predominant component, and more than 50% of the bulk composition of the rock.
   - Some Sedimentary and metamorphic rocks are entirely made up of Silica and includes varieties of quartzites.
   - It is the strongest building stone.
   - Some other rocks granites, sandstones and gneisses made up predominantly silica in combined forms.
2. Calcareous Rocks.
   - In these rocks the dominant component is a carbonate of calcium & magnesium.
   - They belong to Sedimentary and metamorphic groups of rocks.
   - Example – Limestones, dolomite and marble & all these are carbonate rocks.
   - These above rocks are good building stones.
3. Argillaceous Rocks.
   - These rocks belongs to Sedimentary and metamorphic groups of rocks.
   - These rocks are soft & not a good variety of building stone.
   - Example – Shales, slates & Schists.

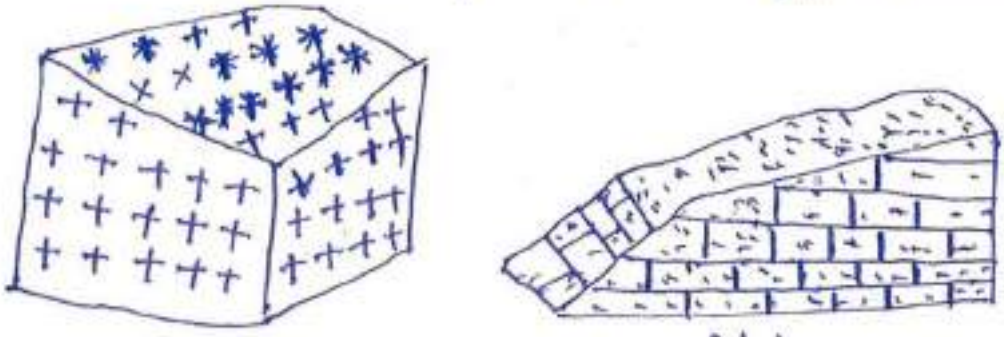
Table – Chemical classification of Rocks.

SILICEOUS. $SiO_2 > 50\%$	CALCAREOUS $CO_3 > 50\%$	ARGILLACEOUS Clays > 50%
Examples:	Examples:	Examples:
Granites (Ign.)	Limestones (Sed.)	Claystones (Sed.)
Quartzites (Sed/Meta.)	Dolomites (Sed.)	Siltstones (Sed.)
Gneisses (Meta.)	Marbles (Meta.)	Slates (Meta.)

C. Structural (physical) classification.

1. The Massive or Unstratified Rocks.

- These occur in huge masses without showing any layered structure.
- Igneous and metamorphic rocks and some sedimentary rocks may be seen occurring as big masses.
- Example:— Granites and quartzites.



(a) (b)

(a) Massive and (b) Stratified rocks.

2. The Stratified Rocks.

- Most sedimentary rocks occur in distinct layers of same or different colour and composition.
- The different layers are also called beds and are separated by planes of weakness called bedding planes.

3. The foliated Rocks.

- These type of rocks develope well defined bands of of different composition.
- Example schists and gneisses.
- Sometimes well-defined layers are induced under pressure, as in slates.
- It is not a good quality of building stone.

2. Hardness:

i). Hardness of a stone may be defined as its capacity to resist scratching or abrasion.

- Samples of two building stones may have same compressive strength but their hardness may be different.
- If you will take two stones, lime stones & quartzite. You will see lime stones can be scratched easily with a knife but it is not possible to make an impression with knife on a granite stone.
- The hardness of stones depends on their mineral composition like silicates, oxides, sulphate, sulphide, carbonates etc.
- Hardness is its resistance to wear and tear during its use in situation where rubbing action due to natural agencies (wind and water) or by artificial causes; such as in flooring slabs it is taken.

ii) Toughness.

- It related to both hardness and strength.
- It is defined as the capacity of a stone to withstand the impact loads.
- It is more important when the stones are used in industrial buildings to construct foundation of machine where vibrations may be a common matter.
- In machine foundation it should be hard & tough also.

3. Water Absorption

- Building stones are liable to contact with water when used in foundation and exterior walls.
- The walls must not absorb moisture.
- It is defined as quantity of water absorbed (in percentage by weight) by a stone till saturation.
- Absorption value of 10% means that a stone on saturation can hold 10% water by weight.

Example

A 10 kg block of stone will be having within its body about 1 litre of water.

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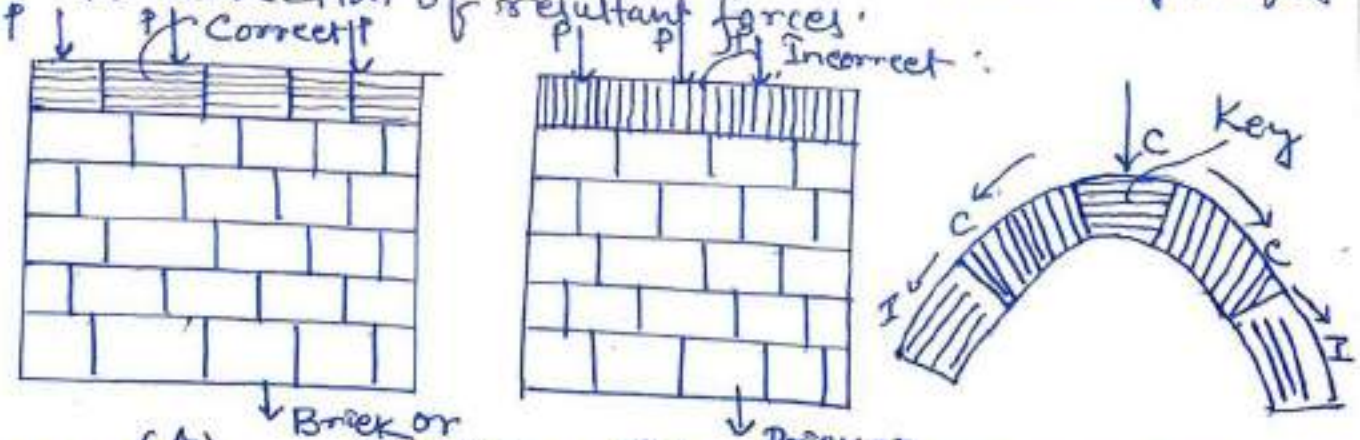
Natural Bed of Stone.

- A stratified or layered rocks show different strengths values when loaded perpendicular to bedding and parallel to bedding.
- The compressive strength of the stone is always greater in the first case where the stone offers maximum resistance.
- When the load is applied parallel to the layers or beds, there is tendency to failure by slipping along the bedding planes.
- The property of natural bedding has to be kept in mind while placing the stone in a particular location in the building.

Take two situations:

- In the walls, the load acts vertically downwards hence the stone should be placed with the natural bed in a horizontal position (A) and not in a parallel position as shown in (B).
- In the arches, the load acts transverse (arch action) hence the stone must be placed with the natural bed vertical or inclined so that it is almost at right angles to direction of resultant forces.



(A) (B) (C)

P = load or forces. (forces with respect to natural bed)

I = Incorrect
C = Correct

4. Appearance.

- Stones are available in almost all colours from milk to blood red pitch black.
- Appearance of a stone for use in building becomes an important factor for selection.
- Example: — i) Taj Mahal of Agra. — White Marble.
  ii) Red fort in Delhi — Red colour sandstone
- Marble may be red, green, pink & grey colour. Sand stone also available.

5. Workability

- Stones when obtained from their natural places are quite irregular masses & they should be converted to appropriate shapes for use in construction.
- The process of giving a proper shape, dimensions and surface finish to a raw stone before it is fit for use in construction is called Dressing.
- Example.
  i) Igneous rocks - Basalt, traps, granites - Difficult to dress & polish. (They are very hard & tough)
  ii) Metamorphic rocks - Marbles. } Can be dress & polish due to soft in nature with low cost.
  iii) Sedimentary rocks - Limestones }

6. Durability

- If a stone is durable it must
  i) withstand loads imposed on it for the entire period of use.
  ii) Must keep up Original Appearance even when used in exteriors.
  iii) must resist the effects of heat and cold.
  iv) must not suffer deterioration and decomposition by gases, effluents and vapour from surrounding industrial towns.

Expand

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Dressing of Stones.

Internal (15)

Definition. Dressing of Stone is the process of giving a proper size, shape, and finish to the roughly broken stone as obtained from the quarry. This is done either manually or mechanically or in some cases using both the methods.

Objects.

Stones as obtained from the quarries are very rough and irregular in shape. Besides, they may be too bulky to be used in construction. The various objectives of dressing are

a) To reduce the size of blocks to easily portable units
b) To give a proper shape to the stone.
c) To obtain an appealing finish.

Method of Stone Dressing

1. Manually 2. Mechanically.

Tools used in the Dressing of Stones.

1. Drafting chisel
2. Masons hammer
3. Plane chisel
4. Scabbling hammer.
5. Punch chisel.
6. Pointed chisel.
7. Club hammer

Expand

Characteristics of Different types of Stone and their Uses.

Granite.

- It is a coarse to medium grained Igneous Rock made up essentially of Felspar orthoclase and quartz minerals.
- It also contains minerals like mica, hornblende and tourmaline.
- It is light colour & often spotted.
- It possess excellent building properties such has high strength values and very high hardness, excess durability and very low absorption value.
- Granites occur in appealing colours and have a capacity to take very fine, glassy, mirror-like finish on polishing.
- It has prior fire resistance.

Occurrence

1. Andhra pradesh.
2. Karnataka.
3. Kerala.
4. Kashmir.
5. Himachal pradesh

Basalt

- It is a volcanic type of igneous rock that is formed from cooling of Lava coming out of volcanoes.
- The basalt also called Traps & their mineral composition are the felspar and ferromagnesian components like hornblende and augite.
- Basalts are dark coloured, fine-textured crystalline rocks. They some times show cavities and pores developed during cooling process because of escape of gases.
- It is very high strength & resistant to weathering, dressing is difficult due to hardness.

Occurrence.

1. Mostly South India
2. Many parts of Maharastra, and Gujarat.

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Lime stones:

1. Lime stones are fine textured sedimentary rocks of calcareous composition and they occur in stratified formations and also as masses

- They are made up of calcium, Carbonate, & some varieties also contains magnesium carbonate.
- Dolomite rocks which is made up of magnesium Carbonate has same properties as lime stones.
- Lime stone available variety of colour, like white, grey, Black.
- Those lime stone which are dense, compact, and massive can be used for building construction.
- It can not used for building (Industry) in facing portion of construction because toxic gases react with lime stone, destroy its look and durability.

Occurrence.

1. Andhra pradesh
2. Delhi
3. Madhya pradesh
4. Uttaranchal
5. Uttar pradesh
6. Rajasthan.
7. Jammu & Kashmir

Marble.

- Marble is a metamorphic rock of granular (Sugar like) texture and calcareous composition.
- It is formed in nature from lime stone through the process of Metamorphism.
- The essential mineral in marble is calcite (Calcium Carbonate ($CaCO_3$))
- Marble occurs in a variety of colours from pure white, red, pink, green to dense black.
- It is strong, uniform in texture, least porous and take excellent polish.
- It is suitable both as ornamental stones and for general construction.
- It occurs in the state of Rajasthan at Jodhpur, Jaipur and Ajmer & Baramulla district of Jammu and Kashmir.
- Makrana in Jodhpur - Pink & white marbles & Ajmer - Green & Yellow Marbles

Sand Stones.

- It is sedimentary group of rocks, siliceous in composition mostly stratified in structure showing texture variable from coarse to medium to fine grained.
- The essential mineral of Sand stone is Quartz (SiO_2)
- In cemented variety of Sand stone, the cementing material may be silicious, calcareous or clay in nature can be used for building material.
- Sand stone show variety of texture ranging from coarse-grained, medium grained to fine grained.
- Sand stone occur in many colour, white, grey, pink, red, maroon and dark.
- It occur in Madhya pradesh, Uttarpradesh, Orissa, Bihar and Jammu & Kashmir.
- Vindhyan Sand stones of Madhapradesh - It is suitable for building and architectural work.

Gneisses

- It is metamorphic group of rocks, & generally silicious in composition, foliated or banded in structure.
- The mineral present in rocks are felspar, Quartz and ferro magnesian minerals.
- It is a crystalline rock, & used as a building stone.
- It occurs in Andhra pradesh, Karnataka, Tamil Nadu and Orissa, Bengal, Bihar. (particular in Southern states)

Laterite

- It is a sedimentary group of rock mostly of oxides of aluminium and oxides of iron are present.
- It creates spongy structure and porous texture.
- It occurs in Maharastra, Madhya Pradesh, Bihar, Orissa & Southern states (Andhra pradesh, Kerala, Madras)

Slate

- It is a metamorphic group of rock with a distinct foliated structure & siliceous composition & fine textured rock.
- It is impervious & very suitable as roofing stone
- It is found in Rajasthan, Haryana, Himachal Pradesh Andhra pradesh, Madhyapradesh,
- It is mainly found many Parts of Rajasthan.

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Bricks

Clays (Brick earth & its composition)

- Clay is a naturally occurring material that is found almost every where on the surface of the earth making the soil cover or the soft ground. It constitute rock particle by natural agencies such as wind, water, ice and atmosphere.
- It compose of one or more minerals of clay group such as Kaolinite, Montmorillonite, Illite, Vermiculite and Allophane etc. Kaolinite is the most important mineral component of common clays.
- Clays occur universally & man has used them since ancient times for making earthenware of great variety.

Brick Making

The process of manufacture of bricks is carried out in a number of stages. It is essentially a sequential process, next stage is reached only when the previous stage has been completed in all respects. These stages are listed below:

1. Selection of suitable type of clay (brick earth)
2. Preparation and Tempering of Mud.
3. Moulding of brick units.
4. Drying of moulded bricks.
5. Loading of the dried bricks in Kilns.
6. Firing or Burning of dried bricks.
7. Cooling of the units.
8. Unloading of the Kiln.

Selection of suitable Brick Earth.

Good type of bricks cannot be made from every type of clay. A suitable brick earth should have the following composition in the desired proportions.

1. Alumina (20-30%) 2. Silica (50-60%) 3. Iron Oxides (4-6%)
4. Lime (4-6%)

Alumina.

- When alumina is higher than 30% the brick will become more plastic and also shrink more on drying & develop cracks on the moulded bricks on drying. But if the alumina is present in lesser than 20%, the clay may be difficult to mould proper shapes.

Silica.

- When present in ideal proportions, i.e. 50-60%, Silica imparts the qualities of hardness and strength the brick. It also resist against shrinkage and durability of the brick to weather. When the poportions of silica is more than 60% they will not be mouldable easily. Such bricks when burnt would be quite brittle and porous & also not burn easily.

Iron Oxides.

- This oxide acts as a flux i.e it lowers down the softening temperature of silica and other clay components during firing.
- It gives red colour to the burnt bricks.
- Excess Iron oxide makes the bricks too soft during the burning stage, deformation in shape and size & creates darker shade which is not a appealing colour.
- A deficiency of Iron oxide in the clays may make their burning difficult and also give them a yellowish appearance.

Lime.

- lime present in clay help burning and hardening of the bricks quicker & more than 4%. causes excessive softening of the clays on heating.
- It must be present in powdered state otherwise when lime is present as nodules if may give rise to slaking when the brick comes in contact with moisture after its use.

Slaking — It is a harmful reaction and may cause slow disintegration of the brick.

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Undesirable Components in clay

1. Lime nodules 2. Organic matter 3. Sulphides & Sulphates.
4. Alkalies salts.

The clay should free from the above components.

Stage-2 Preparation of Mud.

- **Winning**

- The process of obtaining brick earth from its natural deposit is called Winning
- The brick earth deposit is first cleared off from vegetation, pebbles and other organic matter.
- Manual digging or Mechanical excavation methods are used to obtain dry soil or brick earth and such clay is spread out even ground for seasoning i.e exposed to atmosphere for a maximum period.
- It is at this stage that the earth is further cleaned off any pebbles, stones, lime nodules and visible organic matter.
- If needed, any additional quantity of sand and lime are throughly mixed with the soil
- The seasoned clay is ready for making mud by mixing adequate quantities of water.

- **Tempering**

- It is the process of converting the brick earth to mud of proper consistency by thoroughly mixed with desired quantities of water.
- It is done either by manual labour or with the help of a Mechanical called Pugmill

Manual Labour

In manual tempering the clay is spread on a platform and thoroughly kneaded under feet of either man or cattle. & water is added in small quantities till desired homogeneity and plasticity are obtained.

Pug Mill Tempering:

- The process is sometimes called pugging and is done by mechanical device called Pug Mill.
- It consists of a steel cylinder covered at the top or near the bottom.
- It is 2 to 3 meter height, a part being below the ground.
- The top diameter of the pug mill is slightly bigger (1M) than the diameter at the bas (0.7m)
- A vertical shaft pivoted at the base, which can be rotated with the help of a long arm through animal or motor power.
- The central shaft is attached with horizontal blades each carrying some knives.
- Seasoned clay and water are added from an opening provided at the top
- The required quantity of clay and water are fed into the pug mill, the shaft is made to rotate.
- This action provides the churning effect to the clay - water mixture that is converted after some time into mud of desired plasticity and consistency.
- The mud is then taken out from the hole at the base and new charge is filled.

Stage-3: Moulding of Bricks.

Moulding is the process of making green bricks of proper shape and size from thoroughly tempered clay. There are two main methods of moulding

1. Hand Moulding
2. Machine Moulding

Hand Moulding

- In India the most common method for brick manufacture from the tempered mud is hand moulding.
- In hand moulding the quality of tempered clay is soft & can be given desired shape easily.
- In this process mud contains more water (18-25% by weight) than machine moulding. So the process is called soft process of Mud.
- The bricks can be made shape from the soft mud by hand on a specially prepared ground (called ground moulding) or on specially designed tables (called table moulding)

Tools The essential tools used in the hand moulding processare
1. A brick mould
2. Cutting wire or edge or Strike.
3. Wooden plates or pallet
4. Stock board

~~Pallet for strike~~:

1. **The Mould** is made of wood or steel. Its inside dimensions are kept slightly bigger than the desired dimensions of the finished brick. This is done because the bricks on drying are liable to shrink in size. The mould may be a single unit or a multiple unit type.
2. **The Stock Board** also called moulding block, is a small wooden board with a raised central projection carrying the identification marks (frog) of the manufacturer
3. **The Pallets** are thin wooden plates used for handling the green bricks from the moulding boards to the drying field.

4. The Strike, made of wood or metal, has its one edge quite thin to slash surplus mud from the top of the moulded brick while it is in the mould. Sometimes a thin wire strong in a wooden block for holding is used for the same purpose, it is called cutting wire.

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Machine Moulding

- Machine moulding is the essential process in all Mechanized Brick Making plants.
- It is both cheaper in the longer run and gives bricks of uniform quality.

There are two Methods.

a) Stiff Mud Process → Worm gear Moulding machine
b) Dry Press Process → Vacuum press.

a) Stiff Mud process.

In this method throughly cleaned brick clay is mixed with small quantity of water (8-12% by volume) during tempering in pug mills so that it is quite stiff in consistency and stiff mix is then pass out under pressure from a moulding machine.

Worm gear Moulding machine.

i) A feeding chamber provided with a worm gear to apply pressure.
ii) A hopper at the top to receive the clay mix from the pug mill.
iii) A fixed die provided at the front narrow end.
iv) A conveyor belt on a set of rollers.
v) cutting wire device adjusted in front of the die.

Operation Steps

a) feeding the properly mixed stiff mud in to the chamber through the hopper.
b) forcing forward the mud charge with the worm gear.

Process.

- The pressed mud comes out through the die in the form of a continuous rectangular ribbon having the height and width of the brick.
- The ribbon get's cut into brick length by pressing down the cutting wire device when the conveyor belt is under the device.
- The cut out bricks are then carried forward on the conveyor belt and taken away for drying.
- The lengths can be cut edge-wise or side wise depending on the die.
- The machine can mould 1000-2000 units per hour or as per designed capacity of machine.

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Table Moulding

In this process, the skilled worker or the moulder carries out all the moulding operations on a specially designed table of suitable dimensions. Such a table is large enough to accommodate all the materials required in the hand moulding

1. A stock board
2. cutting edge.
3. Buckets for water.
4. Sand & tempered mud.
5. Pallet.

Process.

- The process is similar to pallet moulding on ground.
- The moulder places the stock board in front of him, sprinkles some sand on the inside surface of the mould, places it on the board, dashes a lump of mud into it, presses it thoroughly and skillfully and cuts away any surplus mud with the strike or the cutting edge.
- Then moulder places a pallet over the mould and turns it over.
- The moulded brick is then transferred to the pallet, & which is carried away by a helper standing near by.
- Repeat the process for each brick.
- In this process initial cost is high comparing ground moulding but it is efficient & economical in the long run as production is better in quality and quantity.

Ground Moulding

This is the most common method of moulding bricks in our country. In this process a stretch of land is first flattened, levelled and cleared. may be smooth by mud plastering. Some sand is sprinkled uniformly over it to make it non-sticky

There are two variations of ground moulding.

a) for making ordinary bricks. —

- The mould is either first dipped in water or some sand is sprinkled on its inside surface
- The first method is called slop moulding and the second method is called sand moulding.
- This step is necessary to avoid sticking of the green mud to the inner sides of the mould.
- Then the mould is placed on the ground at desired spot.
- A lump of mud is dashed into the mould by hand.
- Care is taken to see that the mud reaches to the sides and corners of the mould.
- Any surplus mud is then removed by using strike or cutting wire.
- The mould is then lifted up with a jerk, leaving behind the moulded brick on the ground below.
- Repeat the same process & the face of the brick that rests on the surface is naturally rough and without any identification mark.

b) Moulding bricks with frog —

- This is achieved by using a stock board and pallets.
- The stock board is provided with a raised projection carrying trade mark (identification mark) of the brick manufacturer
- Here the mould is placed on the stock board instead of ground.
- The brick is taken away using two pallets to the drying field
- This process is called Pallet moulding.

Useful Purpose of frog.

1. The name of the manufacturer of the brick is easily found and he can be known for the quality of the brick.
2. During use, the frog-faced side is placed upward. It accommodates some extra mortar & the key actions forming a bond of greater strength the upper and the lower brick in the construction work.

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After moulding (or pressing), the green bricks have to be dried before burning.

Reasons for Drying of Bricks.

1. To make the green bricks strong enough to bear rough handling during stacking in the kilns for burning.
2. To allow loss of moisture from the bricks at a slow rate.
3. To save fuel during burning stage.

Drying of green moulded bricks is achieved by two methods.
1. Natural Method
2. Artificial Method

Natural Method

In Natural Method there are two stages involved in the drying process.
1. Pre stacking Stage.
2. stacking stage.

Pre stacking Stage.

The moulded bricks are laid side wise and flat wise for 2-3 days in the drying fields so that they become hard to handle stacking.

Stacking Stage.

1. The hardened bricks are arranged in well made layers, one layer above another & should be done by skilled workers
2. Stacking is done in specially prepared drying grounds.
3. Each stack may be about 100 cm wide, 10 bricks layers high and as long as the ground allows.
4. Enough space is left between the individual bricks in a stack and also between layers for free circulation of air around each brick.
5. The stacks are properly protected from direct ~~sun~~ Sun, rain and strong wind.

Air Drying Method

In this method may take 4-10 days depending upon the season and placed drying & after air dryed the brick still retain 2-4% moisture on them

Sun Dried Bricks : Adobe.

1. The sun dried bricks are also called adobe.
2. These bricks can sustain enough load in small construction also resist continuous rain.

Artificial Drying

- This method is essential in mechanized brick making units.
- Bricks can be dried throughout the year independent of weather condition.

Artificial Drying can be done by 1. Chamber drying
2. Tunnel drying

Chamber Drying

- In chamber drying, bricks are arranged in stacks within specially designed drying chambers & keeping sufficient spaces for free circulation of hot air around them.
- Hot air under controlled conditions of temperature and humidity is made to circulate through these stacks for 2-4 days or more.
- The dried bricks are then taken out and next batch of green bricks is stacked in layers within the chamber.

Tunnel Drying

- In tunnel drying, bricks are stacked on mobile cars that are made to travel on rails within a specially designed drying tunnel.
- The tunnel is divided into compartments and each car loaded with green bricks is made to stay in a particular compartment for pre-fixed duration.
- The cars come out from the other end of the tunnel one by one & this process may take 2-3 days for a car load of bricks to dry to desired extent.

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Stage V. Burning of Bricks.

Need.

- After burning dried bricks develop desired building properties such as, strength, hardness, durability and resistance to decay and disintegration.
- At least three chemical changes takes place in the brick earth during burning process
  1. dehydration.
  2. Oxidation.
  3. Vitrification.

Dehydration – It means complete removal of water from the pores of the bricks.

Oxidation. – All the organic matter in the brick earth gets oxidized & carbon, sulphur are eliminated. also during flux the lime, magnesia and iron becomes reactive at these temprature. The brick acquires the red colour due to iron in the clays.

Vitrification – In this process the constituents of clay i.e, Alumina and silica start softening. The constituent grains get bound firmly.

Methods of Burning:

Bricks are burnt in two ways 1. Clamp burning
2. Kiln burning.

Clamp Burning:

1. Clamp burning is also called as Pazwas.
2. The working arrangement for burning bricks without making any permanent structure.
3. In this process alternate layers of dried bricks and any locally available fuel of ordinary type are stacked together upto a desired height on a properly prepared ground.
4. The heap made is then plastered from outside with mud.
5. It is ignited from the base and allowed to burn for a month also allowed to cool for another month.
6. In a clamp of 10m X 7.5m sides, about one lakh bricks burnt in two months.

Advantages.

1. It is easy to erect and operate.
2. Any type of fuel can be used in clamp burning.
3. It required least supervision after burning.
4. It is economical.
5. It gives ordinary bricks of less strength.

Disadvantages.

1. Burning of bricks is not uniform and some bricks at the lowering regions get over burnt where as bricks from middle and upper regions of the clamp remains under burnt.
2. Burning can not be regulate.
3. Bricks get damaged due to crumbling and falling when the intervening layers of fuel get burnt.
4. Time required for burning is too long.

B. Brick Kilns

The Permanent Structures which are used for burning of bricks is called Kilns. It is divided into two groups basingon their principle of Construction.

1. Intermittent Kilns
2. Continuous Kilns.

1. Intermittent Kilns.

i) In intermittent Kilns burnt bricks can be made available only after a definite interval of time after put on fire.

ii) Here the brick supply is intermittent.

2. Continuous Kilns.

i) Here the brick supply is continuous.

ii) It consist of a number of chambers.

iii) It is a controlled process, when one chamber is in the ~~heating~~ burning stage, loading the another chamber in the ~~heating~~ stage, a third chamber in the preheating stage, a fourth chamber in the cooling stage and a fifth chamber in the unloading or supply stage.

iv) The operation are shifted from chamber to chamber in such a manner at any time one chamber is available for unloading.

BULL'S TRENCH KILN (17) Internal.

Principle:

1. It is a continuous type of Kiln is used for burning of brick.
2. It has number of compartments or sections & can be operated independently as well as in a sequential process.
3. The supply of bricks in a regular manner for loading.

Construction.

1. The Kiln may be of semicircular or rectangular outline in plan.
2. It is excavated below the ground level to conserve maximum heat during the burning process.
3. The dimensions of the trench depends upon Capacity of bricks.

Length - 50 to 78 m width - 4 to 8 m. Depth - 1 to 2 m.

4. A typical trench kiln has two walls both made of bricks.
6. The inner wall is continuous ~~and~~ & outer wall has number of openings or gates.
7. The gates are provided with dampers or door and can be operated opened or closed by raising or lowering the damper as desired by the operator.
8. It has 6 to 12 interconnected compartments inside the kiln.
9. Kiln is provided with chimneys placed at the top for Exhaust of gases & can be shifted from one compartment to another

Loading
1. In this process Stacking of bricks is done carefully within the kiln such that enough space is left between any two bricks in a layer for free circulation of hot gases around them.
2. The top of the loaded section is throughly covered with 20 to 30 cm deep layer of ash and dust taking care that none of the openings from the kilns get blocked in the process.

Preheating
In preheating stage hot and waste gases to pass to the loaded section or chamber by raising the dampers between the two chambers.

Burning
Here required volume of air is supplied by regulating the openings and raising of the gates or the dampers provided in the outer walls. Additional quantities of fuel may be added from the flues at the top. It takes 24 to 30 hours for perfect burning.

Cooling
In this stage all the outer gates are closed by lowering the dampers & inter departmental gates are opened up for leading the hot gases to the preheating sections. It takes 3 to 4 days to cool down completely before unloading can be started from it.

Unloading
The top layer of dust and ash are removed ~~from the~~ & put to unloading. The bricks are removed from the top to bottom one by one & taking care that they are not broken during unloading & handling process.

Sapanda
09.09.2020

HOFFMAN'S CONTINUOUS KILN

Internal (17)

Principle – It is a modern and more refined type of brick kiln used for burning a large number of bricks and other clay products under controlled conditions of temprature.

Construction

1. In construction, Hoffman's kiln consists of circular walled structure generally made over the ground.
2. The circular space enclosed in this way is commonly divided into 12 chambers by suitable partition walls.
3. The adjacent chambers are interconnected by communicating doors, which can be opened or closed by raising or lowering dampers.
4. A Hoffmann's kiln is also provided with a central chimney which is connected to all the twelve chambers through flues.
5. The flues can be closed or opened by dampers provided at the back of each chamber.
6. Each chamber is also provided with a separate gate in the outer wall through which it can be loaded, unloaded and fired.
7. The kiln has a permanent roof so that it can be worked throughout the year.

Working

1. At any given time, some chambers can be in the burning, others on the pre-heating, still others in cooling and some in the unloading stages.
2. In this process an upward draught or current of air within the kiln.
3. This is done by closing all the outer gates except of the chamber which is being unloaded.
4. Natural air enters the kiln through the outer gates 2 to pass through different chambers by opening their interconnecting doors.

5. The flue at the back of each chamber is kept closed.
6. The air is circulating through different chambers for cooling, burning and preheating
7. The air is then made to enter the chimney by opening the back flue of that chamber which is in pre-heating stage.

Epanda
18.09.2020

3rd sem (civil) Civil Engineering Material 19.09.2020

TUNNEL KILN (continuous process)

1. It is a continuous type of Kiln and is considered highly efficient.
2. It consists of a channel or tunnel 60 to 150 m long and 3 to 5 m wide and the tunnel is provided with rail tracks for cars.
3. The tunnel is divided into three sections for working ① Pre-heating section ② Burning section ③ Cooling section.
4. The flow & temprature of gases, humidity is kept under strict control in these sections.

Working

1. It is a simple process for burning in Kiln.
2. A car loaded with bricks is moved into the pre-heating chamber which is ahead of ~~burning~~ burning chamber.
3. Bricks on the loaded cars are heated by the waste gases coming from the burning sections.
4. After a few hours stop, the car is moved into the burning chamber & it may be allowed to stay here for 20 to 24 hours.
5. After burning the car is moved to the cooling chamber. & it is then taken out and unloaded.
6. The process is continuous and quick for supply of well burnt bricks.

Spanda
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3rd sem (civil) Civil Engineering Material 29.09.20

Wet Process.

1. It is considered a better and convenient process for the manufacture of cement where limestone of soft variety is available more in quantity.
2. The processes are in three headings:
   1. preparation of slurry.
   2. calcination.
   3. Treatment of clinker.

1. Preparation of Slurry.

i) In wet process, raw materials are supplied to the kiln in the form of mixture with lot of water in it. This is
ii) called SLURRY.
To obtain SLURRY of a standard composition, the raw materials are first crushed separately using crusher for limestones and grinding mills (wet) for clays.

iii) These crushed materials are stored in separate tanks or SILOS.

iv) They are drawn from the silos in prefixed proportions into the wet grinding mills where in the presence of a lot of water, these get ground to a fine thin paste.

v) This is stored in third silos called the SLURRY SILO.

vi) Its composition is tested once again and corrected by adding limestone slurry and clay slurry in required proportions.

vii) The corrected slurry is then fed into the Rotary Kiln.

2. Calcination or Burning

1. For burning of the slurry, a rotary kiln of almost similar type is used as described in dry process.
2. The length of the drying zone is larger, because the material is fed into the kiln with more water.
3. All the moisture is driven off from the slurry in drying zone and the further process are same as in dry method of processing.

3. Grinding of clinker

1. Lump shaped clinker comes out from the kiln which is hot and then passed through air cooler rotary cylinders.
2. Then gypsum (3 to 4%) added & ground to fine powder as in dry process.
3. Then the cement is packed & same as dry process.

Signature 29.9.2020

Classification of bricks.

1. In every country, bricks have been divided into different classes on the basis of their properties
2. According to BIS the classification of burnt bricks into following four main classes.

Sl no	Class	Characteristics	Use
1	First class Bricks	i) well burnt having even surface and perfectly rectangular shape. ii) when two bricks are struck against each other a ringing-sound is produced iii) Its compressive strength shall not be less than 140 kg/cm^2 and its absorption after 24 hours immersion shall not exceed 20%. iv) It should show a uniform appearance, texture and structure when seen on fracturing.	Excellent for all types of construction in the exterior walls when the plastering is not required. Also suitable for flooring.
2	Second class Bricks	i) well burnt, even slight over burning is accepted. ii) Metallic - ringing sound is also a must in this case as well. iii) In shape, rectangular, but slight irregularity is permitted - Surface may be slightly uneven. iv) Compressive strength shall not be less than 70 Kg/cm^2 and absorption value between 20 to 22%. v) slightly difference in structure on fractured surface is admissible.	i) for exterior work when plastering is to be done. ii) for interior walls. These bricks may not be used for flooring
3.	Third class Bricks.	i) Poorly and unevenly burnt, & may be overburnt or under burnt. ii) on striking a dull sound is produced. iii) Appearance, shape and size are also non-uniform and irregular. iv) compressive strength lies between 35 to 70 Kg/cm^2 and absorption between 22 to 25%.	Used mostly in ordinary type of construction and in dry situations.
4.	JHAMAOR fourth class Bricks	i) Irregular in shape and dark in colour, which is due to over burning. ii) Quite strong in compressive strength, generally above 150 Kg/cm^2 and low in porosity and absorption	Jhama bricks are unfit for building construction. It has distorted shape and irregular size. It can be used in broken form in road construction, foundation & floors as coarse aggregate material

Size of Traditional Bricks
- 9" x 4½" x 3"

Size of Standard Modular Bricks
1. Actual size - 19cm x 9cm x 9cm.
2. Nominal size - 20cm x 10cm x 10cm.

Qualities of Good Building Bricks.

1. It should have a rectangular shape, regular surfaces and red coloured appearance.
2. It should conform in size to the specified dimensions (19cm x 9cm x 9cm)
3. It should be properly burnt. Holding two bricks freely, one in each hand and striking them. A sharp metallic sound indicates good burning, where as a dull sound indicate incomplete burning.
4. A good building brick should not absorb water more than 20% of its dry weight. Absorption should not exceed 25% in any case.
5. A good building brick should possess requisite compressive strength, which in no case should be less than 35 kg/cm². A rough test for the strength of the brick is to let it fall freely from a height of about one meter on to a hard floor. It should not break.
6. Brick should be hard enough so that it is not scratched by fingernail.
7. A good brick has a uniform colour and structure throughout its body. This can be checked by taking a brick from the lot and breaking it into two parts. The broken surface in both the halves should have same appearance and structure.

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20.09.2020

Cement

Types of Cement

After Ordinary Portland Cement (OPC), a number of other types of Cement are also manufactured by varying the ratio of the raw material or by adding some additional materials. Some special purpose cements are mentioned serially.

1. Rapid hardening Cement
2. low-heat cement
3. Quick setting Cement
4. High Alumina Cement.

Another group of cements primarily on the basis of raw materials used
1. Blast furnace slag-cement
2. Pozzolana Cement
3. White cement.

① Rapid Hardening Cement

Defination: 1. It is also known as High Early strength Cement.
2. It attains maximum strength within 24 to 72 hours.

Properties.
1. It contains relatively more tricalcium silicate.
2. This is done by adding greater proportion of lime stone in the raw material s compared to that of OPC.
2. It is more fine grained than the ordinary portland Cement. Due to more fineness of cement it helps quicker and complete hydration during setting also gaining early strength.
3. The setting time for rapid hardening Cement is same as Ordinary port
4. The extra fineness may be a cause of development of cracks.

② Low Heat Cement

Defination - It is a type of Portland Cement in which very low amount of heat of hydration is liberated during setting and hardening. This cement is mostly used in massive concrete structures as dam and Pillars.

Properties.

1. The proportion of dicalcium silicate (C_2S) is increased to almost double than in ordinary portland cement.
2. The proportion to tetra calcium alumino ferrite (C_4AF) is also increased to one and one half time than in Ordinary Portland Cement.
3. The proportion of tricalcium silicate (C_3S) and tri-calcium aluminate (C_3A) are reduced by about 50 percent than in ordinary portland cement.

High Alumina Cement

Definition: — ① It is special purpose cement which contains alumina in considerably large proportions (average 40%) than usual.
② This cement is specially useful against corrosive action of sea water
③ It is the most favoured cement for use in concrete structures in coastal areas

Properties.

1. It is greatly resistant to corrosive action of acids and salts of sea water.
2. The ratio of alumina to lime is kept between 0.85 and 1.30.
3. Its initial setting time (more than 3.5 hours), its final setting time is 5 hours. These setting characteristics give more time for working with high alumina cement
4. Due to short final setting time the R.C.C. structure gains both tensile & compressive strength. It gains compressive strength of 400 Kg/cm^2 within 24 hours and 500 Kg/cm^2 after 72 hours.
5. It evolves great heat during setting.
6. It reacts quickly with free lime & OPC so it should not be in contact with them.

Quick Setting Cement

Definition → 1. After setting this cement gives stone like mass within a period of 30 minutes
2. Quick setting is achieved by following control in manufacturing process is as below.
i) The quantity of retarder like gypsum is reduced.
ii) The quantity of Alumina-rich compounds is increased
iii) The clinker is grinding to extreme fineness.

USE It is used for constructing Pillars & other structures in running & standing water.

Expanding 22/9/20

White Cement

Defination

1. It is a special type of cement which on use gives milky or snow white in appearance.
2. White cement is manufactured from pure limestone (chalk) and clay that are totally free from oxides of iron, manganese and chromium.
3. The kiln is fired by oil rather than by coal to avoid any contamination.

Properties

1. It has properties of strength and setting times similar to ordinary Portland cement.
2. It is costly & used in selective area of construction.

Hydrophobic Cement

Defination

1. It is a special type of cement containing admixtures which reduce the cement grains for water.
2. Admixtures of naphtha, a soap and a acidol are generally added to achieve this property.

USE

This cement are specially useful for application in cold, frost-forming conditions.

Super Sulphate Cement

Defination

1. This variety of cement is manufactured by adding quantities of calcium sulphate & blast furnace slag to the ordinary Portland cement.
2. It is Economical.

USE

1. It is useful for mass concrete construction, specially in sulphate-rich environments and marine conditions.

Low Alkali Cement

1. where there is silica in concrete as aggregate use of low alkali cement is recommended.
2. It is portland cement but alkali content is kept low while manufacturing & a very strict control over the composition of raw materials used.

Epanda 24.09.2020

Portland (Blast furnace) Slag Cement

Defination

1. It is modified type of Portland cement & contains 25 to 65 percent of blast furnace slag.
2. It is manufactured by grinding together the cement clinker with specific amounts of blast furnace slag.
3. The slag is a waste product from blast furnace in the manufacturing of Iron.
4. The slag is first converted to granulated form and is then ground with clinker & small percentage of gypsum is also added for controlling the setting time of the slag cement.

Properties

i) The cement possesses beter workability cohesiveness and plasticity than the Ordinary Portland cement.
ii) The slag cement has better resistance to sulphate of alkali metals, alumina and iron.
iii) It is better suited for use in marine structures as in docks, harbours and jetties.
iv) It is an ideal type of cement for use in road construction in marshy and alkaline soils.
v) It has low heat of hydration. This property makes it useful for mass concrete work.
vi) It is economical than OPC.

Pozzolana Cement

Defination

1. In this type of cement, clinker has been mixed with definite proportions of Pozzolanic material such as volcanic ash, flyash, powdered burnt bricks.
2. Pozzolanic materials react with cement compound and form compounds having cementing properties.

Properties

i) It produces less heat of hydration & used for mass concrete work
ii) It offers great resistance to sulphate and corrosive action of sea water. It is also suitable for use in sewage works and for under water construction.

Coloured Cement

Defination.

1. Any desired colour can be mixed to the Portland cement by mixing with it a definite proportion of a mineral pigment.
2. It is generally less than 10% by weight, and most commonly between 2 to 5%.

Pigments used for coloured cements are.

i) chromium oxide for green colour.
ii) Cobalt for blue colour
iii) Manganese dioxide for black and deep brown colour.
iv) Iron oxide for various shades of red, brown and Yellow colour.

USE

Coloured Cements are extensively used for top coat in flooring and for decorative purpose in various places in a building.

Spanda
23.09.2020

25.09.2020

Methods of Manufacture.

Portland cement is manufactured by two processes.
① Dry Process ② wet process.

Dry Process.

In the Dry process calcareous and argillaceous raw materials are fed into the burning kilns in a perfectly dry state.

In the wet process the above materials are supplied to the kiln in the form of a mixture with water called SLURRY.

Steps in the process of manufacture:

1. Treatment of Raw materials
2. Burning of Dry mix
3. Grinding of the clinker
4. Packaging and storage.

① i) Treatment of Raw materials → The raw materials limestone and clay are subjected to such processes as crushing, drying, grinding, proportioning and blending or mixing before they are fed to the kilns for calcination or burning.

ii) The crushing stage involves breaking the raw materials to small fragments that vary in size between 6 to 14 mm. Machines called crushers are used for this purpose.

iii) The drying stage is typical of the Dry process. Drying of crushed materials is essential and is achieved by heating these materials (separately) at temperatures sufficiently high to drive out uncombined water. Heating is done in drying kilns which are generally of rotary type.

iv) The grinding of each material as obtained from the driers is done in two stages.

- first, the preliminary grinding in which the materials are reduced to a fineness of 50 mm mesh. Ball mills are generally used for preliminary grinding.
- second, the fine grinding in which the size of the materials is reduced to 200 mm mesh. This is done by grinding in Tube mills.

Each raw material is then reduced to a required degree of fineness and is stored separately in suitable storage tanks called SILOS or BINS where from it can be drawn out conveniently in requisite quantities.

v. Proportioning and Blending - Predetermined proportions of finely dried and ground raw materials are mixed together before they are fed into Kiln. The different materials then combined together are mixed thoroughly either by mechanical or by pneumatic method.

Mechanical Method - Materials from different storage Silos are simultaneously drawn off and fed into a single SILO that now contains mixed materials.

Pneumatic Method - Dry proportioned materials are pumped under pressure into a blending SILO, where from they are drawn in the mixed state. The blending materials are then ready for feeding into the burning Kilns. from this stage onwards, there is practically no major difference between the dry and wet processes, except in the design of the rotary Kiln.

See the Vital Sectional View of 1. Rotary Kiln
2. Ball Mill
3. Tube Mill

Ganga
25.09.2020

Manufacturing of Cement (Dry Process)

2.

Burning or Calcination

1. The well proportioned finely powdered mixture is charged into long steel cylinder called the Rotary Kiln.
2. The Kiln is adjusted in an inclined position, making an angle of 15° with the horizontal and rotates around its longer axis
3. It has a charge end and a burner end, the former for introducing the material (called feed) and the latter for supplying fuel.
4. Rotary Kilns differ in design and dimensions in accordance with the production requirements. The length may be 100 to 180 m and 3 to 5 m in diameter and also rotation of 60 to 90 revolutions per hour.
5. Coal in finely pulverized form fuel oil and gas are common fuels used in these Kilns.
6. The raw mixture is burnt in the Kiln till the proper burning is achieved. This is indicated by its taking a greenish black colour and vitreous or shining like glass.
7. This burnt material is called Clinker is Cement in composition but not in size. It is about Walnut-sized lumps when it comes out of the Kiln.
8. The following three reactions during burning.
   i) Complete dehydration - water is completely driven off at the very initial stage of burning at temprature as low as 400°c.
   ii) Dissociation of Carbonates.

Carbonates of calcium and magnesium are completely dissociated at temperatures between 800° to 900°c.

$$CaCO_3 = CaO + CO_2$$

$$MgCO_3 = MgO + CO_2$$

iii) Compound formation: - Lime and magnesia as formed are combined in the next stage with silica, alumina and ferric oxide to form the basic compounds of cement namely, tricalcium and dicalcium silicates. also tetra calcium alumino ferrite, tricalcium aluminates.

ii) These compound formation reactions start at temprature around 1200°C and required temprature as high as 1550°C for their completion.

iii) It is takes place near the burner end of rotary Kiln & Alkalies, moisture and harmful gases are expelled out as water vapour during the burning of the raw materials of the Kiln.

3. Grinding of the clinker

1. The completely burnt or calcined raw material of cement are obtained in lump-shaped product, called clinker which is collected at the lower end of the rotary kiln. It is extremely hot, then first cooled in clinker cooler. Gypsum ($CaSO_4 \cdot 2H_2O$) is added to the cooled clinker & sent for pulverizing.
2. In pulverisers the mixture is reduced to an extremely fine powder by grinding it in two stages
   1. preliminary grinding
   2. fine grinding

- Preliminary grinding is achieved by using gyratory type of crushers.
- Fine grinding of mixture by Tube mill & the tube mills are provided with air-Separators through which material of desired fineness can only pass & coarser portion of material cement is fed back into the mill for further grinding.

Packing and Storage of Cement

1. Cement is most commonly stored after its manufacture in specially designed concrete storage tanks called SILOS, where from it is drawn off for the market in bags.
2. For cement packing ~~cloth~~ Cloth, jute and High density Polyethylene (HDP) are comonly used.

Expanded
28/8/2020

08.10.2020

Mortar

1. In building construction stones and bricks are bound together with the help of an intervening layer of a paste of cementing material like lime or cement. The paste is known as Mortar and is made by mixing together definite quantities of cementing material, sand and water.
2. It is a matrix of cement, sand, water.
3. It binds the grains of the sand and the surfaces of the stone or brick & form a continuous structure offering strong reaction to the loads from above and the sides.
4. The safety, strength and durability of the resulting wall or any structure depends on the quality of the motar used as a binding medium.
5. The mortar has a property of hardening into a rock like mass soon after its application.
6. Plaster is also essentially a lean mortar that has been prepared for the specific use of providing a protective covering on the inner or outer faces of construction.

Classification or Types of Mortar.

Mortars are commonly classified on following considerations.

a) Type of binding material.
b) Nature of application.
c) Density of the mortar.

a) Type of Binding Material.

i) Lime mortar
ii) Cement Mortar
iii) Surkhi Mortar
iv) Gypsum Mortar
v) Gauged Mortar

Lime Mortar.

1. In Lime Mortar, a fat lime or hydraulic lime is used as the binding material.
2. Fat lime can't used in damp and moist condition.
3. Hydraulic lime is suitable for use even in damp situation.

ii) Cement Mortar:

1. It contains portland cement as a binding material, and mixing with sand.
2. The most of the quality construction work lies with the cement mortar.

iii) Surkhi Mortar:

1) It is ordinary type of mortar where sand is partly replaced by surkhi (crushed burnt bricks) as a filling material of lime mortars.
2) Surkhi can't use in reactive cement.
3) Surkhi mortars are quite commonly used in foundation works.

iv) Gypsum Mortar:

1. It is not used in tough construction.
2. It is generally used for application as plasters (covering coats).

v) Ganged Mortar:

1. It is made by adding Portland cement and lime together in properly determined proportions as binding material.
2. It is dense, stronger and durable than ordinary lime mortar.
3. It is inferior to cement mortar.

Nature of Application:

i) Brick laying or Masonry Mortars. - It is generally used as binding medium between the brick Masonry in the construction of foundation and wall of the building.
ii) Depending upon the nature of construction we may use lime-mortar, lime-surkhi mortar and cement mortars of various compositions.
iii) for Brick laying we are using Masonry mortar.

Density of Mortar (Two types)

① Heavy Mortar:
i) It is used for load bearing construction.
ii) The bulk density is greater than 1570 Kg/cm^3
iii) for special work, special heavy mortar having bulk density 2200 kg/cm^3 is used. Example – X-ray room.
iv) High density rock crushed to sand grain size is used.

② Lightweight Mortar:
i) Here the bulk density is below 1500 Kg/cm^3
ii) Sand contains quartz & pumice stone crushed to sand grain size is used.
iii) Blast furnace slag cinder is used in place of sand.
iv) Bulk density between 640 Kg/cm^3 to 1000 Kg/cm^3 is used for soundproofing & walls.

3rd sem (civil) Material Technology 16.10.2020

Sources of Sand & its classification

Fine and coarse aggregate.

Fine aggregates - If most of the particle pass through 4.75 mm IS sieve and contain only so much coarser material as is permitted for various grading zones.

Coarse aggregates - If most of the particle retain on 4.75 mm IS sieve and contain only so much coarser material as is permitted for various grading zones or specifications

Sources of Sand.

1. Various sands are commonly used as fine aggregate and obtained from riverbeds or by crushing the rock.
2. Flyash is also sometimes used as a part of replacement of fine aggregate.
3. The sand obtained from river bed contains particles of varying size and easy to procure.
4. Sand should not contain more than 5 percent dust if it is natural sand and 2 percent in case of crushed sand.
5. Sand contains mica reduces strength and durability of Concrete.
6. The particle shape of river sand desert, sea shore and wind blown sand is rounded.

Bulking of Sand (Experiment)

(15) Internal

Bulking factor Test.

1. Take 500 gm (V_1) of dry sand by mass.
2. put it in a mixing pan and add one percent water (5 c.c)
3. Mix it throughly to get uniform colour.
4. Fill it in the measuring cylinder and note the volume. (V_2).
5. The increase in volume is $(V_2 - V_1)$ and percentage bulking is $\frac{(V_2 - V_1)}{V_1} \times 100$
6. Bulking factor - $\frac{\text{Volume of moist sand.}}{\text{Volume of dry sand.}}$

7. Repeat the procedure of Experiment using different percentage of water.
8. Plot graph of bulking factor V/S moisture content, by percentage of dry mass of Sand.
9. This is known as bulking curve.

Note.

Finer Sand has higher maximum bulking factor than that of coarse Sand, as large surface area is available with finer Sand.

Salt contamination

1. Sand obtained from sea-shore or from a river estuary contains salt.
2. This salt is harmful as it absorbs water from air, causes efflorescence and corrosion of reinforcement.
3. The fine aggregates should wash on fresh water before use.

Spandy
16.10.2020

Use of flyash as Building Material & Road construction

1. flyash can be used as brick due to certain advantages over the conventional red bricks.
   i) Uniform and standard product size resulting in 10% less consumption of bricks per unit construction.
   ii) Cement consumption is less in cement and mortar.
   iii) Compressive strength is more than conventional red bricks (> 100 kg/cm²) & further increase with the passage of time.
   iv) less load on foundation due to light weight.
   v) Due to the property of less water absorption and no weathering effects, surfaces can be left exposed without plastering and direct application of paint is also possible.

2. flyash can be used for manufacturing of (PPC) cement (Portland pozzolana cement)
   when highly reactive flyash is mixed with portland cement clinker and ground with 5-6% of gypsum the resultant is portland pozzolana cement (PPC). It contains 25% of flyash. It has lower heat of hydration & gives sulphate resistant, lower shrinkage, used all types of construction

3. flyash can be used for Sintered Lightweight aggregates & cellular Light weight aggregates
   i) The production of (SLWA) is done by using dry flyash, mixing with water with the addition of high carbon flyash or carbon.
   ii) The production of (CLWA) is done by using flyash, cement, coarse sand, fine sand a foaming agent in a ~~slurry~~ mixture to form a thin slurry.

This slurry is then poured in moulds and allowed to set. The blocks are then removed from the moulds and are cured by spraying water on the stack. The blocks are specially useful in high rise construction reducing the dead weight of the structure.

4. Flyash can be used for road Embankment & Stabilization of sub base course.

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1. The most distinguishing feature of a flyash embankment would be use of flyash as core material with earth cover.
2. Intermediate soil layer of thickness 200 to 400 mm are usually provided when height of embankment exceeds 3m.
3. These intermediate soil layers provide flyash embankment from erosion due to rain and winds the embankment should be protected by providing earth cover
4. Sub base course can be constructed using ash replacing conventionally used moorum.
5. flyash is cohesionless & non-plastic in nature Morrum & Gravel used as in Road construction & building Material

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1. Natural soils, sands, gravel material and Morrum are frequently used as sub-base material for road construction.
2. Now a days crushed stone and crusher dust mixes as sub-base and base courses in road construction.

Note
i) flyash can be used to replace a portion of cement in concrete
ii) In cement concrete flor a mixture of cement, sand, gravel can be used
iii) Morrum flooring can be adopted in ~~Kuccha~~ Kutcha flooring in village house

Concrete.

1. Fresh concrete may be defined as a plastic mixture of cementing materials (like cement or lime) with sand and crushed stones or gravels in the presence of water.
2. Certain other materials called admixtures are also added some times to obtain specific effects.

Ingredients.

- Cement
- Sand
- Gravels (or crushed stones)
- Water
- Admixtures if required.

1. All the ingredients are mixed in pre-determined proportions and in accordance with a set procedure.
2. Concrete sets and hardens into a strong, rock like mass within a short period of time.
3. The ultimate strength and other properties of concrete depends on a number of factors like the nature of aggregate materials used, the quality and proportions of cement, aggregates and water used for making the mixture and also workmanship is important for concrete preparation.

$M_{15} = 1:2:4$

4. The function of a cementing material (lime or cement) in the concrete is to bind the coarse and fine aggregates together by setting and hardening around such particles.
5. Portland cement & hydraulic lime is used for preparation of concrete.
6. Hydraulic lime is generally used for ordinary type of construction which is economical & strong.
7. In a concrete mix, coarse particle more than 6.35mm in diameter can withstand load & act as a strong rock mass.

8. The fine aggregates serve the purpose of filling all the open spaces in between the coarse particle

9. The maximum particle size of fine aggregates is always less than 4.75 mm & the grain size of sand is around 2mm.

Gpaul9
31.10.2020

3rd sem (civil) Building Material 05.11.2020

Concrete

Water Cement Ratio

Patterne (19)

1. The quantity of water added to cement while preparing concrete mixes has been known to extent tremendous influence on the quality of concrete
2. It was first discovered in 1918, when D.A. Abraham evaluated this aspect of concrete proportioning and stated

"for all plastic mixes using sound aggregates, strength and other desirable properties of concrete under given job conditions are governed by the net quantity of water used per sack of cement."

✓ Water performs two essential functions in concrete.

i) It hydrates the cement which is an essential chemical reaction for formation of complex silicate crystalline gel that are responsible for the strengths of the cement.

ii) It lubricates all the concrete ingredients by passing around them in the form of films so it is responsible for the plasticity and mobility of concrete which define its workability.

3. After experimental investigation it is established that, ordinary portland cement requires 1 part (by weight) of cement to 0.25 parts (by weight) of water for complete hydration, setting and hardening. for lubrication and workability of the mix, additional water must be added.
This additional water varies from 0.15 to 0.45 percent by weight of cement and has to be determined with great caution.
4. This additional (lubricating) water, evaporates after the concrete is placed & also released during compaction. Both these processes (of escape of additional water) result in voids in the concrete.

5. These voids reduces the strength of the concrete. on setting.

6. So keep the ratio of water to cement as low as possible. to obtain a strong, dense concrete.

7. Any extra amount of water added to concrete ingredients at the time of mixing also favours segregation of aggregates during transport and placement.

8. In figure for a given type of cement, aggregates of same type and size and same method of mixing the concrete develops a maximum compressive strength of 380Kg/cm^2 at a w/c = 0.4. W = C x 0.4 C = Cement = ml of water

9. When this ratio is increased to 0.5, 0.6 and 0.7, the resulting batches of concrete show considerably less compressive strength.

Gpanda
05.11.2020

Workability

The workability is defined as the ease with which concrete may be mixed, handled, transported, placed in position and compacted. A workable concrete does not show any bleeding or segregation.

Factors Affecting Workability of Concrete. (25) Internal.

Workability of concrete mix depends upon the number of factors. These factors are listed below.

1. **Water Content**: Water content mix plays a significant role in workability. With increase in water content, the workability of mix also increases but excess of water in a mix results in low compressive strength and lesser durability.
2. **Size of Aggregates**: for the same volume of aggregate in concrete the use of coarse aggregate of larger size gives higher workability. Therefore, lesser quantity of water used in large size particles reduces the quantity of cement for given W/c ratio and is considered as economical.
3. **Shape of Aggregates**: Shape of aggregates plays a vital role in workability of concrete. Round and smooth aggregates gives higher workability where as angular and rough surface aggregates have lesser workability.
4. **Temperature**: The workability of a concrete mix is affected with change in temperature. ~~Rounded and smooth aggregates~~ On a hot day, it becomes necessary to increase the water content of mix in order to maintain the desired workability.
5. **Effect of Time**: The freshly prepared concrete mix loses workability with time mainly because of the loss of moisture due to evaporation.
6. **Grading of Aggregates**: Generally the mixes with higher w/c ratio would require somewhat richer grading and mixes with low w/c ratio a coarser grading of aggregates is preferable.

7. Admixtures: Certain admixtures are added in concrete mix to increase the workability such as air entraining agents which produce air bubbles.

Test of Workability

1. Slump cone Test.
2. Compactron factor Test
3. Vee-bee Test.

Three Types of slumps have been observed to occurs

a) True Slump – Where sliding is equal throughout the cone
b) Shear Slump – where one half from the top fails by shear and slides to one side, reduction in height is different on different directions.
c) Collapse Slump – This occurs in concrete of high water content, the material almost flows unequally in all direction.

Epanda
07.11.2020

Grading of Aggregates

Internal (2)

1. When some materials of equal size are packed together, voids or open spaces are always left within the pack.
2. The percentage of voids may be as high as 45% of the total volume of stones.
3. It has been observed that this result (presence of voids) is independent of size of stones used in packing, whether coarse, medium or fine.
4. Stones should be of equal size of same grade & Either all of them should be coarse, or all of them should be medium or of fine grade.
5. If sand is packed voids in the range of 40–45% are left.
6. When the coarse aggregates are packed to make concrete the voids formed within the mass must be filled by some finer material & sand is used for that purpose, but there
7. will be voids left between the sand grains too. These are filled by the cement particles. In this way, the resulting concrete mass is void less or dense mass.
8. Cement is made use of to give this dense mass a cohetive stone like character.

Fineness Modulus

1. Grading of aggregates is aimed at determining the mean size of the particle in a given batch of aggregates. This is found by the method of Fineness Modulus.
2. The method can be used to determine fineness modulus of coarse aggregate, fine aggregate and all in aggregate of mixed aggregates.
3. In this method a convenient weight of the sample is taken and passed through a set of sieves one after another.
4. The number of sieves is five for the coarse aggregates, and six for fine aggregate & ten for All-in-aggregates.

   Coarse Aggregates (five) – 80 mm, 40mm, 20 mm, 10 mm, IS Nos 4
   Fine Aggregates (six) – IS No 480, 240, 120, 60, 30 and 15
   All-in-Aggregates (10) – 80 mm, 40 mm, 20 mm, 10 mm, 480, 240, 120, 60, 30, and 15.
5. It will be be noted that each successive sieve has the diameter of mesh reduced to 50%
6. Calculation involve dividing the cumulative percentage of weights retained on these set of sieves by 100.

7. The resulting figure gives fineness modulus of the respective aggregate.

Example

A weight of 10Kg of coarse aggregate and 5kg of fine aggregate has been taken to determine fineness modulus on ease case separately. Let us assume that the weight of aggregate retained on each case. and the calculated cumulative percentage of retained. weights are as follows.

Table (fineness Modulus)

A. Coarse Aggregate (weight of sample: 10kg)

B. Fine Aggregate. (weight of sample: 5kg)

Limits of fineness.

Repeated trials with mix designs using different aggregates have shown that following limits of fineness modulus hold good for obtaining concrete mixes of good workability. cement consumption is also reasonable when these limits are followed.

Note: The upper limit of fineness modulus is, therefore always below 8.5 for coarse aggregates and 7.0 for Mixed aggregate.

for fine ~~Sand~~ness modulus the following limits may be taken as guidance.

fine Sand - 2.2 to 2.6.

Medium Sand - 2.6 to 2.9.

coarse Sand - 2.9 to 3.2.

Sand having fineness modulus more than 3.2 will be unsuitable for making satisfactory concrete.

09.11.2020

Mechanical properties of Aggregate.

There are three types of aggregates as per Origin and Density as basis:

~~Density~~

1. Natural aggregates
2. Bye-product aggregates
3. processed aggregates

Origin as basis

① Natural Aggregates

These includes all those types of fine and coarse aggregates that are available in almost ready to use form from natural resources.

Example - Sands from riverbeds, pits and beaches and gravels from riverbanks.

② Bye-product Aggregates.

These include materials obtained as waites from some industrial products which are suitable for being used as aggregates. Cinder obtained from burning of coal in locomotives and Kilns and slag obtained from blast furnaces are the best examples.

③ Processed aggregates.

These are specifically manufactured for use in making quality concretes and include burnt clays, shales. They are essential ingredients of light weight aggregates

What is meant by blast furnace slag?

Blast furnace slag is a non metallic coproduct produced during heating process in Blast furnace for production of Iron. The slags are highly resistant to weathering actions such as freezing and thawing or warming.

Density as basis.

i) Standard or normal Aggregates.

These give concrete of standard strength and weighing.

Example Gravels, sands crushed stone.

Gravel — Gravel size is from granules to boulder size.

ii) High-density Aggregates.

It is those aggregates which when used in standard proportions yield heavy concretes. Such concretes are specially useful as shields against X-rays and radiations in atomic power plant.

iii) Light weight Aggregates

These consist of natural and artificial materials of very low density. So that the resulting concrete is very light in weight. It is specially applied in sound proofing and heat proofing construction. It is also useful in the manufacture of light weight pre-cast concrete blocks.

Epunda
12.11.2020

17.11.2020 Civil Engineering Material 3rd sem (civil)

Mixing of Concrete.

1. This is the most common method of construction.
2. In this method a watertight platform is made from bricks, steel or wood at a convenient distance from the actual place of construction.
3. The cement and aggregates are first placed in predetermined proportions on this platform.
4. They are mixed thoroughly in dry state using shovels.
5. After this, water, also in predetermined quantity is added gradually while mixing is continued.
6. This process is continued till concrete mix of designed consistency is obtained.
7. Only such volumes of ingredients are mixed in a batch so that the prepared concrete is used within 30 minutes after adding water.

Machine Mixing & Precautions While mixing ingredients with mixture

1. For major construction jobs with concrete, machine mixing is an absolutely essential method.
2. Concrete mixers of several designs and capacities are available.
3. A simple concrete mixture essentially consists of a central drum, which can be rotated about an axis.
4. It may be of tilting or non-tilting design & of it is power driven & gives thorough mixing.
5. The drum in the mixer is provided with steel blades fixed at various angles.
6. Concrete mixers are of two general designs: the batch mixer and the continuous mixer.
7. In the batch mixer only a small quantity of concrete is prepared at a time.
8. In the continuous mixer predetermined proportions of ingredients are continuously fed from the top and volumes of concrete ready for use are available on regular basis.

Laying of Concrete

1. Concrete from platforms or mixers has to be transported to the job place. There it is laid or deposited on the form work of suitable material according to the design requirements.
2. Great care has to be taken in handling concrete from mixing place to the job as well as while placing it on the form work.

Handling and Transport

1. The coarse aggregates are most likely to separate out (called segregation) quickly from the mix during transport
2. Great care must be exercised to prevent their segregation
3. All sorts of jerks to the transporting medium must be avoided.
4. No water should be mixed with concrete while it is being transported because the water will destroy the effect achieved by mixing the ingredients.
5. Careless dropping at the place of construction will also result in segregation of coarse aggregates & thus must also be avoided.
6. Common methods used for transporting concrete are: manual transport in iron pans, in wheel barrows, in concrete buggies and on pipelines, belt conveyors and chutes.
7. Selection of a particular method is decided according to the nature of job and type of concrete mix being transported.
8. An experienced engineer is the best judge to take a decision in this regard.

Methods of Concrete Transportation.

- Mortar pan. It is a labour intensive method and generally used for small works.
- Wheel barrow or Hand Cart.
- Bucket and Ropeway.
- Truck Mixer and Dumper.
- Belt conveyor.
- Chute.
- Skip and Hoist
- pump and pipe-Line method.
- Transit Mixer.

Mortar Pan.

It is a labour intensive method and generally used for small works. There are no chances of segregation of concrete. In hot weather, there is a substantial loss of water due to more exposure of concrete to environment.

Wheel Barrow or Hand Cart

It is normally used on ground level i.e road construction and other similar structures. Segregation can occur if transportation is done on rough roads, and this problem can be minimized if pneumatic tyres are used.

Bucket Conveyor

It has limited application due to chances of segregation on steep slopes, roller points and changes in direction of belt. It also involves over-exposure of concrete to environment.

Chute

It is generally used for concreting in deep locations. Care should be taken that slope should not be flatter that 1 vertical to $2\frac{1}{2}$ horizontal otherwise concrete will not slide down. But workability should not be changed to suit the delivery by chute. Technically it is not a good method but it is extensively used in the field.

Skip and Hoist

It is a widely used method for high rise structures. Concrete is fed into the skip which travels vertically on rails like a lift. After discharging, it is better to turn over the concrete before use to avoid segregation.

Pump and Popeline Method

It is the most sophesticated method particularly suitable for limited space or when a large quantity of concrete is to be poured. Pumping of concrete can be done @ 8 to 70 m^3 per hour up to a horizontal distance of 300 meter and vertical distance of 90m. Pope dia is generally 8 to 20 cm. and it is made of steel, plastic or aluminium. Th. workability for pumped concrete should have a minimum of 40 to 150 mm. At delivery point the workability may be reduced by 25% due to compaction and this factor should be kept in mind while designing mix.

Transit Mixer

Transit mixer is one of the most popular equipment for transporting concrete over a long distance particularly in ready mix concrete plant. They are truck mounted having a capacity of 4 to 7 m^3. There are two variations. In one, mixed concrete is transported to the site by keeping it agitated all along at a speed varying between 2 to 6 revolutions per minute. In other category the concrete is batched at the central batching plant and mixing is done on the truck mixer either in transit or immediately prior to discharging concrete at the site.

Epanda 20.11.2020

Following precautions are necessary while mixing ingredients with mixers:

1. All the ingredients are fed onto the drum before mixing is started, and this is especially true for water, which must be added simultaneously with sand, cement and coarse aggregate.
2. Care must be taken about the time spent on mixing the batch. It must be neither more nor less than required for complete blending. In either case, the quality of concrete will be effected adversely.
3. After one batch of concrete mix is removed the interior of the mixer drum must be cleaned thoroughly; otherwise, lumps of hardened concrete from earlier batches may form a part of next batch, and spoil the quality of concrete. This condition is valid for batch type mixers. In continuous mixers, regular cleaning after fixed intervals is necessary.
4. Concrete from the mixer must be used within 30 minutes from the time of its preparation (that is when ingredients and water were added to the drum).

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23.11.2020

Consolidation:

1. After placement of concrete the concrete has to be compacted and consolidated.
2. It is essential for let concrete perfectly dense and voidless.
3. Compaction is also essential in R.C.C to develop complete bond between the concrete and steel bars.
4. Voids cannot be removed once the concrete has become hard hence, compaction and consolidation have to start soon after its placement.
5. At present two methods available for consolidation of concrete ① consolidation by hand and consolidation by vibrators.

Consolidation by hand.

1. The hand consolidation is a common technique to compacts on the freshly laid concrete with the help of suitable tools.
2. Tamping, rubbing and spading are some of the methods for consolidation of concrete.
3. These methods can be applied for ordinary type of construction.
4. for hand consolidation, the concrete mix has to be sufficiently plastic with slump between 75-200 mm.
5. Stiff concrete mix offers resistance to consolidation by hand.

Consolidation by Vibrators

1. In modern concrete, the mechanical devices called vibrators which are run by power, diesel or compressed air are commonly used for the compaction and consolidation work.
2. The vibrators are available in following three categories
   i. Internal vibrators
   ii. form vibrators.
   iii Surface vibrators.

i) Internal Vibrators

1. The Internal Vibrators usually consist of tubes provided with small vibrating units.
2. The vibrating head is onserted vertically into the freshly laid Concrete.
3. The vibrators can give 300-10000 vibrations per minute. depending upon the type of vibrator.
4. The energy released from such vibrations is high enough to compact concrete before it is completely set
5. Internal vibrator of 50mm diameter may be able to compact about 6 m^3 of concrete with a slump around 50 mm.

ii) Form Vibrators

1) It is a external vibrator may impart vibrations through the form work to which they are thoroughly tied up.
2) It is used where Internal vibrator can't be used because of the type of construction
3) In these vibrator, vibrations are first given to the rigid form work which in turn imparts them to the concrete, & there is considerable loss of energy also the cost per m^3 for compaction is higher
4) These vibrators require very form and rigid formwork.
5) Vibrating table which are used for the manufacture of precast concrete, are a class of external vibrator.

iii) Surface Vibrators

1) These come in the form of plates, pans and beams and are used for compacting floor slabs, dam construction, abutment, road surfaces, flat surfaced concrete construction
2) The thickness of freshly concrete should not exceed 300 mm

Note.

1. Great care and caution are necessary for compacting the concrete properly.
2. It required trained and skilled man power for quality concrete work.
3. Under compaction & over compaction are both dangerous. & destroy quality concrete work.

Gopal 9
23.11.2020

Curing of Concrete.

Defination.

Cement concrete has to be kept wet for a few days after its placement to ensure complete setting and hardening of cement.

Objects of Curing.

1. A good quantity of water is added to the concrete ingredients while making the mix (2) Internal
2. After placing the concrete, some water from concrete may be lost due to evaporation so first object is provide enough quantity of water for cement to hydrate for setting.
3. Another object of curing is to maintain a proper temperature in and around the concrete during the setting process because freezing and drying temprature hamper the process of setting of cement.
4. The third and most important object of curing is to ensure a concrete of good quality when set. i.e ① strong enough to stress ② hard enough to abrasion to chemical attack the concrete should be durable.

Methods of Curing

Imp ⊗ It depends upon following factors: a) The type of construction b) The place of construction c) Weather condition. (23) Internal

Imp ⊗ Methods.

a) spraying of water b) ponding of water c) wet covering d) Use of curing compounds (Membrane method).

a) Spraying of water

It is a common method for horizontal surface areas ~~such as road~~ also vertical surface on almost all types of construction & involves spraying water with the help of hose pipes connected to main water supply lines. The dis advantage lies in that on tall structure, water supply through spraying at top levels may hamper work on the lower floors.

b) Ponding of water

It is generally used for horizontal surface areas such as roads, floors slabs. Small ponds, not more than 5cm deep are made over the surface by raising temporary barriers. These ponds are kept filled with water for a number of days. In hot weather, ponding is ideal method.

c) Wet covering

It is used for horizontal flat surfaces also column and vertical surface after the formwork is removed from them. In this method, covering made of straw, burlap, hessian and jute are soaked in water and placed over the concrete. These are kept moist for the entire period of curing. They prevent the evaporation from within the concrete and supply of additional water required for hydration.

4) Use of Curing Compounds (Membrane Method)

1. It is called as chemical curing
2. Some suitable chemical compounds dissolved in solvents are sprayed over the fresh concrete to be cured.
3. The solvent evaporates leaving behind a thin film of the chemical compound spread over the concrete surface.
4. The film has the characteristic property that it allows little or no evaporation from the concrete.
5. The thin film of chemical compound starts peeling off after 2 to 4 weeks leaving behind properly cured concrete.
6. The disadvantage is continuous concrete can not be done on this type of curing.

9) Time Required for curing

1. This varies with the type of construction, place of construction and the type of cement used in concrete.
2. Normally curing of Ordinary Portland Cement Concrete may take a minimum of two days after placement
3. On an average curing for 5 to 7 days give better result to achieve the objective of curing
4. Longer period of curing is recommended for exposed surfaces for to obtain a uniform finish in the concrete work.

Sparda
25.11.2020

Growth or classification of timber.

There are two ways in which trees grow up:
i) Endogenous growth.
ii) Exogenous growth.

i) **Endogenous growth**
In the endogenous growth, the plant grows by the addition of new cells only at the end (tip) of the previous year's plant height.
ii) The tree grows upwards without becoming thicker and broader.
iii) They remain thin, slender and knotted.
Example - Bamboo, palms
iv) It is practically useless as structural timber.

Exogenous growth
i) In the exogenous growth, the plant grows by the addition of a new layer of cells all around those grown in the previous year.
ii) This process results in increase in the height as well as diameter of the plant & results big, tall & also fat-type of tree, having very well developed root system, crown system because they require a lot of food.
Example - pines, deodar, mango, & shisham,
iii) The rate of growth of exogenous plant varies with the season, the soil and the types of tree. Generally Spring is the season of fastest growth & winter growth almost stops.

Arrangement of Wood Element or Structure of Timber

following structural zones may be recognized in the stem of a mature tree.

1. **Bark** - It is the outer most zone of wood structure which can be described as skin of the tree. It is hard, rough and thick in some trees, it may be comparatively smooth & soft in other trees. The bark may be divided into outer bark and inner bark. 993776

The inner bark is thin, soft, moist membrane like structure. The function of the bark is to protect the inner wood tissue from heat, rain, wind and any injuries.

Cambium

In the living trees, there is always present just inside the inner bark a delicate layer of special cells. This layer is called cambium. It is in this layer that the process of growth of tree takes place by cell division. In old and cut trees, the cambium is no longer distinguished from the rest of wood.

2. Wood

It is main zone of the tree tissue. It starts from cambium and extends right up to the centre of the tree trunk. It is made up of concentric rings of cells. Each ring is surrounding another inner ring. In this arrangement the youngest ring is near the cambium and the oldest in the centre of the tree.

Wood zone is divided into heart wood and sapwood.

i) Heart Wood - It is made up of wood cells lying close to the core of the tree. They are older in age and darker in appearance. In the heart wood cells almost become inactive and rigid. They provide strength and support to the tree.

ii) Sapwood - It is made up of new and light tissue that lies close to the skin or bark. In this zone, in younger trees, the ratio of sapwood may be much greater compared to heart wood. But as the age increases, more and more rings of cells get added to the heart wood zone. The timber of mature tree is harder, stronger and better for use in construction.

iii) Pith - The inner most cells of heart wood become practically inactive and dead with the passage of time. These cells, being in centre of the tree, receive little or no food (sap) in later years & they start deteriorating and decaying. The inner most zone of such decaying cells forms pith zone of the tree. The older the tree grows, bigger the pith zone becomes in size. This is the reason that older trees do not give sufficient yield of good timber.

3) Medullary Rays

These are made up of rectangular cells which arise from cambium and spread towards the inner parts of the tree. These rays, besides making the food storage zone of the tree.

Ejaondo
30.11.2020

Seasoning of Timber (Importance)

By seasoning of wood is understood lowering its moisture content to acceptable proportions before putting to any use. There are five major objects of seasoning.

① Reduction in Weight

1. If the moisture content of freshly cut logs is 50%, it means that 50% weight of wood is due to water only & if these timber logs are to be transported in this green condition, it will mean we are paying quite huge money for transport of useless water stored in timber so logs must be seasoned as near to the felling place as possible before they are transported and if this wood is used as beam in a building it will take unnecessary weight of water definitely the load will increase in building.

② Increase in Strength.

1. Moisture content in green wood decreases the strength of the timber
2. The volume of dry wood is more than green timber.
3. The wood tissue bears all the load & water in wood tissue can't bear load.

③ Improvement in workability

1. Timber has to be cut into smaller boards and planks and other parts for various uses.
2. Green timber will be more difficult to work with compared to seasoned timber because, the seasoned timber will involve less effort less wastage of tools and better workmanship. but green timber is difficult to paint & work.

④ freedom from shrinkage defects

1. If the green timber is sawn into thin boards and planks, it will get deformed within a short time.
2. This deformation is called warping & it will make the timber almost useless for further working & such defects will not appear if the thin boards are cut from the seasoned timber.

⑤ Longer life or durability

1. Moisture in timber invites a number of micro-organisms and insects
2. The fungi and insects have a special taste for cell sap & green timber is attacked by these organisms quite easily.
3. They destroy the wood tissue & durability of timber.

Objectives of seasoning

i) Reduces much of the useless weight of timber.
ii) Increases its strength considerably.
iii) Improves the workability of the timber.
iv) Decreases the chances of development of shrinkage defects.
v) Increases the life of timber i.e makes it more durable.

Characteristics of good timber

1. Colour And Odour

1. It has typical colour and odour.
   Example – walnut wood – brown colour
   Teak wood – Golden Yellow colour
   Deodar & pine – light white colour

2. Specific Gravity

1. Wood is a very light material having specific gravity less than 1.20 wood floats in water.
2. Some varieties are as light as 0.3 & some varieties as 0.9.
3. It depends upon structure and presence of pores in timber.
4. Heart wood is heavier than sapwood & hard wood are denser than soft wood.

3. Moisture content

1. All woods are porous & hygroscopic in nature.
2. Wood gain moisture from atmosphere depending upon moisture content in cells & humidity in atmosphere.
3. Wood lying in the air (six months to one year) after felling loses most of its moisture to the atmosphere & up to four year loses moisture considerably.
4. A moisture content of 12-15% of air seasoned wood is safe for timber in any construction; if wood is seasoned in Kilns loses moisture 6 to 7% of their dry weight.

4. Grain

1. The grain is understood the arrangement and direction of growth of the wood.
2. Sometimes the fibres do not grow parallel to the trunk & these may be twisted, spiral manner.

5. Shrinkage and Swelling

1. The newly cut wood loses moisture when subject to drying, naturally or artificially.
2. On drying, the wood undergoes shrinkage & dry wood on getting rain soaked or wetted may undergo considerable swelling.
3. Shrinkage and swelling are related to the behavior of cell walls of wood tissue towards water & thick walled cells shrink more than the thin walled cells. It is for this reason that the hardwood shrink more than the softwoods.

6. Strength

1. The strength of wood is not the same with all direction & it depends upon direction of grain of wood under load.

Other factors influence the strength of timber

a) **Density** - Higher density of timber, greater will be its strength or thicker wall timber.

b) **Moisture Content** - Higher the moisture content lower is the strength of the timber. Because water has no load bearing capacity & it increases the volume but reduces the wood tissue. also more water invites fungal, insect growth which destroy the wood tissue. They tend to reduce the strength in an indirect manner.

c) **Presence of defects** - There may be a number of natural and artificial defects in timber such as cross grain, knots and shakes. All of them cause a decrease in the strength of the timber.

Spanda
05.12.2020

Clay Products and refractory materials

Clay

1. Clay is a naturally occuring material that is found almost ~~every~~ everywhere on the surface of the earth making the soil cover or the soft ground & in common language it is called as earth.
2. It is formed in nature by chemical decomposition mechanical disintegration and also by natural agencies such as wind, water, ice and atmosphere.
3. Mineralogically, pure clay may be composed of one or more minerals of clay Group such as Kaolinite, Montemorillonite illite, vermiculite and Allophane. Kaolinite is the most important mineral component of common clays.
4. It is generally used for making earthenware of great variety.

classification of clays.

clays are classified in two ways: 1) Mode of formation.
2) Dominant characteristics

Mode of formation.

- The residual clay
- The Transported clay.

• Residual clay

1. It includes all varieties of clay that are found covering the rocks & they are formed by natural processes.
2. It is pure in their chemical composition broadly related to parent rock. Example - China clay.

• The Transported clay

1. They are formed by the disintegration and decomposition of the pre-existing rocks by natural agencies also by the removal and transport of broken pieces to far off places where they are finally deposited.
2. It is heterogeneous in mineralogical and chemical composition.
3. The transported clays are some times known as glacial clays, marine clays, alluvial clays and lacustrine clays which glaciers, seas, rivers and lakes have played dominant roles in their formation

(2) Dominant characteristics

i) It is grouped into four groups ① china clays ② fire clays ③ vitrifying clays ④ Brick clays:

① china clay

i) It is pure clay & high percentage of mineral Kaolinite or Kaolin ($Al_2Si_2O_5(OH)_4$)

ii) It is high grade clay used for manufacture of crockery and other ~~porcelain~~ Porcelain ware.

② Fore clays

i) It is also called as refractory clay and contains Kaolinite, silica and alumina in a very high proportions.
ii) It withstand high temprature without any deformation of shape at the time of moulding.
iii) It is used as refractory bricks.

③ Vitrifying clays

i) It contains iron oxide, carbonates of calcium & magnesium.
ii) It can't withstand high temprature on heating above 1100°C it softens and form glass like material.
iii) It is used for manufacture of bricks, flooring tiles, sewer pipes.

④ Brick clays

i) It is low grade clay & used for manufacture of bricks.
ii) It is rich in silica, alumina, iron oxide, calcium, magnesium and organic matter.
iii) After giving temprature in Kiln the brick gives desired properties of cohesion and strength.

Refractories.

Defination - A refractory material may be defined "as a non-metallic material suitable for the construction of lining of furnaces operated at high temprature & the material must physically stable at high temprature.

Properties.

i) It has to withstand high pressure, which may be due to the weight of the furnace walls and from the furnace contents.
ii) It has to resist repeated thermal shocks due to repeated heating and cooling of the furnace contents.
iii) It has to bear internal stresses resulting from temprature changes.
iv) It has to resist against rubbing action which may be due to repeated movement of contents of the furnace against the refractory lining.
v) It has to face chemical attack by hot liquids, solids, and gases and fumes.

Classification.

① Silica refractories. (SiO_2)

i) It contains silica to maintain its strength and temprature.
ii) It forms excellent ACID refractories & used in roofs of metal-melting furnaces.
iii) It has low porosity and high thermal conductivity.

② Fore clay bricks

i) It consist of 60% silica & 40% alumina.
ii) It resist high strength, elevated temprature and low co-efficient of thermal expansion.
iii) It is used on glass making furnaces, steel making furnaces & it is not used for metal-melting furnace.

③ Magnesite Bricks.

i) It is made by heating the rock magnesite ($MgCO_3$) at 1700°C.
ii) The product again mixed with some clay for moulding.
iii) It is high strength & poor in thermal shock & it is used in the metallurgy of iron & steel.

④ High Alumina (Bauxite) refractories.

i) It contains 50% Alumina (Al_2O_3).
ii) It can resist high temprature & have high crushing strength.
iii) It is used in cement making kilns, glass furnace.

⑤ Chromite refractories

i) It is natural refractories & they are manufactured from a natural mineral CHROMITE.
ii) Bricks made from chromite possess a high thermal conductivity, low porosity & acidic attack.
iii) It is used for lining the furnaces for steel making and in copper metallurgy.

⑥ Graphite.

i) It can withstand high temprature as high as 2500°C & possesses high strength.

⑦ Silicon Carbide

i) It has good refractory properties.
ii) It is high strength & durability but it is high cost.

⑧ Zirconia

i) It is a yellow colour refractory.
ii) It is excellent resistance against alkalin & fluxes.
iii) It is used in high quality glass making.

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11.12.2020 Civil Engineering Material 3rd Sem (civil)

Iron and Steel.

Uses of Cast Iron

With its relatively low melting point, good fluidity, castability, excellent machinability, resistance to deformation and wear resistance cast irons have become an engineering material with a wide range of applications and are used in pipes, machines and automotive Industry parts, such as cylinder heads, cookware, iron, frying pans, oven,

Uses of Wrought Iron

1. Decorative fences, gates, railing, balconies, porches, hardware, rails, structural members (I, H and other beams)
2. Wrought-Iron pieces are usually riveted or forge. moulded (heatwelded)

USES of Mild Steel

1. Mild Steel is used as a construction frame material;
2. It is high strength, just like R/C beams.
3. It is used in seismic and wind prone areas.
4. Example – MS pipes, MS plates, MS steel beams, MS flats, steel angles, Mild Steel Bars,

USES of Tor Steel

1. These bars are commonly used as reinforcement in concrete structures such as building, bridge, road, precast concrete.
2. Tor steels are best grade steel & it has ribs. So limit the slippage.
3. Grades of Tor Steel – Fe_{415}, Fe_{550}, Fe_{500}
   Yield Strength – 415 N/mm² & 550 N/mm² →
   Ultimate Tensile strength – 485 N/mm² & 545 N/mm² →
4. Grade of Mild Steel – Fe_{250} whose yield strength – 250 N/mm²
5. Mild steel can be used for rebar stress but Tor steel is used both for stress & limit the slippage in R.C.C.

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Protective Materials

Composition of Paints, Enamels, Varnishes

1. The paints, varnishes & enamels are such material which give the final appearance to the structure.
2. The above material give the aesthetic appeal to the construction and also protect the material many deterioration agents thereby increasing their life.

Defination:

A paint is essentially a coating or covering material applied on a metallic or non-metallic surface and is defined as a "dispersion of a pigment in a suitable drying oil in the presence of a solvent called thinner or diluted"

A paint has three essential ingredients.

- a pigment – which is the real colouring substance.
- a solvent – in which the pigment is dissolved.
- a drier – which is necessary to quick the process of evaporation

A Varnish – contains no pigments but it has a resinous substance dissolved in a suitable oil or volatile liquid.

A Laequer – It is a finishing material which is a dispersion of resin and cellulose esters in a volatile solvent.

An Enamel – It is a blend of a paint with a varnish, giving a finish that is strong, durable and brilliant at the same time.

Ingredients of a Paint (composition of paints, enamels and varnishes)

1. **The Vehicle** – It is an oil which can dry on exposure. The drying oil or vehicle has the capacity to keep the pigment and other ingredients in solution or suspension.
   Example – linseed oil, castor oil, tung oil, bleached oil, fish oil.
2. **Driers** – It is those substances which are added to drying oils to accelerate their rate of drying.
   Example – linoleats, resonate, naphthanates of metals like, lead, magnesium, vanadium commonly used as drier.

3. Bases. - A base is a solid substance that forms the body of the paint. It consists of a very fine powder of a suitable material such as white lead, red lead, iron oxide, and titanium oxide. The base material makes the ultimate paint film, harder, stronger, elastic and safe against cracking and moisture - it makes the paint stable against ultra-violet light.

4. The Pigment It is a colouring material added to impart a desired shade and colour. It is added in a finely powdered state.

5. Solvents and diluents

These are volatile substances that are added to a paint in order to make its application easy, smooth and uniform. The solvents and diluents must possess the capacity:

i) for taking all the other components into solution or suspension.

ii) for evaporating on exposure to atmosphere.

These are also called thinners which reduce the viscosity to a great extent.

Example - Spirits or naphthas, turpentine, coal tar. (All are Petroleum product)

6. Extenders - These are also called fillars. A fillar is a substance which can be added to a paint to increase its bulk volume without effecting its useful properties.

Example chalk, gypsum, barite, silica and magnesium silicate

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12.12.2020.

Types and uses of Surface protective materials

Paints (Types)

1. Cold water paints
   i. This consist of mineral pigment (Gold, Silver, Carbon) and are carried out in water with presence of drier like linoleates, resonates and naphthanates of metals, lead, magnesium and vanadium.
   ii) It is washed away in excess water & generally used for interior application.

2. Oil paint
   i) It can be used in metal & woodwork.
   ii) An oil paint contains an unsaturated oil like linseed oil & it is hardening due to oxidation in the atmosphere.

3. Enamel paint
   i) It is ready made paints & consist of white lead or zinc white, petroleum, resinous matter and an oil.
   ii) The surface gives good appearance and it is resistant to chemical attack by acids and fumes, alkalies (barium, sodium, ammonium, calcium)
   iii) It is used in Industrial buildings & available in all colour and shades.

4. Lacquers
   i) A lacquer is defined as a solution of resin (lakh) and cellulose ester (Polymer) in a volatile solvent.
   ii) A mixture of shellac and alcohol forms a common example of rapid drying lacquer.

5. Emulsion paints
   i) An emulsion is defined as a suspension of one liquid within another liquid.
   ii) Here one liquid must be the paint source & other liquid is carrier.
   iii) Latex paints used for painting wood and cement plaster.

6. Synthetic paint Resins
   1. It is used for manufacture of high quality paints.
   2. These are mostly emulsions (not soluble) like synthetic resin along with another liquid.
   3. Example of synthetic paint resins - Cellulose (Nitrate, Butyrate, Ethyl) & Epoxy (Amine, Phenolic).

7. Alluminium paint
   1. An aluminium paint is usually an emulsion (droplet not soluble) of very fine flakes of aluminium in a vernish.

ii) It gives good appearance.
iii) It is used on metal painting such as water pipes, oil storage tanks and gas tanks.

8) Cement paints
i) It is a paint in which cement is the main constituent besides a colouring pigment in powdered form.
ii) It is cheap & durable & it needs moisture to set & harden & curing is necessary after painting.
iii) It may require two or more coats for best decorative & protective result.
iv) It is given on both external and internal portion in buildings.
v) It is not used in metal & wood surfaces.

9) Distemper
i) It is used for interior of Building & it consist of whiting (chalk) & glue mixed with water.
ii) In colour Distemper it is mixed with pigment & generally used in place of ordinary white wash.
iii) It is durable, smooth and gives pleasing appearance but it is destroyed by moisture during wet season.

Miscellaneous paint
10. i) Graphite paint - It is a black paint used on iron parts and other underground works also in Industrial plants.
ii) Luminous paint - It emits light after light source is discontinued. It is used for painting symbols on road and highways. It is made by calcium sulphide in varnish.
iii) Indorous Paint - It is mixed with white lead or zinc white in fine powdered state & dissolved in methylated spirit.
iv) Silicate paint. It is the mixing of calcined silica and a resinous substance like silicone resins. It is used in boilers, ovens and on concrete & masonry work. It is resistant against ultraviolet radiation, chemical attack & against heat.

Emulsion - A fine dispersion of minute droplets of one liquid in another in which it is not soluble.

French polish - It is a wood polish technique & gives high gloss surface by applying thin coats of shellac dissolved in alcohol with rubbing pad lubricated with one of a variety of oil.

Wax polish - It last for 3-5 weeks & if sealant is used instead of wax it protect 4 months.

Varnishes - It is generally resinous substance dissolved in suitable oil of volatile liquid. Example - copal, shellac, amber & dammer.

Sunanda 5.12.2020

1. Types of varnishes — linseed oil as solvent
2. Turpentine varnishes — These are made by dissolving gum, mastic or resin in turpentine
3. Spirit varnishes — Shellac in methylated spirit
4. Japan — Asphalt dissolved in linseed oil in presence of thinner.

GOVT. POLYTECHNIC JAJPUR

Lecture Note

Th-3 building Materials & Construction Technology

3rd Sem. Civil Engg.

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