BUILDING MATERIALS & CONSTRUCTION (20A01503)

LECTURE NOTES

III - B.TECH & I- SEM

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech (CE)– III-I Sem

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(20A01503) BUILDING MATERIALS AND CONSTRUCTION

Course Objectives:

- To teach various types of building materials their manufacturing process and utilisation in low-cost housing techniques
- To teach the functions and manufacturing process of glass and plastic materials that are commonly used in building construction
- To teach various types of thermal and acoustic insulation materials used in building construction
- To teach the functions and importance of various structural components
- To teach in detail about the materials like paints and floor finishes meant for interior works

Course Outcomes:

- Identify the alternate waste and sustainable materials for low-cost housing construction as per appropriate standards
- Understand the properties and utilisation of glass and plastic materials in building construction
- Evaluate various types of thermal and acoustic insulation materials
- Identify various structural components and their functions
- Understand the finishing works meant for flooring, roofs and walls

UNIT I

INTRODUCTION TO BUILDING MATERIALS:

Traditional &OrganicBuilding Materials – Stone – Dressing of Stones – Modern Building Materials – Bricks – Manufacturing process – Ceramic Products – Manufacturing Process – Building Materials for Low Cost Housing – Utilisation of Wastes for Alternative Building Materials –Sustainable Materials in Construction, Concepts of energy efficient building envelopes as per ECBC – National Standards.

UNIT II

GLASS:Introduction to Fenestration - Functions of Glass in Buildings – Constituents and Classification of Glass – Manufacturing Process –Properties of Glass – Common Types of Glass – Special Glass – Advantages and Disadvantages of Glass – National Standards such as ECBC.

PLASTIC: Introduction – Polymerisation – Classification of Plastics – Commonly Used Plastics – Moulding and Fabricating for Plastic Products – Applications – Advantages – Disadvantages – Intelligent Use of Plastics in Buildings – National Standards such as ECBC.

UNITIII

INSULATING MATERILAS: Thermal Insulating Materials: Introduction – Thermal Insulation – Heat Transfer Fundamentals – Thermal Properties of Insulating Materials – Selection of Insulating Materials – Classification of Insulation materials – Reflective Insulation Systems – Commonly Used Building Insulation Materials – Insulation that Should not be Used – National Standards such as ECBC.

Sound Insulating Materials: Introduction – Basics of Acoustics – Sound Absorption or Insulation – Green Insulation – Cool Roof, Green Roof, Power Roof – National Standards such as ECBC.

UNIT IV

STRUCTURAL COMPONENTS: Foundations – classification of Foundations – consideration in selection of foundation types–Masonry – Brick and block walls – Cavity walls – Damp–proof courses and membranes – Mortars – Arches and openings – Windows – Glass and glazing –Doors – Stairs – Types and Applications – Cladding to external walls – Flat roofs – Dormer windows – Formwork & Scaffolding – Precast concrete frames – Portal frames – Types – components – Framed structures – components – construction Procedure – Panel walls – National Standards such as ECBC

UNIT V

INTERNAL CONSTRUCTION AND FINISHES: Internal elements – Internal walls – Construction joints – Internal walls, fire protection –separating walls – Partitions – Plasters and plastering – Domestic floors and finishes – Sound insulation – Timber, concrete and metal stairs– Internal doors – Door sets – Fire resisting doors – Plasterboard ceilings – Suspended ceilings –Paints and painting – Components of Paints – Types of Paint – Considerations in Selecting Paints – Cement Paints – Oil Paints –Emulsion Paints – Whitewash and Colourwash – Application of Paints – Distempers – Varnishes – Safety –Joinery production – Composite boarding – National Standards such as ECBC

Textbooks:

1. Building Materials by M.L.Gambhir, TMH Pubilishers 2017 edition
2. Building material by S K Duggal – New Age International Publishers; Fifth Edition
3. Building Construction by B.C.Punmia, Ashok Kumar Jain and Arun Kumar Jain - Laxmi Publications (P) ltd., New Delhi 11th edition
4. A Textbook on building construction by S.K.Sharma, S.ChandPubilishers 2016 edition

Reference Books:

1. Building construction by W.B.Mckay, Vol. I, II, III & IV Pearson Publications, 2013 edition.
2. Building materials by S.C.Rangawala, CharotarPubilishing House, Anand- India.
3. Building Construction by S.C.Rangawala, CharotarPubilishing House, Anand- India
4. Building Construction by P.C. Varghese, Prentice-Hall of India private Ltd, New Delhi.
5. ECBC (Energy Conservation Building Code).BEE (Bureau of Energy Efficiency) Manuals on Energy efficient building envelope concepts.

Online Learning Resources:

https://nptel.ac.in/courses/105102088

UNIT 1

BASIC BUIDING MATERIALS

STONE:

- Stone has been used as a building material for thousands of years. It has been recognised as a material of great durability.

The stones are obtained from the three naturally occurring rock types:

- Igneous
- Sedimentary
- metamorphic

Igneous - Hard and non-porous rock formed from the slow or quick cooling of molten magma. The best example is granite.

Sedimentary - Soft and fairly porous rock formed from deposits of eroded pre-existing rock that settled in layers mostly on sea beds, and became compacted. The best examples are sandstone and limestone.

Metamorphic - Hard and non-porous rock formed from pre-existing rock that has been altered by intense heat or pressure. The best examples are marble and slate.

CHARACTERISTICS OF A GOOD BUILDING STONE

Appearance:

- Building Stones used for the face work of the building should have fine, compact texture.
- Light coloured stone is usually preferred as dark colours are prone to fade out with time.
- They should be free from clay holes, bands or spots of colour.

Workability:

- Stones are said to be workable if the wok which is involved in their cutting, dressing and shaping is considered as economical and easy to conduct.

Strength:

- Stones used in construction should be strong and durable to withstand the disintegrating action of weather.
- Stones with compact fine crystalline texture are stronger. Compressive strength of building stones in practice, range between 60 to 200 N/mm^2.

Hardness:

- When stones are utilized for floors, pavements, aprons of bridges and weirs of rivers, the stones are subjected to abrasive forces which are caused by the wear and friction.
- Hence the stones which are to be used in such places should be tested for hardness.

Structure:

- A stone when broken, should not be dull in appearance and should show uniformity of texture.
- It should be free from cavities, cracks, and patches of loose or soft material. Stratifications, which are usually found in sedimentary rocks should not be visible to naked eye.

Weathering:

- It is the extent to which the face of a stone resists the action of weather. Stones with good weathering properties only should be used in the construction of important buildings.

STONE MASONRY

- Stone masonry is a type of building masonry construction that uses stones and mortar.
- This construction technique is used for building foundations, floors, retaining walls, arches, walls and columns.
- The stones used for masonry construction are natural rocks. These natural rocks are cut and dressed into proper shape in order to use it in masonry construction.
- Stones are one of the most durable and strong building materials.

TYPES OF STONE MASONRY

The two main classifications of Stone Masonry are:

- Rubble Masonry

- Ashlar Masonry

1. Rubble Masonry

- This is the stone masonry type where stones employed are either undressed or roughly dressed. These masonry constructions do not have a uniform thickness.

The strength of the rubble masonry is dependent on the

- Quality of Mortar Used
- Proper filling of mortar between the stone spaces and joints

Rubble masonry can be again classified into

a. Coursed Rubble Masonry

b. Uncoursed Rubble Masonry

A. Coursed Rubble Masonry

- In coursed rubble masonry construction, the stones in a particular course are in equal heights. The stones hence used possess different sizes. In this type, all the courses do not have same height.
- This type is commonly employed in the construction of public buildings, abutments, residential buildings and piers of ordinary bridges.

B. Uncoursed Rubble Masonry

- An uncoursed rubble masonry is the cheapest and roughest form of stone masonry construction. These construction use stones of varied shape and size.
- The stones are directly taken from the quarry called as undressed stone blocks. The courses is not maintained regularly in this

method of construction. Initially larger stones are laid first.

- The spaces between them are filled with spalls or sneeks.

This is divided into two types:

- Random Uncoursed Rubble Masonry
- Square Uncoursed Rubble Masonry

Random Uncoursed Rubble Masonry: In this type, the weak corners and edges of the stone are removed with the help of a mason's hammer. At the quoins and jambs, bigger stones are employed in order to increase the strength of the masonry.

Square Uncoursed Rubble Masonry: Here, the stones are made roughly square shape and used in construction. The facing stones are provided a hammer-dressed finish. Larger stones are used as quoins. Chips are not used as bedding.

C. Polygonal Rubble Masonry

- Here, the stones for masonry are roughly shaped into irregular polygons. The stones are then arranged in such a way that it avoids vertical joints in the face work. Break the joints as possible. Use of stone chips to support the stones.

D. Flint Rubble Masonry

- In areas where flint is available plenty, a flint rubble masonry is employed.
- Flints are irregularly shaped nodules of silica. They are extremely hard but brittle in nature.
- The thickness of the flint stones varies from 8 to 15cm. Their length varies from 15 to 30cm.

E. Dry Rubble Masonry

- These are rubble masonry construction performed without the use of mortar. Small spaces are filled with smaller stone pieces. It is used in pitching the earthen dams and the canal slopes.

2. Ashlar Masonry

- Ashlar masonry is constructed using accurately dressed stones that possess uniform and fine joints.
- The thickness of the joints ranges about 3mm which is arranged in various patterns.
- The size of the stone blocks must be in proportion with the thickness of the walls.

The various types of ashlar masonry are:

- Ashlar Fine Masonry
- Ashlar Block in Course
- Ashlar Chamfered Masonry
- Ashlar Rough Tooled Masonry
- Rock or Quarry Faced Masonry

1. Ashlar Fine Masonry

- In ashlar fine masonry construction, each stone is cut into uniform size and shape, almost rectangular in shape.
- This shape hence provides perfect horizontal and vertical joints with the adjacent stones.
- An ashlar fine masonry construction is very costly.

2. Ashlar Rough Masonry

- This type has stones whose sides are finely chisel -dressed.
- The face of the stones is made rough by means of tools.

3. Rock and Quarry Faced

- This masonry type has a 25 mm wide strip made by a chisel placed around the perimeter of every stone. The remaining portion of the face is left in the same form as it is received.

4. Ashlar Block in Course Masonry

- This type is a combination of ashlar masonry and rubble masonry. The faces work of the masonry stones is either rough tooled or hammer dressed stones. The backing of the wall may be done in rubble masonry.

5. Ashlar Chamfered Masonry

- A strip is provided as shown in the figure below. But the sides are chamfered or beveled at an angle of 45 degrees by means of a chisel at a depth of 25mm.

BRICKS

- A brick is a type of block used to build walls, pavements and other elements in masonry construction.
- Bricks are laid in courses and numerous patterns known as bonds, collectively known as brickwork, and may be laid in various kinds of mortar to hold the bricks together to make a durable structure.

CHARACTERISTICS OF GOOD QUALITY BRICK

1.Colour

- Colour is the primary thing which describes the aesthetic appearance of the brick and it is one of the requirements of good brick masonry.
- The colour is attained by burning of clay. We know that bricks are manufactured by heating different types of clay.
- The brick should have deep red or cherish colour as a measure of uniform chemical composition.

2.Size and Shape

- The bricks should uniform rectangular surfaces and these surfaces should be parallel to each other. The bricks should have sharper edges.

3.Crushing strength

- The main characteristics of good brick earth in strength point of view is crushing strength of bricks.
- Crushing strength is an important property for checking the quality of bricks. The crushing strength of bricks should not be less than 10N/mm^2.

4.Water Absorption

- The water absorption should not exceed 20 percent of its dry weight when the brick is immersed in water for 24 hours.

MANUFACTURING OF BRICKS

- The manufacturing process of bricks involves the following steps

(1) Preparation of clay

(2) Moulding

(3) Drying

(4) Burning.

(1) Preparation of Clay:

The clay for bricks is prepared in the following order:

(i) Un-Soiling:

The top layer of soil, about 200 mm in depth, is taken out and thrown away. The clay in top soil is full of impurities and hence it is to be rejected for the purpose of preparing bricks.

(ii) Digging:

- The clay is then dug out from the ground. It is spread on the levelled ground, just a little deeper than the general level of ground. The height of heaps of clay is about 600 mm to 1200 mm.

(iii) Cleaning:

- The clay, as obtained in the process of digging, should be cleaned of stones, pebbles, vegetable matter, etc. If these particles are in excess, the clay is to be washed and screened.

(iv) Weathering:

- The clay is then exposed to atmosphere for softening or mellowing. The period of exposure varies from few weeks to full season.

(V)Tempering:

- The water in required quantity is added to clay and the whole mass is pressed under the feet of men or cattle.
- For manufacturing good bricks on a large scale, the tempering is usually done in a pug mill.
- A typical pug mill capable of tempering sufficient earth for a daily output of about 15000 to 20000 bricks.

(2) Moulding: The Following are the two ways of moulding:

(i) Hand moulding:

- In hand moulding, the bricks are moulded by hand i.e., manually. It is adopted where manpower is cheap and is readily available for the manufacturing process of bricks on a small scale.
- The moulds are rectangular boxes which are open at top and bottom. They may be of wood or steel.

The bricks prepared by hand moulding are of two types:

(a) Ground-moulded bricks

(b) Table-moulded bricks.

a)Ground moulded bricks:

- The ground is first made level and fine sand is sprinkled over it. The mould is dipped in water and placed over the ground. The lump of tempered clay is taken and is dashed is the mould.
- The clay is pressed in the mould in such a way that it fills all the corners of the mould. The surplus clay is removed by wooden strike or framed with wire. A strike is a piece of wood or metal with a sharp edge. It is to be dipped in water every time.
- The mould is then lifted up and raw brick is left on the ground.
- The process is repeated until the ground is covered with raw bricks. The lower faces of ground moulded bricks are rough and it is not possible to place frog on such bricks.
- A frog is the mark of depth about 10mm to 20mm which is placed on raw brick during moulding.

Table Moulded Bricks:

- The process of moulding of bricks is just similar as above. But in this case, the mould stands near a table size 2m x 1m. The bricks are moulded on the table and send for further process of drying.
- However, the efficiency of the moulder gradually decreases because of standing at some place for a longer duration. The cost of a brick is also increased when table moulding is adopted.

ii) Machine Moulding:

The moulding may also be achieved by machines It proves to be economical when bricks in huge quantity are to be manufactured at the same spot in a short time. It is also helpful for moulding hard and strong clay.

These machines are broadly classified in two categories:

(a) Plastic clay machines

(b) Dry clay machines.

a)Plastic Clay Moulding

- Such machine consists of a rectangular opening having length and width is equal to an ordinary bricks. The pugged clay is placed in the machine and it comes out through the rectangular opening.
- These are cut into strips by the wire fixed at the frame. The arrangement is made in such a way that the strips thickness is equal to that of the bricks are obtained. So it is also called as 'WIRE CUT BRICKS'.

b)Dry Clay Machine moulding:

- In these machines, the strong clay is finally converted into a powdered form. A small quantity of water is then added to form a stiff plastic paste.
- Such paste is placed in mould and pressed by the machine to form dry and well-shaped bricks. They do not require the process of drying.

3) Drying:

- The damp bricks, if burnt, are likely to be cracked and distorted.
- Hence the moulded bricks are dried before they are taken for the next operation of burning.
- For drying, the bricks are laid longitudinally in stacks of width equal to two bricks. A stack consists of eight or ten tiers.

(4) Burning:

- This is a very important operation in the manufacture of bricks.
- It imparts hardness and strength to the bricks and makes them dense and durable.

- The bricks should be burnt properly. If bricks are over-burnt, they will be brittle and hence break easily. If they are under-burnt, they will be soft and hence cannot carry loads.

TYPES OF BONDS IN BRICK WORK

The most commonly used types of bonds in brick masonry are:

- Stretcher bond
- Header bond
- English bond and
- Flemish bond

1. Stretcher bond

- Longer narrow face of the brick is called as stretcher as shown in the elevation of figure below.
- Stretcher bond, also called as running bond, is created when bricks are laid with only their stretchers showing, overlapping midway with the courses of bricks below and above.
- Walls constructed with stretcher bonds are not stable enough to stand alone in case of longer span and height.
- They need supporting structure such as brick masonry columns at regular intervals.
- Stretcher bonds are commonly used in the steel or reinforced concrete framed structures as the outer facing.
- Other common applications of such walls are the boundary walls, gardens etc.

2. Header bond

- Header is the shorter square face of the brick which measures 9cm x 9cm. Header bond is also known as heading bond.
- In header bonds, all bricks in each course are placed as headers on

the faces of the walls.

3. English Bond

- English bond in brick masonry has one course of stretcher only and a course of header above it, i.e. it has two alternating courses of stretchers and headers.

4. Flemish Bond

- Flemish bond, also known as Dutch bond, is created by laying alternate headers and stretchers in a single course.
- The disadvantage of using Flemish bond is that construction of Flemish bond is difficult and requires greater skill to lay it properly
- Flemish bonds have better appearance but are weaker than English bonds for load bearing wall construction.
- The next course of brick is laid in such a way that header lies in the middle of the stretcher in the course below, Every alternate course of Flemish bond starts with header at the corner.

Flemish bonds are classified as:

Single Flemish Bond

- Single Flemish bond is a combination of English bond and Flemish bond. In this type of construction, the front exposed surface of wall consists of Flemish bond and the back surface of the wall consists of English bond in each course.

Double Flemish Bond

- Double Flemish Bond has the same appearance both in the front and back elevations, i.e. each course consists of alternate header and stretcher. This type of bonding is comparatively weaker than English bond.

- As porcelain tiles are fired in higher temperature and finer grain is used, this type of tiles is denser, less porous and more resistant to moisture and stains than ceramic tiles.
- These characteristics made this tiles suitable to use both indoor and outdoor tiling work.

CAVITY WALL

- Cavity wall is a wall consisting of two separate walls called skins or leaves of masonry separated by an air space and joined together with metal ties at suitable intervals.

HOLLOW BLOCK WALL

- Hollow block walls are widely used in load bearing and non load bearing walls in which horizontal and vertical reinforcement bars are embeded.

TILES

- Tile is a manufactured piece of fired clay, stone or concrete. It is mainly used for covering walls, floor, roof, and ornamental or architectural design purpose. Mostly, it has square and rectangular shape.

TYPES OF TILES

Ceramic Tiles

- The ingredients of the ceramic tiles are clay, sand, and other natural substances.
- Ceramic tiles are commonly used tiles in residential building projects. These are mainly used in interior walls and floors

Mosaic Tiles

- Mosaic tiles are made of porcelain and clay composition.
- This type of tiles are decorative pieces and commonly used in bathrooms, kitchen backsplash, and small counter space area.

Porcelain Tiles

- Porcelain tiles are actually the ceramic tiles.
- The material used to make ceramic tiles also used for making porcelain tiles.
- But the clay grain used to make porcelain tiles is finer than the ceramic tiles. It is also fired in higher temperature than the ceramic tiles.

SAND

- Sand is a granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt.

Natural Sources of Sand:

- The sand particles consist of small grains of silica (SiO_2). It is formed by the decomposition of sandstones due to various effects of weather.

(1) Pit Sand:

- It is excavated from a depth of about 1 m to 2 m from ground level. The pit sand consists of sharp angular grains which are free from salts

(2) River Sand:

- This sand is obtained from banks or beds of rivers. The river sand consists of fine rounded grains probably due to mutual attrition under the action of water current.

- The colour of river sand is almost white. As river sand is usually available in clean condition, it is widely used for all purposes.

PROPERTIES OF GOOD SAND

The following are the properties of good sand:

- It should be chemically inert.
- It should be clean and coarse. It should be free from any organic or vegetable matter. Usually 3 to 4% clay is permitted.
- It should contain sharp, angular, coarse and durable grains.
- It should not contain salts which attract moisture from the atmosphere.
- It should be well graded i.e., should contain particles of various sizes in suitable proportions.
- The fineness modulus of sand should be between 2 and 3.

UNIT 2

BINDING MATERIALS

DEFINITION:

- Binding material or cementing material can be described as a material with adhesive and cohesive properties, which make it capable of bonding mineral fragments into a compact whole.

PROPERTIES AND CHARACTERISTICS OF BINDING MATERIALS:

- The main quality that binding material should possess is adhesion. Good binding material should provide good adhesion to building units (bricks, Stones etc).
- Binding material should be water resistant. It should have the capability of resisting the penetration of water.
- Mortar should be easily workable in the site condition.
- It should possess high durability.

BINDING MATERIAL : CEMENT

A good cement should have the following properties:

- Provides strength to masonry.
- Stiffens or hardens early.
- Possesses good plasticity.
- Easily workable.

GYPSUM

- Gypsum is a soft sulfate mineral containing Calcium sulfate dihydrate ($CaSO_4$:$2H_2O$).
- It is found in the form of rock in nature having white colour.
- It is widely used in fertilizers, moulds, sculptures and as a plaster material.

GYPSUM PLASTER

- Gypsum plaster is a white cementing material made by partial or complete dehydration of the mineral gypsum, commonly with special retarders or hardeners added.
- When dry gypsum powder is mixed with water it gets hardened. This material can be applied over block, brick or concrete surface to form a smooth surface.
- It is available in ready to use format and does not need sand. Only the addition of water is required.

PROPERTIES OF GYPSUM PLASTER

- It is light-weight and hence its usage for plastering does not increase the structural load on the building.
- Gypsum plaster does not shrink during drying.
- It is less prone to cracks.
- Gypsum plaster prevents rusting of metal fittings like pipes and increases their durability.
- Gypsum plaster has low thermal conductivity and ensures energy and power saving.
- Gypsum plaster gives high tensile and flexural strength.

- Gypsum plaster sets, or dries, quickly.
- Gypsum contains nearly 50 percent water, which accounts for gypsum plaster's fire resistance

BUILDING PRODUCTS MADE OF GYPSUM

Plasterboard:

- Plasterboard is used for partitions and the lining of walls, ceilings, roofs and floors.
- Plasterboard has the ability to resist shocks and humidity. Gypsum is a vital ingredient in modern plasterboard.

Decorative plaster:

- Dehydrated plaster powder, mixed with water, is used to line brick and block walls and ceilings, as well as for elaborate and beautiful decorations.
- This gypsum plaster is widely known as plaster of Paris

Building plaster:

Gypsum plaster is widely used for walls and ceilings. It is a high performing and easy to apply material with a quick setting time, which facilitates the building's construction.

Plaster block

- Gypsum blocks are used for indoor partitions and gypsum tiles for ceilings.
- Gypsum blocks are easy to install quickly. They are used in particular for walls that need to provide a high level of passive fire protection.

USES OF GYPSUM

- Gypsum is non-combustible and contains crystal water. These superior qualities are used in building elements that prevent a fire from spreading for up to 4 hours.
- Gypsum provides sound insulation. Gypsum boards, used as part of insulation materials, provide a sound barrier between rooms and spaces.
- Gypsum has a low thermal conductivity. When used with insulation materials for walls and linings, it can trap heat in rooms and buildings.
- Gypsum can improve the impact resistance of areas that need strong walls, such as schools, public buildings and hospital corridors.
- Gypsum is easy to install and to disassemble. At the end of use it can be completely recycled into new gypsum products.

LIME

- Lime is a calcium-containing inorganic mineral composed primarily of oxides, and hydroxide, usually calcium oxide and/ or calcium hydroxide.
- Lime is the high-temperature product which is obtained from calcination of limestone.
- If the rock contains at least 50 percent calcium carbonate, then it is called as a lime stone.

MANUFACTURING OF LIME

The Following are the three distinct operations involved in the manufacture process of fat lime:

1. Collection of Lime Stones
2. Calcination of Lime Stones
3. Slaking of Burnt Lime.

1. Collection of Lime Stones:

- The lime stones of required quality are collected at site of work. For fat lime, the percentage of impurities in lime stones should not exceed 5 per cent.
- It is desirable to use comparatively pure carbonate of lime in the manufacturing process of fat lime.

2. Calcination of Lime Stones:

- The calcination or burning of lime stones to bright red heat is the next important operation.
- The fuel required for calcination of lime stones may consist of charcoal, coal, firewood or coal ashes.
- The initial firing is achieved with the help of few chips of dry wood or cow-dung cakes.
- As in case of bricks, the burning of lime stones can be achieved either in clamps or kilns. The clamps are temporary structures

The burning of lime stones is thus carried out in one of the following:

- a) Clamps
- b) Intermittent kilns
- c) Continuous kilns

a) Clamps:

- The ground is levelled and cleaned. The lime stones and fuel are placed in alternate layers, if fuel is wood. But if fuel is of coal or charcoal, the lime stones and fuel are mixed together and placed in a heap form.

b) Intermittent Kilns:

- The two important types of intermittent kilns is discussed here.

- The intermittent kiln in which alternate layers of limestone and fuel are arranged. Such a kiln is known as the **intermittent flame kiln.**
- The top of kiln is covered with un-burnt material.
- The kiln is ignited from bottom and lime stones are allowed to burn for about 3 days or so. The kiln is then cooled and unloaded. The process is then repeated.

- The intermittent kiln in which fuel is not allowed to come into contact with lime stones. Such a kiln is known as the **intermittent flare kiln.**
- A rough arch of selected big pieces of lime stones is formed and smaller pieces of lime stones are packed over this arch.
- The fuel is placed below the arch and when it is ignited, only flame comes into contact with lime stones.
- When lime stones are sufficiently burnt, the kiln is cooled and unloaded. The process is then repeated. This type of kiln is easy to manage.

- The flare kiln produces lime of better quality because the lime stones are not in contact with the fuel and the finished product is not mixed with ashes.

c) Continuous Kilns:

- The two important types of continuous kilns is discussed here.
- The kiln is partly under the ground and partly above the ground.
- A loading platform is provided at the top
- The continuous kiln in which mixture of lime stones and fuel is fed from the top. Such a kiln is also known as the **continuous flame kiln.**

- The continuous kiln in which fuel is not allowed to come into contact with lime stones. It is known as the **continuous flare kiln.**
- This kiln consists of two sections – upper and lower. The upper section serves as storage of lime stones. The lower portion is provided with fire-brick lining.
- While starting the kiln, a small quantity of fuel is mixed with limestone and ignited. The fuel is then fed through shafts around the upper and lower sections of kiln.
- The feeding of lime stones is done from opening at top. The removal of calcined material is done through a grating placed at the bottom of kiln. A roof is provided at the top to protect the kiln

3. Slaking of Burnt Lime:

- The quick lime is obtained by burning of lime stones slakes when exposed to the atmosphere. This is known as the natural slaking or air slaking and it is a very slow process. Hence the slaking is achieved by adding water to quick lime.

Following are the two methods of slaking:

a) Slaking to paste

b) Slaking to powder.

a) Slaking to Paste:

- In this method, the quick lime is spread in a layer of 150 mm depth in a wooden or masonry basin. The water is then added in sufficient quantity so as to submerge quick lime.
- It is found that the quantity of water required is about 2½ to 3 times the volume of quick lime. The excess water retards slaking and little water results in unsatisfactory slaking.
- The water should be added at a time and it should not be added after the temperature has risen.
- The basin is covered with wooden planks to preserve heat and to ensure proper slaking of the entire mass of quick lime.
- The stirring is not necessary and slaking is completed in about ten minutes or so.

b) Slaking to Powder:

This may be achieved in one of the following two ways:

- (i) The quick lime is broken into pieces of size not more than 50 mm. It is then carried in a basket and the basket is immersed in water for few seconds. It is then taken out and thrown on a wooden or masonry platform in a heap form. The quick lime crumbles and falls as powder form.

- (ii) In this arrangement, the quick lime is spread in layer of 150 mm depth on a wooden or masonry platform. The water is then sprinkled over this layer from a water-can or vessel fitted with a

rose or perforated nozzle. The quick lime swells, crumbles and falls as powder form. This method is generally used to slake quick lime obtained from the shells.

CLASSIFICATION OF LIME

Lime is classified into three categories:

(1)Fat Lime

(2)Hydraulic lime

(3)Poor Lime

(1) Fat Lime/Pure Lime:-

- Fat lime is also known as pure lime, white lime or rich lime, this is manufactured using the purest form of the limestone.
- It is popular with its name as fat lime since its volume is increased to about 2 to 2.5 times its originally volume after getting slaked. It slakes vigorously.

(2) Hydraulic Lime:

- This lime has the hydraulic property, means it can set under the water also. It contains clay and some amount of ferrous oxide also.
- This is also known as water lime. Depending upon the amount of clay hydraulic lime is classified into further three categories:

(a) Feebly hydraulic lime

(b) Moderately hydraulic lime

(c) Eminently hydraulic lime

a)Feebly hydraulic lime

- Feebly hydraulic lime is used for internal work and external work in sheltered areas.
- Feebly hydraulic lime contains up to 10% clay/ clay mixed with other impurities.
- It might take one week or more to set after the addition of water.

b)Moderately hydraulic lime

- Moderately hydraulic lime can be used for external work in most areas.
- Moderately hydraulic lime contains clay in the range of 11% to 20%. This type of lime sets within a few days after the addition of water.

c)Eminently hydraulic lime

- Eminently hydraulic lime is used for external work in exposed areas, such as chimneys and for floor slabs/underpinning.
- Eminently hydraulic lime contains clay in the range of 21% to 30%.
- Eminently hydraulic lime sets within one day after the addition of water.

(3) Poor Lime:

- Poor lime contains more than 30 percent of clay therefore it is also known as impure lime.
- It slakes very slowly and also does not dissolve into water. It has poor binding property and its colour is muddy white.
- This lime forms very poor mortar and so such lime can be used for inferior types of work or at places where good lime is not available.

Classification according to Indian standards

Class A lime

- It is used for structural purposes because it is eminently hydraulic lime and has the property of setting even in the absence of air.
- It has to be supplied in the hydraulic form only.

- Its minimum strength with lime sand mortar of proportion (1:3) by weight at the end of 14 days and 28 days should be respectively 1.75 N/mm^2 and 2.80 N/mm^2.

Class B lime

- It is the semi-hydraulic lime which is used for mortars for masonry
- It can be supplied either as quick lime or as hydrated lime.
- Its minimum compressive strength with lime sand mortar of proportion (1:3) by weight at the end of 14 days and 28 days should be respectively 1.25 N/mm^2 and 1.75 N/mm^2.

Class C lime

- It is the fat lime which is used mainly for finishing coat in plastering, whitewashing and with suitable admixture such as surkhi or any other pozzolanic material to produce artificial hydraulic mortars.
- It is to be supplied in hydraulic or quick form.

Class D lime

- It is the magnesium or dolomitic lime which is used for finishing coat in plastering, whitewashing, etc.
- It is to be supplied in the hydrated or quick form.

Class E lime

- It is the kankar lime and is used for the masonry works, it is to be supplied in the hydraulic form only.

Class F lime

- It is also known as Siliceous dolomitic lime which is used for undercoat and finishing coat of plaster.

- It is to be supplied in the hydrated or quick form.

PROPERTIES OF LIME

Lime is considered one of the important building material because of following properties.

- It is easily workable.
- It has good plastic properties.
- It can withstand moisture well.
- It imparts sufficient strength to the masonry when used as mortar.
- It stiffens quite easily in short span of time.
- Masonry in lime mortar is more durable because of its comparatively low shrinkage on drying.
- It has good adhering properties with stone bricks both.

USES OF LIME

- The lime can be used extensively for the following purposes :

  (i) It can be used as a binding material in mortar.

  (ii) It can be used as a binding material in concrete.

  (iii) Crushed lime is used in the form of an aggregate.

  (iv) It is used for plastering.

  (v) It is used for white washing and also as a base coat for distempers.

  (vi) It is used for preparing lime-sand bricks.

  (viii) It finds use in masonry work in the form of limestone.

LIME PUTTY

For conservation work, non-hydraulic lime is usually used in the saturated form known as 'lime putty'. This is supplied to site covered by a thin film of water in air tight tubs, to minimize the risk of carbonation. It is made by slaking the lime with a slight excess of water.

When matured (lime putty continues to mature for months), the result is the purest form of non-hydraulic lime, ideal for making fine plasterwork and limewash, but also widely used for pointing masonry and making render, daub and other lime-based mortars.

Uses of Lime Putty

- Fill and repair fine cracks
- Dilute with water to make a bright white limewash
- Can be coloured with natural earth pigments
- Makes non-hydraulic lime mortars & lime plaster by adding sand

CEMENT

- Cement is manufactured through a closely controlled chemical combination of calcium, silicon, aluminium, iron and other ingredients.

Raw materials:

- Common materials used to manufacture cement include limestone, shells, and chalk or marl combined with shale, clay, slate, blast furnace slag, silica sand, and iron ore.
- These ingredients, when heated at high temperatures form a rock-like substance that is ground into the fine powder that we commonly think of as cement.

MANUFACTURING OF CEMENT

The process of manufacturing of cement involves the following steps:

- Mixing of raw materials
- Blending
- Burning
- Grinding

MIXING OF RAW MATERIALS:

- The raw materials such as limestone or chalk and shale or clay may be mixed either in dry conditioner or in wet condition. The process is accordingly known as the dry process and wet process.
- All except soft materials are first crushed and then ground, usually in a rotating, cylindrical ball, or tube mills containing a charge of steel grinding balls.
- This grinding is done wet or dry, depending on the process in use, but for dry grinding the raw materials first may need to be dried in cylindrical, rotary dryers.

BLENDING:

- In the dry process these mixes are stored in silos; slurry tanks are used in the wet process. Thorough mixing of the dry materials in the silos is ensured by agitation and vigorous circulation induced by compressed air.

- In the wet process the slurry tanks are stirred by mechanical means or compressed air or both. The slurry, which contains 35 to 45 percent water, is sometimes filtered, reducing the water content to 20 to 30 percent, and the filter cake is then fed to the kiln. This reduces the fuel consumption for burning.

BURNING:

- The earliest kilns in which cement was burned in batches were bottle kilns, followed by chamber kilns and then by continuous shaft kilns.

- But the dominant means of burning is the rotary kiln. These kilns—up to 200 metres (660 feet) long and six metres in diameter in wet process plants but shorter for the dry process

- The raw material feed, introduced at the upper end, moves slowly down the kiln to the lower, or firing, end.

- The fuel for firing may be pulverized coal, oil, or natural gas injected through a pipe. The temperature at the firing end ranges from about 1,350 to 1,550 °C , depending on the raw materials being burned.

- The burned product emerges from the kiln as small nodules of clinker. These pass into coolers, where the heat is transferred to incoming air and the product cooled.

- Dust emission from cement kilns can be a serious nuisance. In populated areas it is usual and often compulsory to fit cyclone arrestors, bag-filter systems, or electrostatic dust precipitators between the kiln exit and the chimney stack.

- Modern cement plants are equipped with elaborate instrumentation for control of the burning process.

- Raw materials in some plants are sampled automatically, and a computer calculates and controls the raw mix composition.

- The largest rotary kilns have outputs exceeding 5,000 tons per day.

GRINDING:

- The clinkers obtained from the rotary kiln are grounded in tube mills .A small quantity of gypsum is also added to control the initial setting time of cement. Finally the cement is fed to the packer machines.

BOUGE'S COMPOUNDS

Mineral	Chemical formula	Oxide composition	Abbreviation
Tricalcium silicate (alite)	Ca_3SiO_5	$3CaO.SiO_2$	C3S
Dicalcium silicate (belite)	Ca_2SiO_4	$2CaO.SiO_2$	C2S
Tricalcium aluminate	$Ca_3Al_2O_4$	$3CaO.Al_2O_3$	C3A
Tetracalcium aluminoferrite	$Ca_4Al_nFe_{2-n}O_7$	$4CaO.Al_nFe_{2-n}O_3$	C4AF

FUNCTIONS OF BOUGE'S COMPOUNDS

Tricalcium silicate, C3S:-

- This compound hydrates and hardens rapidly. It is largely responsible for portland cement's initial set and early strength gain.

Dicalcium silicate, C2S:

- C2S hydrates and hardens slowly. It is largely responsible for strength gain after one week.
- Used for Latter strength of Cement, Low heat cement, used for

Mass concreting like Bridge, piers, Abutments, Foundation, Water retaining structures, Retaining walls etc..

Tricalcium aluminate, C3A

- It liberates a lot of heat during the early stages of hydration, but has little strength contribution. Gypsum slows down the hydration rate of C3A. Cement low in C3A is sulfate resistant.

Tetra calcium Alumino Ferrate, C4AF

- It hydrates rapidly, but does not contribute much to strength of the cement paste.
- Controls setting time and Impart colour to cement.

TYPES OF CEMENT

The following are the various types of cement:

1. Ordinary Portland Cement (OPC):

- This is the most common type of cement which is extensively used. It has good resistance to cracking and dry shrinkage but less resistance to chemical attack.
- OPC is not suitable for the construction work which is exposed to sulphates in the soil.
- Ordinary Portland cement is available in following types
  33 grade, 43 grade & 53 grade.
- The grade represents the strength of cement at 28days.

33grade = 33N/mm^2

2.Portland Pozzolana Cement (PPC):

- The pozzolanic materials used in manufacturing are Fly ash and Calcinated clay.

- These cements react with water due to the presence of calcium hydroxide liberated in the hydration process.

3. Portland Slag Cement (PSC):

- This cement is made by inter-grinding Portland Cement clinker and granulated blast furnace slag.
- This cement has high resistance to sulphates, and it is suitable for environments exposed to sulphates.

4.Rapid Hardening cement:

- Rapid hardening cement is very similar to ordinary Portland cement (OPC). It is used where there is a need for high early strength.
- Ex. Pavements, busiest roadways

The strength of Rapid Hardening cement at age of 3 days is almost same as the 7 days strength of Ordinary Portland cement. It requires same water-cement ratio as OPC.

5.High alumina Cement:

- This type of cement has rich alumina content about 35% which helps in gaining ultimate high strength within a short period.
- This type of cement is used where a structure is subjected to the action of sea water, chemical plants and furnaces.

6.Quick-setting Cement:

- This cement is specially made for under-water concreting.
- It is obtained by adding a certain quantity of aluminium sulphate and reducing the quantity of gypsum and made into a fine powder.

7.Sulphate Resisting Portland Cement:

- It is manufactured by keeping the percentage of C3A below 5%.
- This type of cement is used where the structure is prone to severe

sulphate attacks(alkaline conditions) such as construction in the foundation of soil, marine conditions, sewage treatment tanks.

TESTS ON CEMENT

1.Consistency test on cement:

- This test is conducted to find the setting times of cement using a standard consistency test apparatus, known as Vicat's apparatus.

2.Initial Setting Time:

- For this test, a needle of 1 mm square size is used. The needle is allowed to penetrate into the cement paste.
- The time taken to penetrate 33-35 mm depth is recorded as the initial setting time.

3.Final Setting Time:

- After the paste has attained hardness, the needle does not penetrate the paste more than 0.5 mm.
- The time at which the needle does not penetrate more than 0.5 mm is taken as the final setting time.

4.Fineness test on cement:

- The fineness of cement is responsible for the rate of hydration, rate of evolution of heat and the rate of gain of strength.
- Finer the grains more is the surface area and faster the development of strength.
- The fineness of cement can be determined by Sieve Test or Air Permeability test.

5.Soundness test of cement

- This test is conducted in Le Chatelier's apparatus to detect the presence of un combined lime and magnesia in cement.

USES OF CEMENT

- It is used in mortar for plastering, masonry work, pointing, etc.
- It is used for making joints for drains and pipes.
- It is used for water tightness of structure.
- It is used in concrete for laying floors, roofs and constructing lintels, beams, stairs, pillars etc.
- It is used in the construction of important engineering structures such as bridges, culverts, dams, tunnels, lighthouses etc.
- It is used in the preparation of foundations, watertight floors, footpaths etc.
- It is employed for the construction of wells, water tanks, tennis courts, lamp posts, telephone cabins, roads etc.

Following are the different uses of cement in construction works:

1. To prepare cement mortar
2. To prepare cement concrete
3. To build fire proof and thermal proof structure
4. To build chemical proof structures
5. As a grout material
6. To construct Cement concrete roads
7. To manufacture precast members
8. For aesthetic concrete construction

1. To Prepare Cement Mortar

- Cement mortar is like a paste which is prepared by adding certain quantity of water to cement and sand mixture. Plastering is done by cement mortar which gives smooth finish to the structure.

- Generally, the cement sand ratio in a mortar is in between 1:2 to 1:6. The ratio of cement and sand mix is decided based on the importance of work.

2. To Prepare Cement Concrete

- The ingredients of cement concrete are cement, fine aggregate, coarse aggregate and water respectively.

- In general, ordinary Portland cement is used to prepare concrete. But for special cases or based on different circumstances many types of cements like rapid hardening cement, high alumina cement etc. are discovered.

3. To Build Fire Proof or Heat Proof Structures

- To with stand against high temperatures and to prevent fire accidents structures should be built with great fire-resistant materials like cement. High alumina cement is more suitable material to make concrete for the structures in high temperature regions.

4.To Build Chemical Proof Structures

- In chemical industries, different chemicals are stored and they may damage the structure if proper resistance is not there. Acid

resistant cement is very much useful in this case.

- Similarly, for the constructions under marine conditions, sewage carrying structures etc. Sulphate resistant cement is useful.

5.For Grouting

- Grouting is the process of filling cracks, joints, openings in foundations or any other structural members to improve their strength

6.To Construct Cement Concrete Roads

- Cement concrete roads are more famous as high standard roads which are stronger than all other types of roads. They are also called as rigid pavements because of their rigid nature. C.C roads have long life span even without proper maintenance. Load wise also they are much capable than all other types.

7.To Manufacture Precast Members

- Many precast members are made using cement as binding material. Cement concrete pipes are widely used as drains, pipes under culverts etc.

UNIT 3

FERROUS & NON FERROUS MATERIALS

STEEL

- Reinforcement steel, is used as a tension device in reinforced concrete and reinforced masonry structures to strengthen and aid the concrete under tension.
- Concrete is strong under compression, but has weak tensile strength. So providing of steel bars significantly increases the tensile strength of the structure.

CHARACTERISTICS OF STEEL

The characteristics of an ideal reinforcing material are:

- It should be easily and cheaply available in bulk.
- It should possess high tensile stress and elasticity.
- It should have a long and durable life so that it can render service for longer time.
- It should be capable of forming perfect bond or grip with concrete so that stresses are transferred from one material to the other.

HARDNESS TEST

- The hardness of a material measures how much it will resist local plastic deformation due to mechanical indentation or abrasion.
- Typically metals will be hardened through a heat treatment process.
- There are several different hardness tests and we use the Brinell, Vickers and Rockwell methods.

TENSION TEST

- Tensile testing, or tension testing, is used to determine the behaviour of the metal when it is being pulled.
- Tensile testing can measure yield strength, proof strength and ultimate tensile strength.
- We have a range of tensile testing machines which can apply loads from a few newtons to 1,000 kilo newtons, and test up to 600°C.

COMPRESSION TEST

- A compression test in which a material experiences opposing forces that push inward upon the specimen from opposite sides.
- The test sample is generally placed in between two plates then the plates are pushed together by a universal testing machine.

IMPACT TEST

- Impact testing measures the material's ability to absorb energy when fractured at high velocity. This gives an indication of the 'toughness' of the metal and two methods are usually employed for impact testing, Charpy or Izod.

a) Charpy impact test

- The Charpy impact test, also known as the Charpy V-notch test, is a standardized high strain-rate test which determines the amount of energy absorbed by a material during fracture.
- The standard Charpy-V notch specimen is 55mm long, 10mm square and has a 2mm deep notch with a tip radius of 0.25mm machined on one face.
- Charpy tests show whether a metal can be classified as being

either brittle or ductile.

- A brittle metal will absorb a small amount of energy when impact tested, a tough ductile metal absorbs a large amount of energy.

b) Izod impact strength test

- The Izod impact strength test is an ASTM standard method of determining the impact resistance of materials.
- A pivoting arm is raised to a specific height and then released. The arm swings down hitting a notched sample, breaking the specimen.
- The energy absorbed by the sample is calculated from the height the arm swings to after hitting the sample.
- The test is similar to the Charpy impact test but uses a different arrangement of the specimen under test.

WEAR TEST

- Wear test is carried out to determine the amount of materials removed (or worn away) after a wear test.
- From a material point of view, the test is performed to evaluate the wear property of a material so as to determine whether the material is adequate for a specific wear application.
- The material worn away can be expressed either as weight (mass) loss, volume loss, etc.

CORROSION TEST

- The process of corrosion is due to a chemical or electrochemical reaction, of an exposed surface with the surrounding environment that leads gradually to the material degradation
- Corrosion testing can help to predict materials resistance to corrosion through its life time and to known the behaviour of the material.

- The salt spray (or salt fog) test is a standardized and popular corrosion test method, used to check corrosion resistance of materials and surface coatings.
- The apparatus for testing consists of a closed testing cabinet/chamber, where a salt water (5% NaCl) solution is atomized by means of spray nozzle(s) using pressurized air.

MICRO HARDNESS TEST

- Hardness testing is divided into two ranges: macro hardness and micro hardness.
- Macro hardness covers testing with an applied load over 1 kg or about 10 Newton (N).
- Micro hardness testing, with applied loads under 10 N, is typically used for smaller samples, thin specimens, plated surfaces or thin films.
- The two most common micro hardness techniques are Vickers and Knoop hardness tests

FRACTURE TOUGHNESS TEST

- Fracture toughness testing is a mechanical test method used to determine the energy needed to initiate and cause failure within a material.
- There are several types of test used to measure fracture toughness of materials.
- A widely utilized standardized test method is the Charpy impact test whereby a sample with a V-notch or a U-notch is subjected to impact from behind the notch.

CREEP TEST

- Creep is the tendency of a solid material to slowly move or deform permanently under constant stresses. Creep tests measure the strain response due to a constant stress.

These occurs in three stages

- Primary creep
- Secondary creep
- Tertiary creep

- The creep test is conducted using a tensile specimen to which a constant stress is applied, often by the simple method of suspending weights from it. Surrounding the specimen is a thermostatically controlled furnace, the temperature being controlled by a thermocouple attached to the gauge length of the specimen,
- The extension of the specimen is measured by a very sensitive extensometer since the actual amount of deformation before failure may be only two or three per cent. The results of the test are then plotted on a graph of strain versus time

STRESS RUPTURE TEST

- Stress rupture testing is similar to creep testing except that the stresses are higher than those used in a creep testing.
- Stress rupture tests are used to determine the time necessary to produce failure. so stress rupture testing is always done until failure.

FATIGUE TEST

- **Fatigue testing** is a specialised form of mechanical testing that is performed by applying cyclic loading
- These tests are used either to generate fatigue life and crack growth data, identify critical locations or demonstrate the safety of a structure that may be susceptible to fatigue.

STEEL FIBRES

- Steel fibres strengthen the concrete by resisting tensile cracking.
- Fibre reinforced concrete has a higher flexural strength than that of unreinforced concrete
- Steel fibre reinforced concrete is commonly used in tunnel construction, as it provides additional flexural strength, reduces

shrinkage cracking and reduces permeability.

Advantages of Steel Fibres in Concrete:

- Reduction of concrete slab thickness
- Increased durability
- Low maintenance costs

Application of steel fibre reinforced concrete:

- water resources engineering
- hydropower engineering
- structure engineering
- bridge engineering

PLASTICS

- Plastics are (mostly) synthetic (human-made) materials, made from **polymers**, which are long molecules built around chains of carbon atoms, typically with hydrogen, oxygen, sulfur, and nitrogen filling in the spaces.

The plastics are mainly classified into two types given below:

- Thermoplastics
- Thermosetting plastics

Thermoplastics:

- The plastics that do not undergo chemical change in their composition when heated and can be moulded again and again.
- **Examples**: polyethylene, polypropylene, polystyrene, polyvinyl chloride(PVC), etc.

Thermosetting plastics:

- These are made up from long chains of molecules that are cross-linked. They have a very rigid structure.
- Once heated, thermosetting plastics can be moulded, shaped and pressed into shapes. Once set they cannot be reheated since they are permanently set.
- **Examples:** Vulcanized rubber, Bakelite, Polyurethane

ADVANTAGES OF PLASTICS

Installation:

- Plastics are easy to install, operate and maintain because of their light weight. In fact, maintenance can also be less.

Insulation:

- Plastics provide effective insulation from cold and heat, prevent energy leakage, and allow households to save energy.

Fire resistance:

- Many plastic products in the building and construction sector are valued because of their fire resistance.
- Smoke detectors, alarms and automated fire fighting systems are largely made of plastics.

Durability:

- The durability of plastics is good and their anti-corrosion properties provide them with an impressive life span

MECHANICAL PROPERTIES OF PLASTICS

Strength:

- The measure of the resistance of a material to external stress

Stiffness:

- The measure of the resistance of a material to deformation

Hardness:

- The measure of the resistance of a material to deformation under concentrated compressive load

Toughness:

- The measure of the energy absorption capacity of a material during impacts

USE OF PLASTIC IN CONSTRUCTION

The plastic products can be used in construction, so some of the uses are given below

1.Concrete

- Recycled plastics can be used to make stronger concrete structures in the form of sidewalks, driveways and more.
- This can produce concrete that is up to 15% stronger than regular concrete, allowing this form of construction to be both longer-lasting and more eco-friendly.

2.Bricks

- Bricks are a stable material to build a home , and more companies are embracing the idea of building bricks with recycled plastic.
- The building time is much quicker than it would be with traditional brick. This plastic product can also be fire-resistant, is cheaper, and, of course, is more eco-friendly.

3.Roofing Tiles

- Using recycled plastics to build roofing tiles is a great way to resemble other more expensive materials, while providing the same high-quality you can expect with materials such as slate.

4.Flooring

- The floor covering in your house is one of the most essential aspects in creating your dream home, and it has become more common to utilize floor tiles that contain recycled plastics.

Some of their benefits include:

- Easy installation process
- Easy to clean
- Affordable

POLYPROPYLENE FIBRES

Polypropylene (PP)

- Polypropylene (PP) is a strong yet flexible plastic that can withstand high temperatures upto 200 degree centigrade.
- Being a lightweight material, PP has high tensile strength and is highly resistant to corrosion, chemicals, and moisture.
- **Common uses of Polypropylene:** Clothing, surgery tools and supplies, bottle caps, food containers, straws, crisp bags, kettles, lunch boxes, packing tape.

GLASS

- Glass is a non-crystalline, amorphous solid which is transparent and has a wide range of use in decorative purpose (ex: window panels, tableware, and optics).
- Glass is most often formed by rapid cooling of the molten form, some glasses such as volcanic glass are naturally occurring.
- Silicon dioxide (SiO_2) is a common fundamental constituent of glass. Fused quartz is a glass made from chemically-pure silica

INGRIEDIENTS IN GLASS

1. Silica
2. Sodium or Potassium Carbonate
3. Lime
4. Manganese Dioxide
5. Cullet
6. Colouring Substance

1. Silica:

- It is the principle constituent of glass. Along with silica some alkaline materials (sodium or potassium carbonate) and lime is added to make the glass easily workable

2. Sodium or Potassium Carbonate:

- It is an alkaline material and forms an essential component of glass. It is added in suitable proportion to reduce the melting point of silica and to impart viscosity to the molten glass

3. Lime:

- It is added in the form of chalk. It imparts durability to the glass.
- In place of lime, sometimes, lead oxide is also added; it makes the glass bright and shining.

4. Manganese Dioxide:

- It is added in suitable proportion to correct the colour of glass due to the presence of iron in raw materials of glass.
- It is also called 'Glass maker' soap.

5. Cullet:

- It is the old broken glass of the same type
- It is added in small quantity to provide body to the glass.

6. Colouring Substance:

- While manufacturing a coloured glass, a suitable colouring substance is added at fusion stage to provide the desired colour to the glass.

PROPERTIES OF GLASS

The Engineering Properties of Glass are:

1.Transparency

2.Strength

3.Workability

4.U value

5.Recycle property

1. Transparency of Glass:

- Transparency is the main property of glass which allows the vision of outside world through it.
- The transparency of glass can be from both sides or from one side

only.

- In one side transparency, glass behaves like mirror from the other side.

2.Strength of Glass:

- Strength of glass depends on modulus of rupture value of glass. In general, glass is a brittle material but by adding admixtures and laminates we can make it as more strong.

3. Workability of Glass:

- A glass can be moulded into any shape or it can be blown during melting. So, workability of glass is superior property of glass.

4. U value of Glass:

- U value represents the amount of heat transferred through glass. If a glass is said to be insulated unit then it should have lower u value.

5. Recycle Property of Glass:

- Any glass can be 100% recyclable. It can also be used as raw material in construction industry.

TYPES OF GLASS

FLAT GLASS:

- Flat glass is the basic first product from the float process of making glass.
- This glass type is the base material of many common products we see today, including: windscreens, home windows, bus stops, electronics, appliances, and much more.

TOUGHENED GLASS:

- Toughened glass is strong glass.

- It is available in all thicknesses and when it is broken it forms small granular chunks which are dangerous.
- This is also called as tempered glass. This type of glass is used for fire resistant doors, mobile screen protectors etc.

Laminated glass

- Laminated glass also known as bulletproof glass is produced by adding laminate layers. Such glasses are used in high security zones and even in the cars of most VVIPs.

Tinted glass

- Tinted glass is another type of glass that reduces the brightness of light and hence used more in places where the brightness of sun is more than or in locations with extreme heat conditions.

Reinforced glass

- Reinforced glass is a type of safety glass that is storm-resistant. It can also withstand explosions and stop burglars from entering the house.

CLASSIFICATION OF GLASS

- The glass has been classified mainly three types. They are:

1.Soda lime glass:

- It is obtained from the fusion of a mixture of silica, lime, soda and alumina.
- Powdered glass may also be added
- This glass is also termed as Soda-ash glass, Soda glass or Soft glass
- It is used for glazing doors, windows and making ordinary glass wares

2.Lead glass:

- It is obtained from the fusion of a mixture of silica, lead and potash
- This glass is also termed as Flint glass
- Lead glass has highly shining appearance

- It is not affected by temperature
- Cut glass work, electric bulbs and optical glass are made from it

3.Boro-silicate glass:

- It is obtained from the fusion of a mixture of silica, borax, lime, and feldspar.
- This glass withstands high temperature
- Laboratory equipment and kitchen utensils are made out of it

GLASS FIBRE

- **Glass fibre** also called fibre glass. It is material made from extremely fine fibres of glass.
- Fibre glass is a lightweight, extremely strong material.
- Although strength properties are somewhat lower than carbon fibre but the raw materials are much less expensive.
- It can be easily formed using moulding processes.

Uses:

- It can be used in the building industry as insulation material, structural component, external glazing material, cladding material
- It is used to make delicate looking fenestrations on facades as well as conventional windows.

UNIT 4

BASICS OF BUILDING COMPONENTS

COMPONENTS OF BUILDING

1. FOUNDATION

- A foundation is necessary to evenly distribute the entire building load on the soil in such a manner that no damaging settlements take place. Hence, the foundations need to be constructed on good/solid ground.

2. PLINTH

- A plinth is normally constructed just above the ground level and immediately after the foundation. It raises the floor above the ground level and herewith prevents surface water from entering the building.

3. DAMP PROOF COURSE (DPC)

- Damp proof course is a layer of water proofing material such as asphalt or waterproof cement. Walls are constructed above the damp proof course.
- Damp proof course prevents surface water from rising into the walls.
- Damp proofing layer is not required where a plinth beam is constructed, because the plinth beam already performs like a DPC.

4. FLOOR

- This is the surface on which we do most of our activities. Floorings is laid over the filling of the plinth and on subsequent floors.
- Flooring can be done with different materials, but care must be given that the ground below the floor is well compacted.
- Flooring is done to prevent dampness from rising to the top and to have a firm platform that can be kept hygienic and clean.

5. WALLS

- Walls are the vertical elements on which the roof finally rests. They can be made of different materials like bricks, stones, mud, concrete blocks, lateritic blocks etc. If the walls are very long, columns can be provided to carry the roof.
- Walls provide privacy and enclosure. Walls also provide security and protection against natural elements such as wind, rain and sunshine.
- Openings are to be provided in wall for access and ventilation.

6. OPENINGS

- Openings are normally provided in the walls as door, windows and ventilators.
- Doors provide access; windows and ventilators provide light and ventilation.

7. ROOF

- The roof provides protection for the building and the people living in it. The roof rests on the walls

8.LINTELS:

- Lintels are constructed just above the openings. It is normally a stone slab or a concrete slab.
- Lintels are constructed to hold up the walls above the openings. In earthquake prone areas a continuous lintel beam is provided all over the walls.

9. STAIRS

- A stair is a sequence of steps and it is provided to afford the means of ascent and descent between the floors and landings.

AREA CONSIDERATIONS

1. **Building Site and Orientation:**
    - Assuming that the building site has already been determined and all the analyses related to the location have been completed, consideration must now be given on how the building must be oriented on the site.
    - The correct orientation of the building takes advantage of the natural vistas afforded by that location. It also takes advantage of micro-climates, natural drainage, topography and takes into consideration how the use of the building will affect neighbouring properties.

2. **Building Height:**
    - Thought must be given to the size and scale of buildings located in the area when determining the maximum height of the structure. There may also be statutory limitations that must also be considered.

3. **Building Setbacks:**

- This is the distance which a building must be set back from property boundaries at ground and/or upper floor levels.
- There are standards that govern minimum setbacks and they are applied in order to provide an adequate buffer zone between buildings, minimize fire hazards by providing access for firefighting equipment and prevent discharge of rainwater from roofs to adjoining properties.

4.Vehicular Access:

- Consideration to how vehicles will enter and exit the proposed site, access to minor and major roads. Right of way, road signs and traffic light considerations. For example, where a building is located on a corner plot between a minor and a major road, access off the minor road is preferable.

5.Pedestrian Access:

- Entrances and exits of a building should be designed so as to provide convenient access to parking areas, walk-ways and adjacent streets, with particular attention being given to the needs of the physically handicapped.

6.Landscaping:

- Landscaping can be regarded as an essential feature of any development since it serves to enhance and complement the appearance and visual appeal of built features on the site. The ease of future maintenance is an important consideration in the planning of the site and will influence the choice of trees and materials to be used.

CONSTRUCTION PRINCIPLES

The following are the construction principles should be followed

Environmental Protection

- Construction work should be environmentally friendly and pollution free.

Safety

- Construction work has to be carried out in safety and comfort, with a method that implements the highest safety criteria.

Speed

- Construction work should be completed in the shortest possible period of time.

Economy

- Construction work must be done rationally with an inventive mind to overcome all constraints at the lowest cost.

Aesthetics

- Construction work must proceed smoothly and the finished product should portray cultural and artistic flavour.

DAMP PROOFING

- Damp proofing or a Damp-Proof in construction is a type of moisture control applied to building walls and floors to prevent moisture from passing into the interior spaces.

- A DPC is a durable, impermeable material such as slate, metal,

plastic or special engineered bricks

Materials widely used for damp proofing include

- Flexible materials like butyl rubber, hot bitumen (asphalt), plastic sheets, bituminous felts, sheets of lead, copper, etc.
- Semi-rigid materials like mastic asphalt
- Rigid materials, like impervious brick, stone, slate, cement mortar, or cement concrete painted with bitumen, etc.
- Stones
- Mortar with waterproofing compounds
- Coarse sand layers under floors
- Continuous plastic sheets under floors

METHODS OF DAMP PROOFING

- Membrane damp proofing
- Integral damp proofing
- Surface treatment
- Cavity wall construction
- Guniting
- Pressure grouting

Membrane damp proofing

- In this method of damp proofing a water repellent membrane or damp proof course(D.P.C.) is introduced in between the source of dampness and the part of building adjacent to it.
- Damp proofing course may consist of flexible materials such as bitumen, mastic asphalt, bituminous felts, plastic or polythene sheets, metal sheets, cement concrete.
- Damp proofing course may be provided either horizontally or vertically in floors, walls etc. Provision of Damp Proofing Course in basement is normally termed as ‘Tanking’.

Integral damp proofing

- In the integral damp proofing method certain water proofing compounds are added to the concrete mix, so that it becomes impermeable.

Surface treatment

- Moisture finds its way through the pores of material used in finishing. In order to check the entry of the moisture into the pores, they must be filled up. In the surface treatment method a layer of water repellent substances or compounds are applied on these surfaces through which moisture enters.

Cavity wall construction

- Cavity wall construction is an effective method of damp prevention. In this method the main wall of a building is shielded by an outer skin wall, leaving a cavity between the two. The cavity prevents the moisture from travelling from the outer to the inner wall.

Guniting

- In this method of damp proofing, an impervious layer of rich cement mortar is deposited under pressure over the exposed surfaces for water proofing or over pipes, cisterns etc. for resisting the water pressure. The operation is carried out by use of a machine known as cement gun.

Pressure grouting

This consists of forcing cement grout under pressure, into cracks, voids, fissures and so on present in the structural components of the building, or in the ground. Thus the structural components and the foundations which are liable to moisture penetration are consolidated and are thus made water-penetration-resistant. This method is quite effective in checking the seepage of raised ground water through foundations and sub-structure of a building

ANTITERMITE TREATMENT

- Termite (ant, white ant, etc.) infestation is often observed in buildings. As eradication of termite infestation of existing building is very difficult and elaborate, it is always better to provide antitermite treatment of buildings during construction to ensure and guard against any future infestation.

There are two types of anti termite treatment

- Pre-construction anti termite treatment
- Post-construction anti termite treatment

pre-construction anti-termite treatment

- **Step 1:** Treating the foundation with an anti-termite solution, known as a termiticide.
- **Step 2:** Treatment of the soil that is around the foundation. In this step, liquid termiticide is applied to the soil.
- **Step 3:** Treating the consolidated earth within the plinth walls, with the help of liquid termiticide.
- **Step 4:** Treating the soil that's around the pipes, gutters and tubes that run inside the area of a foundation.

VERTICAL CIRCULATION

- Vertical circulation in multistory buildings is used for movement of people and goods between floors.

Ex: stairs

Stair:

- A stairway, staircase, is a construction designed to connect a large vertical distance by dividing it into smaller vertical distances, called steps. Stairs may be straight, round etc.

TYPES OF STAIRS

1.L Shaped:

- The L shaped stair is a variation of the straight stair with a bend in some portion of the stair.
- This bend is usually achieved by adding a landing at the transition point. The bend is often 90 degrees, it is sometimes referred to as a long L stair or a quarter turn stair.

2.U shaped:

- U shaped stairs are essentially two parallel flights of straight stairs joined by a landing that creates a 180-degree turn in the walk line.

3.Winder stairs:

- Winder stairs are a variation of an L shaped stair but instead of a flat landing, they have pie-shaped or triangular steps at the corner transition.

4. Spiral stairs:

- Spiral stairs follow a helical arc. They usually have a very compact design and the treads radiate around a central pole.

5.Curved stairs:

- These stairs have a much larger radius and typically do not make a full circle. Curved stairs add elegance to any home or business.

6.BIFURCATED STAIRS

- These stairs are so arranged that there is a wide flight at the start which is subdivided into narrow flights at the mid-landing.
- The two narrow flights start from either side of mid landing. Generally these stairs are more suitable for modern public buildings.

TYPES OF FLOORING

1.Carpet flooring:

- This flooring is laid from wall to wall in a room or the hallway.
- This is, however, rapidly losing popularity due to the availability of other affordable and long-lasting flooring options.

2.Tile flooring:

- This flooring comes with a variety of colours, designs, and patterns to choose from.
- It gives a fresh look to your house. It is affordable and long-lasting if properly maintained.
- It is well-received due to its durability and versatility. However, it is not a good insulator of heat.

3.Laminate flooring

- This flooring is similar to other flooring types such as marble, ceramic or even hardwood flooring.
- This quality makes it the favourite choice for those who cannot afford other flooring option.
- It is also versatile and dynamic.
- It is quick to install and is long-lasting.

4.Hardwood Flooring

- This flooring looks beautiful and it enhances the resale value of the house.
- It offers rustic as well a modern look among others.
- It gives the home a cosy feel and adds warmth to it. However, it is expensive.

5.Vinyl Flooring:

- This flooring is colourful and versatile.
- It is easy to install and water-resistant.
- It is an affordable flooring option.

6.Marble Flooring:

- The marble represents luxury and prestige. It is expensive than other available flooring options. However, the look they offer cannot be compared.
- Marble is a soft stone due to which it remains prone to scratching, cracks as well as other damages

7.Cement concrete floor:

- The types of floors whose topping consists of cement concrete is called cement concrete floor.
- These floors consists of 2.5 cm to 5cm thick concrete layer laid over 10 cm thick base concrete and 10 cm thick clean sand over ground whose compaction and consolidation is done.

FLOORING MATERIALS

The following are the materials which can be used for flooring

- Ceramic Tiles
- Vitrified Tiles
- Porcelain Tiles
- Marble
- Granite
- Limestone
- Sandstone
- Slate

UNIT 5

INTERNAL AND EXTERNAL FITTINGS OF A BUILDING

DOOR

- A door is a movable structure used for opening and closing an entrance or for giving access to something.

CONSTRUCTION DETAILS OF A DOOR

Doorframe or casing:

- This is the part of the door that is fixed into the rough opening when mounting a door. Another word that can also be used for the doorframe is “casing”.

Door Jamb

- Door jambs are the interior sides of the doorframe

Threshold Or Sill

- The threshold, also known as the sill, is the bottom part of the door that is directly below the header.

Hinge:

- The hinge is the part the door swings on. A door usually has three or four hinges. One part of the hinge is screwed to the door jamb and the other side is screwed to the door itself.

Mullions

- If the door is divided into four sections, each containing one panel, mullions divide the door vertically down the middle, intersecting the lock rail.

Panels

- Panels are the main surfaces of the door, the parts that make up most of the area of the door. Doors come in many shapes and sizes, and some have only one panel while others may have several, depending on the type.

Stile:

- The stiles are the side sections of the door itself. The stile on the hinge side is known as the “hinge stile” while the one on the opposite side is called the “lock stile”. The stiles serve as a frame for the door panels.

Top Rail

- The top rail does the same job as the stiles but at the top of the door. It forms the upper frame for the panels below it.

Bottom Rail

- The bottom rail is the same as the top rail but is located at the bottom of the door.

TYPES OF DOORS

TIMBER DOORS

- Traditionally, timber or wood as is popularly has been the mainstay for the manufacture of doors/windows.
- Its main advantage has been local availability of material and the ease with which it can be made by the local carpenters.
- Timber is most commonly being used for making of doors/windows

BATTENED AND LEGGED DOORS

- Battened and ledged doors are the Simplest form of doors and are

used in olden days.

- Such doors consist of vertical wooden battens of the height of the door with about 35 mm thicknesses which are usually tongue and groove jointed.
- Usually three ledges (horizontal members) are provided, one each at the top and bottom and one in the middle.
- Such doors are commonly adopted for toilets, baths etc.

FRAMED AND PANELLED DOORS

- These types of doors are most commonly provided in the houses.
- The frame for the door is made out of Wood and the shutter panels out of timber, plywood, block board, hard board, etc.
- The panels can also be made out of glass. In cases where part of the door is in wooden panels and the remaining is of glass panels, the door is known as panelled and glazed.

FLUSH DOORS:

- A flush door is a completely smooth door, having plywood or Medium Density Fibre board fixed over timber Frame which is comparatively light.

STEEL DOORS

- Steel or other such metal construction has been used for years as they are efficient and are a sturdy option for exterior and interior doors alike.
  These doors can be either be solid or hollow.

GLASS DOORS

- Glass is usually provided for doors and windows, mostly for panelling.
- Normally such doors are provided on the backside of the house as it provides unobstructed view of the backyard or garden.

- Such doors are costly and require good maintenance.

PVC DOORS

- PVC is a common term for the product called Poly Vinyl Chloride.
- It is basically a plastic material commonly used for making various products including water tanks, pipes, fittings etc for houses.
- The use of PVC for the manufacture of doors has become very popular
- The advantages of using PVC doors are that they are termite proof, durable, anti corrosive, light weight, moisture resistant etc. They are also easy to fabricate and install.

WINDOWS

- Windows are openings fitted with glass to admit light and allow people to see out. They are often openable to allow ventilation

Windows can include a number of different components:

- **Frame** - This holds the light in place and supports the window system.
- **Lintel**- A beam over the top of a window.
- **Jamb** - The vertical parts forming the sides of the frame.
- **Sill** - The bottom piece in a window frame.
- **Head** - The uppermost member of the frame.
- **Sash** - The frame holding the glazing.

SINGLE HUNG

- The single hung window is a classic and very common design. It operates with the bottom sash being manipulated.

Pros:

- easy installation

- perfect for narrow outside space
- affordable

Cons:

- Since only the lower stash is operational, this type of windows require you to clean it from the outside.
- Ventilation can be limited.

DOUBLE HUNG

- The double panel sash window is probably the most widely used of all window types. It consists of two vertically arranged panels, both of which can be moved all the way up and down.

Pros:

- Easy maintenance since both the upper and lower stashes can be manipulated to allow ventilation inside.
- Affordable.

Cons:

- Limited ventilation.
- Depending on the materials and functionality, this type of window is not as airtight as other window types in the market

AWNING WINDOW

- The awning window is a casement that's mounted vertically, with the hinge at the top so the window pushes out. This type of window is especially useful for allowing air to flow without admitting seasonal debris (e.g., falling leaves) or rainfall.

Pros:

- Saves energy.

- Provides good insulation.
- Prevents snow and rain from entering the room.

Cons:

- Difficult to clean the outer portion of the window pane.

CASEMENT

- Casement windows also open out (like awning windows) and usually pivot from side hinges.
- Casements also typically offer more open ventilation area than other window types

Pros:

- Excellent for ventilation.
- Easy and low maintenance.

Cons:

- Difficult to use with window screens since it usually cranks outwards.
- Not very secure.

Bay windows

- Bay windows are an excellent resource for architects to create angles and projections on a building structure.
- Bay windows allow light to enter at different angles, and most bays include side windows that can be opened for airflow.

Pros:

- Adds space and aesthetic touch to your room.
- Gives an enhanced panoramic view of the outside.
- Can instantly transform the look of your house by adding an elegant touch.

Cons:

- Can possibly block narrow outside space.

Replacement and maintenance is costly.

Bow windows

- Bow windows are variations of the bay window.
- The only difference is instead of having hexagonal and straight edges, the bow window is curved, forming an arch.
- Because of the curved edges, this type of window is typically larger than bay windows.

Pros:

- Most elegant window design.
- Gives a panoramic view.
- Adds space to the interior.

Cons:

- Costly.
- Difficult to clean.

GABLE ROOF

- The term ‘gable’ refers to the triangular shape that is formed when the two pitched areas of your roof meet.

Pros:

- Gable roofs will easily shed water and snow and allow more ventilation.
- Their inherently simple design makes it easy to build them and cheaper than more complex designs.

Cons:

- Gable roofs can be problematic in high wind and hurricane areas.
- If the frames are not properly constructed with adequate supports, the roof can collapse.
- High winds can also cause materials to peel away from gable roofs.

HIP ROOF

- A hip roof has slopes on all four sides. The sides are all equal length and come together at the top to form a ridge.

Pros:

- Hip roofs are more stable than gable roofs.
- The inward slope of all four sides is what makes it more sturdy and durable.
- They are excellent for both high wind and snowy areas. The slant of the roof allows snow to easily slide off with no standing water.

Cons:

- Hip roofs are more expensive to build than a gable roof. It's a more complex design that requires more building materials.

MANSARD ROOFS

- A mansard roof, also known as a French roof, is a four-sided roof with a double slope on each side that meet forming a low-pitched roof.
- The lower slope is much steeper than the upper. The sides can either be flat or curved, depending on the style.

FLAT ROOFS

- As the name suggests, flat roofs appear to be completely flat with no pitch. However, they do have a slight pitch to allow for water run -off and drainage.

- These roofs are generally used on industrial or commercial buildings. However, they can also be installed on residential houses in both high and low rainfall areas.
- Flat roofs are easier to construct than pitched roofs and require fewer building materials, keeping costs down.

BUTTERFLY ROOF

- A butterfly is a V-shaped roof constructed of two tandem pieces which are angled up on the outside.
- The midsection is angled downward where the two pieces meet into a valley. The overall effect is of a butterfly's wings in flight.

Domed Roofs

- The Domed roof is polygonal with an inverted bowl shape. Domed roofs are not only beautiful in design but also very durable.

Salt Box Roof

- A salt box roof is asymmetrical in design, with one side being more of slightly sloping flat roof and the other more of a lean to, with gables at each end.

Skillion roofs

- Skillion is also referred to as a shed roof or lean-to. It is a single, sloping roof, usually attached to a taller wall. – It can be thought of as half of a pitched roof, or as a more angled flat roof.

LINTEL

- A lintel is one type of beam which is utilized to support the above wall or partition material when openings like doors, windows, and so forth are necessary to provide a building structure.
- The primary function of the lintel is to take loads originating from the high wall and transfer its heap to the side walls.

Types of Lintel

- Timber lintel
- Stone lintel
- Reinforced concrete lintel
- Brick lintel
- Reinforced brick lintel
- Steel lintel

CHAJJA

- chajja is the projecting roof usually called a sunshade projected as a cantilever from walls.
- It can also provide protection for lower levels.

Functions of Chajja

- Protects from external sunlight.
- Protects from rainwater
- a recess place to keep utilities like A.C compressor

WATER SUPPLY FITTINGS

Pipe Fittings

- Pipe fittings are an important component of the plumbing system.
- In plumbing, many types of fixtures are joined with the help of various types of material as per the requirement.

Type of Fittings

1. Collar
2. Elbow
3. cross
4. Union
5. Reducer
6. Tee
7. Nipple
8. valves

Collar

- While joining two pipes in the same length, collar is used. Collar is fitted in the end of pipe

Elbow

- It is installed at the time of joining two pipes. With the help of an elbow, the direction of liquid is changed. Normally a 45° or 90° elbow is used.

Cross

- When four pipes are joined,a cross is formed. It is also called a cross branch line or a four-way fitting

Union

- When two ends of pipes are joined, the pipe fitting used is called union.

Reducer

- It is used to connect pipes of different diameters. A reducer may be of various types like reducer tee, reducer elbow and reducer socket

Tees

- It connect pipes of various diameters and help in changing the direction of water or material in a pipe. Tees are made in various sizes like equal or unequal. The equal tee is most commonly used

Nipple

- It is a piece of pipe having thread at both sides, and could be used for short extension of plumbing lines. It can also be used for connecting two fittings within small distance.

Valves

- For proper functioning of the pipeline, valves made of iron or brass are used in the water-supply mains. Valves stop or control the flow of fluid like liquid, gas, condensate, etc.

SANITARY FITTINGS

Wash basins

- Wash basins are made of fire-clay, stoneware, earthenware or vitreous china.
- But nowadays steel, aluminium and plastic wash basins are also available in the market which are very popular.
- It may be available in rectangular, square, circular etc. shape depending on the choice.
- These may be supported on the brackets fixed on the wall or supported on the pedestals.

Sinks:

- These are rectangular shallow receptacles suitable for kitchens or laboratory.
- The floor of the sink is given a slope towards the waste outlet. The sinks are provided with circular waste hole.
- The sinks are made of glazed earthenware or stoneware. The height of the top of the sink from the floor should be 90 cm.

Bath tubs

- Bath tubs may be made of various materials, such as enamelled iron, plastic, cast iron, porcelain enamelled, marble or fire clay etc.
- For high class residential buildings marble, plastic or enamelled iron or fibre glass baths are used.
- For public places glazed fire-clay or porcelain enamelled cast iron baths are used.

Flushing Cisterns:

- These are used for flushing water closets and urinals after use. There are several varieties of flushing cisterns.

Water-Closet:

- This is a sanitary appliance to receive the human excreta directly and is connected to the soil pipe by means of a trap.

ELECTRIC FITTINGS

Conduit:

- An electrical conduit is a tube used to protect and route electrical wiring in a building or structure.
- Most conduit is rigid, but flexible conduit is used for some purposes. The conduits internal surface shall be smooth.

Fuse

- It is a circuit breaker commonly used for protecting wiring and for safety.

Wires:

- Wires are used to bear mechanical loads or electricity and telecommunications signals.
- Unless otherwise specified all wires shall be PVC insulated single core, stranded copper conductor.

- Phase A of 1: Red Colour of wire
- Phase B of 2: Yellow Colour of wire
- Phase C of 3: Blue Colour of wire
- Neutral: Black
- Ground: Yellow Green or Green

Telephone Cables:

- They consist of numerous pairs of copper insulated wires having a diameter that ranges from 0.3 to 0.9 and are either twisted into two or four pairs. These pairs of wires are then connected to each phone jack in your house.

Electrical boxes

- It also known as junction boxes, enclose wire connections to protect against short circuits, which can cause fires.

Socket outlet:

- It is popularly known as power points, designed to accept a plug connected to the flexible wire of an appliance.

switch

- A switch in an electronic device is used to interrupt the flow of electricity or electric current.

LIFT

- An elevator or lift is a type of vertical transportation machine that moves people or goods between floors, levels, or decks of a building, vessel, or other structure.
- Elevators are typically powered by electric motors
- Elevator doors prevent riders from falling into, entering, or tampering with anything in the shaft.
- The most common configuration is to have two panels that meet

in the middle, and slide open laterally.

ESCALATOR

- An escalator is a moving staircase which carries people between floors of a building.
- It consists of a motor-driven chain of individually linked steps on a track which cycle on a pair of tracks which keep them horizontal.
- Escalators are often used around the world in places where lifts would be impractical, or they can be used in conjunction with them.

Uses:

- Various usage include department stores, shopping malls, airports, transit systems (railway/railroad stations), convention centers, hotels, stadiums and public buildings.
- Escalators have the capacity to move large numbers of people. They can be placed in the same physical space as a staircase.

Fire protection systems

Fire extinguishers

- Fire extinguishers are provided for a 'first attack' fire fighting measure, generally undertaken by the occupants of the building before the fire service arrives.
- Most fires start as a small fire and may be extinguished if the correct type and amount of extinguishing agent is applied.

Fire hydrant systems

- Fire hydrant systems are installed in buildings to help fire fighters quickly attack the fire. Essentially, a hydrant system is a water reticulation system used to transport water.

Automatic Sprinkler Systems

- Time is essential in the control of fire. Automatic sprinkler systems are one of the most reliable methods available for controlling fires.
- A sprinkler head is really an automatic tap. The sprinkler head is connected to a pressurised water system.
- When the fire heats up the sprinkler head, it opens at a pre-set temperature, thus allowing pressurised water to be sprayed.

PLASTERING

- Plastering is a process by which coarse surfaces of wall or ceiling roofs are changed or turned or rendered to provide smoothness.

Types of plastering:

Lime plaster :-

- When lime is used as a binding material it is called lime plaster.
- Lime plaster is a type of plaster composed of hydrated lime, sand and water.

Cement plaster:-

- When cement is used as a binding material it is called cement plaster. It is specially suited for damp condition.
- Cement plaster is usually applied in one coat.

Mud plaster:-

- The surface to be prepared exactly in the same manner as that of for lime plaster or cement plaster.
- Mud plaster is generally applied in two coats, the first coat being 18mm thick while the thickness of second coat kept 6mm.

Gypsum plaster

- Gypsum plaster is made of mineral rocks rich in calcium sulphate.
- It is also known as the plaster of Paris. Using fine ground gypsum mixed with water, gypsum plastering is highly preferred over cement in many ways.
- Generally, gypsum-based construction products are the safest to use.

Stucco plaster:-

- Stucco is the name given to decorative type of plaster which gives an excellent finish.
- Stucco plaster can be used for interior as well as exterior surfaces.
- It is usually laid in three coats making the total thickness of plaster about 25mm.
- The first coat is called scratch coat, the second coat is called fine coat, it is also known as brown coat and the third coat is called white coat or finishing coat.

POINTING

- In brick/stone masonry, joints are weak and most vulnerable where dampness can enter. Implementation of joints to a depth of 10 to 20 mm and filling it with better quality mortar in desired shape is called pointing in civil brick work.

Types of pointing:

- Flush pointing rubbed, keyed or grooved pointing
- Recessed pointing tuck pointing
- Beaded Pointing V-pointing
- Struck Pointing Weathered pointing

DISTEMPERS

- Distempering is the widely used method of painting the interior as well as exterior surfaces of the house.
- It is just a process of applying wash like white wash or colour wash on the surface.
- But the finished surface obtained by distempering is far superior to those obtained by white or colour wash.

Composition of Distempers

- Distemper consists of Chalk powder mixed in water with colouring pigments.
- Dry distempers are available in powder form. They are mixed with hot water before use.
- Oil bound distempers are available in paste form in different shades of colour.
- Before applying, it is mixed with water to dilute it to the required consistency.

COLOUR WASHING

- Colour washing is prepared by adding colouring pigment to the screened white wash.
- For colour washing on new surface, the first primary coat should be of white wash and the subsequent coats should be of colour wash.

PAINT

- Paint is a liquid or mastic material that can be applied to surfaces to colour, protect and provide texture. They are usually stored as a liquid and dry into a thin film after application.

Types of paints:

- Oil Paint
- Enamel Paint
- Aluminium Paint
- Anti-Corrosive Paint
- Cellulose Paint