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Materials, Testing & Construction Practices

By

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— Page —

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KCE 401 : Materials, Testing & Construction Practices

1 UNIT

Introduction

PART-1

Classification of Building Materials : Building Materials and their Performance, Economics of the Building Materials.

CONCEPT OUTLINE : PART-1

Building Material : It is any material used for a construction purpose. Many naturally occurring substances such as clay, sand, wood and rocks have been used as a building material for construction of a building or structure.

Factors Affecting the Choice of Building Materials : Following factors may be considered as :

i. Cost, ii. Durability,
iii. Supplier, iv. Availability,
v. Performance, and vi. Maintenance.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 1.1. What do you mean by building material used in construction ?

Answer

1. Building material is any material which is used for a construction purpose.
2. Many naturally occurring substances such as clay, sand, wood and rocks, even twigs and leaves have been used to construct buildings.
3. Building materials can be generally categorized into two sources, natural and synthetic.
4. Natural building materials are those that are unprocessed or minimally processed by industry, such as lumber or glass.
5. Synthetic materials are made in industrial settings after much human manipulations, such as plastics and petroleum based paints.
6. During construction of the building generally cement, sand, stone chips, steel, tiles etc., are used as materials of construction.
7. Also electric wires for wiring, pipes for water line, tanks for storage of water, bathroom, kitchen, sewers for sewer lines are also used as materials during construction of the building.

Que 1.2. Describe the different types of building material used in construction.

Answer

Following are the various types of building materials used in construction work :

1. **Cement :**
   i. Cement is a common building material made from rock and is a very important material.
   ii. In general cement has been classified by different groups depending upon its strength e.g., grade 43, grade 53 etc.
2. **Sand :**
   i. In general sand is mined from rivers and canals. The coarser the particles of sand, the better it is.
   ii. Sand is used in plastering, brick work and in concrete work.
   iii. The fineness modulus of coarse sand should be less than 2.6.
3. **Bricks :**
   i. A brick is a block made of kiln-fired material, usually clay or shale, but also may be of lower quality mud, etc.
   ii. The quality of brick is evaluated on the basis of its shape, water absorbing capacity, and load carrying capacity.
   iii. The edges of the bricks should be straight.
4. **Plastic :**
   i. The term plastics covers a range of synthetic or semi-synthetic organic condensation or polymerization products that can be molded or extruded into objects or films or fibers.
   ii. Plastics vary immensely in heat tolerance, hardness, and resiliency.
5. **Ceramics :** Ceramics are such things as tiles, fixtures, etc. Ceramics are mostly used as fixtures or coverings in buildings, ceramic floors, walls, counter-tops, even ceilings.
6. **Metal :**
   i. Metal is used as structural framework for larger buildings such as skyscrapers, or as an external surface covering.
   ii. There are many types of metals used for building.
   iii. Steel is a metal alloy whose major component is iron, and is the usual choice for metal structural building materials.
7. **Wood :**
   i. Wood is a product of trees, and sometimes other fibrous plants, used for construction purposes when cut or pressed into lumber and timber, such as boards, planks and similar materials.

ii. It is a generic building material and is used in building just about any type of structure in most climates.

8. **Stone :** Stone is a naturally available building material derived from the rocks, a portion of the earth crust, having no definite shape and structure.

Que 1.3. **What are the factors influencing the choice of a building material ?** **AKTU 2013-14, Marks 05**

Answer

Following factors may be considered for choice of building material :

1. **Cost :**

i. One important consideration when choosing building materials is the cost.

ii. Choose building materials that will serve you well for a long time and this will end up being cost efficient.

2. **Durability :**

The building materials should be more resistant to decay, moisture and other environmental hazards.

3. **Availability :**

It is always advisable to buy readily available materials. This will help to ensure that you do not have to wait for long to get the materials you need.

4. **Performance :**

i. Select materials that have the structural capability to support the building loads.

ii. The materials selected should also make it possible for the occupants to live comfortably without any adverse effects like those caused by harmful chemical emissions.

5. **Maintenance :**

i. The best materials are those that are easy to maintain. Maintenance will help to keep the building looking good for long.

ii. Good quality building materials will usually require less maintenance than cheaper materials.

Que 1.4. **Discuss in detail all major properties of building material.**

Answer

Following are the major properties of building material :

1. **Chemical Properties :** Some common chemical properties are as follows :

i. Crystallisation is a property of a substance to form crystals when passing from a fluid state to solid state.

ii. Corrosion resistance is a property of a material to resist destruction or decay when exposed to and acted upon by corrosive media.

iii. Durability of concrete is a very important property. Concrete must be durable under adverse environmental conditions.

iv. Cohesion is the property of a material to be strong enough to cause the attraction between molecules.

v. Ageing is the property of materials to change from one state into another due to physio-chemical processes.

2. **Mechanical Properties :** The properties that determines the behaviour of engineering materials under applied forces and loads are called mechanical properties.

Mechanical properties can be dealt in :

i. **Elastic Properties :**

a. Elasticity is a property possessed by the material of resuming its original shape upon removal of any force, which has modified its form by stretching, compressing, twisting etc.

b. Elastic limit is defined as maximum stress that can be applied to a material without producing a permanent plastic deformation when the load is removed.

ii. **Plastic Properties :**

a. The plastic properties of a material are those which define the ability to resist loads and deformation and the capacity to absorb energy in the plastic range.

b. A material has a higher plastic strength if it resists load without fracture.

c. Ductility represents ability of material to deform in plastic range.

d. A material has high toughness if it can absorb high value of strain energy in the plastic range.

3. **Electrical Properties :**

i. Materials may be designated as conductors with low electrical resistance *i.e.*, from 1.6×10^{-8} to 1.4×10^{-6} ohm at room temperature and insulators *i.e.*, with resistance 10 Ω to 10 MΩ and material with resistivity in between are designated as semi-conductors.

ii. Dielectric strength is the property of a material to resist an electrical breakdown.

4. **Thermal Properties :**

i. This includes heat resistance, heat capacity, thermal expansion, conductivity, thermal stock resistance etc.

ii. Specific heat is defined as the ratio of the heat capacity of the material to that of water. The specific heat of a material depends upon the condition of measurement.

iii. The stresses developed in the material when its expansion or contraction is partially or wholly prevented due to a temperature change by rigidly fixing its two ends, are known as thermal stresses.

5. **Magnetic Properties :**

i. The magnetic properties of materials arise from spin of electrons and orbital motion of electrons around the atomic nuclei.

ii. All the materials can be characterized as :

a. Diamagnetic

b. Paramagnetic

c. Ferro-magnetic

6. **Technological Properties :**

i. These properties give an idea about the method to be adopted to give shape to the different materials.

ii. Machinability is a measure of ease and the success of the operation such as turning, milling, drilling, threading etc, that can be carried on one metal in comparison with the other.

iii. Other technological properties are castability, resistance to corrosion which decides the life and economy of the part in use, resistance to wear and tear, weldability etc.

7. **Other Properties :**

i. Chemical properties such as chemical composition, atomic weight, acidity, alkalinity, atomic number etc.

ii. Physical properties such as shape, finish, density, specific gravity.

iii. Optical properties such as colour, lustre.

Que 1.5. **Discuss building materials by economic point of view.**

Answer

1. From the economic point, construction materials may be classified as :

i. **Basic/Primary Materials :** It require little or no processing before use. For example clay, sand.

ii. **Semi-Processed Materials :** It require limited amount of processing such as cement, timber.

iii. **Fully Processed Materials :** It require manufacturing such as fabricated steel, plastic, bricks and tiles.

2. The economic resources used in the form of capital and labour are usually proportional to the amount of processing required.

3. With time durable dwelling, increase in monetary value and conserve materials, non durable dwellings diminish in value and spoil material which, if used differently, could have longer operating life.

4. Durability should help to reduce the consumption of energy and materials as well as completion expenses when materials can be required for use in new or rehabilitated buildings.

5. The degree of durability of a material may be linked directly to the consumption of energy in its production.

PART-2

Stones, Requirement of Good Building Stone, Characteristics of Building Stones and their Testing, Common Building Stones, Methods of Preservation of Stones.

CONCEPT OUTLINE : PART-2

Stone : Stone is defined as the natural, hard substance formed from minerals and earth material which are formed from rocks.

Common Building Stones : These may be as follows :

i. Granite, ii. Sandstone,
iii. Limestone, iv. Slate,
v. Marble, vi. Basalt.

Tests of Stones : Following test may be carried out :

i. Compressive strength test, ii. Transverse strength test,
iii. Tensile strength test, iv. Shear strength test,
v. Weathering test, vi. Toughness test, and
vii. Soundness test.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 1.6. **Write a short note on building stones.**

Answer

1. Stone has been defined as the natural, hard substance formed from minerals and earth material which are present in rocks.

2. Rock may be defined as the portion of the earth's crust having no definite shape and structure.
3. Use of stone in building construction is traditional in the places where it is produced, although even there its high cost imposes limitations on its use.
4. The conditions which govern the selection of stone for structural purposes are cost, fashion, ornamental value and durability.
5. As building material stone has gradually lost importance with the advent of cement and steel. Secondly, the strength of the structural elements built with stones cannot be rationally analyzed.

Que 1.7. Explain the classification of stones in detail.

AKTU 2016-17, Marks 05

Answer

The stones used by building industry are obtained from rocks. The rocks are classified in the following three ways :

A. Geological Classification : According to this classification, the rocks are of the following three types :

1. Igneous Rocks :

i. The inside portion of the earth's surface has high temperature so as to cause fusion by heat at even ordinary pressures.

ii. The molten or pasty rocky material is known as the magma. This magma always tries to come out of the earth's surface through cracks or fissures.

iii. The rocks which are formed by the cooling of magma are known as the igneous rocks. These rocks are durable, hard, massive and stronger than other rocks.

Types of Igneous Rocks : The igneous rocks are of the following three classes :

i. Plutonic Rocks :

a. These rocks are formed due to cooling of magma at a considerable depth from earth's surface.

b. The cooling is slow and rocks possess coarsely grained crystalline structure.

c. The igneous rocks commonly used in building industry are of plutonic type. Granite is an example of this type of rock.

ii. Hypabyssal Rocks :

a. These rocks are formed due to cooling of magma at a relatively shallow depth from earth's surface.

b. The cooling is fast and hence these rocks possess finely grained crystalline structure.

c. Dolorite is an example of this type of rock.

iii. Volcanic Rocks :

a. Such rocks are formed due to pouring of magma at earth's surface.

b. The rate of cooling is fastest and hence these rocks are extremely fine grained in structure.

c. They sometime contain some quantity of glass which is a non-crystalline material.

d. Basalt is an example of this type of rock.

1. Sedimentary Rocks :

i. These rocks are formed by regular deposition of products of weathering on the pre-existing rocks.

ii. The various weathering agencies, e.g., rain, sun, air, frost, etc. break up the surface of earth.

iii. Rain water carries down these broken pieces to the rivers. As the rivers descend down to the plains, the velocity decreases gradually and the sediments (disintegrated rock pieces, sand, silt, clay, debris, etc.) in the water settle.

iv. Due to the seasonal variation, sedimentation takes place in layers. With time, the sediments get consolidated in horizontal beds due to the pressure exerted by overlying material.

v. The examples of sedimentary rocks resulting from the precipitation of salts in drying water basin (chemical deposits) are gypsum, anhydrite, magnesite, dolomite, etc.

vi. Sedimentary rocks resulting from the accumulation of plant or animal remains (organogenous rocks) are limestone, shale, chalk, diatomite and tripoli.

vii. The examples of rocks resulting from the deterioration of massive magmatic or sedimentary rocks (fragmental rocks) are sandstone, sand, gravel, carbonate conglomerate and breccia.

3. Metamorphic Rocks :

i. Metamorphic rocks are formed from igneous or sedimentary rocks as a result of the action of the earth movements, temperature changes, liquid pressures, etc.

ii. The resultant mass may have a foliated structure, e.g. slate, gneiss, schist and phyllite or non-foliated structure, e.g. marble, quartzite and serpentine.

B. Based on Physical Characteristics :

The rocks may be classified as stratified, unstratified and foliated.

1. Stratified Rocks : Stratified rocks show distinct layers along which the rocks can be split. The examples are sandstone, limestone, shale, slate, marble, etc.

2. **Unstratified Rocks :** Unstratified rocks do not show any stratification and cannot be easily split into thin layers. The examples of such rocks are granite, basalt, trap, etc.
3. **Foliated Rocks :** Foliated rocks have a tendency to split up only in a definite direction. Most of the metamorphic rocks have a foliated structure, except for quartzite and marble which have granulose structure.

C. **Based on Chemical Characteristics :**

The rocks may be classified as argillaceous, silicious and calcarious.

1. **Argillaceous :** The principal constituent is clay (Al_2O_3). The rocks are hard and brittle. The examples are slate, laterite, etc.
2. **Silicious :** The principal constituent is silica (SiO_2), *i.e.*, sand. The rocks are very hard and durable. The examples are granite, basalt, trap, quartzite, gneiss, syenite, etc.
3. **Calcarious :** The principal constituent is lime. The examples are limestone, marble, dolomite, etc.

Que 1.8. **Discuss in detail the major characteristics of stones.**

Answer

The important characteristics of stones are as follows :

1. **Appearance :** For face work it should have fine, compact texture ; light-coloured stone is preferred as dark colours are likely to fade out in due course of time.
2. **Structure :** A broken stone not be dull in appearance and should have uniform texture free from cavities, cracks, and patches of loose or soft material. Stratifications should not be visible to naked eye.
3. **Strength :** A stone should be strong and durable to withstand the disintegrating action of weather. Compressive strength of building stones in practice range between 60 to 200 N/mm².
4. **Weight :** It is an indication of the porosity and density. For stability of structures such as dams, retaining walls, etc., heavier stones are required, whereas for arches, vaults, domes, etc., light stones may be the choice.
5. **Hardness :** This property is important for floors, pavements, aprons of bridges, etc. The hardness is determined by the Mohs scale.
6. **Toughness :** The measure of impact that a stone can withstand is defined as toughness. The stone used should be tough when vibratory or moving loads are anticipated.
7. **Porosity and Absorption :** Porosity depends on the mineral constituents, cooling time and structural formation. A porous stone disintegrates as the absorbed rain water freezes, expands, and causes cracking.

8. **Seasoning :** The stone should be well seasoned.
9. **Weathering :** The resistance of stone against the wear and tear due to natural agencies should be high.
10. **Workability :** Stones should be workable so that cutting, dressing and bringing it out in the required shape and size may not be uneconomical.
11. **Fire Resistance :** Stones should be free from calcium carbonate, oxides of iron, and minerals having different coefficients of thermal expansion.
12. **Specific Gravity :** The specific gravity of most of the stones lies between 2.3 to 2.5.

Que 1.9. **Briefly describe the test on building stones and their significance.**

OR

Briefly describe the tensile strength test and the water absorption test of stones. **AKTU 2013-14, Marks 05**

Answer

Following are the important test for stones :

1. **Compressive Strength :** The compressive strength of stones is generally determined by testing core drills in the form of cylinder cub etc. It is resistance to rupture.

Procedure :

i. Specimen is put in compression testing machine and a load is applied uniformly.
ii. Increase the load continuously at the rate of 140 N/mm² per minute. The maximum load applied and type of failure is recorded.
iii. Three specimen parallel to rift and perpendicular to rift should be tested.

$$\text{Compressive Strength} = \frac{\text{Maximum load in N at failure}}{\text{Area of bearing face of specimen (mm}^2\text{)}}$$

2. **Transverse Strength :** Capacity to withstand transverse stresses is called transverse strength.

Procedure :

i. Put the specimen uniformly supported upon two self aligning bearers of 4 cm in diameter.
ii. Apply load at a uniform rate of 200 kg/m in through a third bearer of 4 cm in diameter and placed midway and parallel to the supports.
iii. The length of bearers should be maximum width of the specimen tested.

$$\text{Transverse strength } (R) \text{ in N/mm}^2 = \frac{3WL}{2bd^3}$$

where, W = Central breaking load in N.
L = Length of span (mm).
b = Average width (mm) of test piece.
d = Average depth (mm) of test piece.

3. **Tensile Strength :** The ultimate stress in tension is called the tensile strength of a material. Ultimate stress is the greatest stress which can be produced in body before rapture occurs.

Procedure :

i. Put test pieces between steel plates (25 mm width, 10 mm thick and length equal to length of test piece).

ii. The movable portion of spherically seated compression plate should be held on spherical seat.

iii. Load is applied continuously at a uniform rate. Record maximum load when specimen splits.

iv. Calculate and take average of three saturated and dried specimens separately.

$$\text{Tensile strength} = \frac{2 \times \text{Applied load in N}}{\text{Perimeter} \times \text{Length of specimen}}$$

$$S = \frac{2W}{\pi dl}$$

where, d = Diameter (mm) of specimen.
l = Length (mm) of specimen.

4. **Toughness Test :** Toughness is the ability to withstand high stress together with great deformation. Toughness is an index of the ability of a material to withstand impact about complete fracture.

Procedure :

i. Test cylinders should be held without rigid lateral support and the upper surface of test cylinder should be under the plunger.

ii. A hammer weighing 2 kg should be used with a free fall at 1 cm for the first blow, 2 cm for the second blow and an increase of 1 cm fall for each succeeding blow until the failure of test occurs.

iii. Three tests should be performed one perpendicular, another parallel and third should be performed on test piece drilled at random.

5. **Water Absorption Test :**

i. Keep 50 gms of stone chippings in an oven at 105 °C for three days and then cool in a desiccator and takes the weight w_1 of the dry sample after being cooled in a desiccator.

ii. Now immerse the sample in distilled water for three days and takes the weight w_2 of the wet sample on taking out from distilled water.

iii. Then, absorption of water = $\frac{w_2 - w_1}{w_1} \times 100$

iv. This is expressed in percentage.

Que 1.10. **Give the classification of various building stones with their suitability.**

Answer

S.No.	Type	Classification	Suitability
1.	Granite	Igneous	Most suitable for important engineering works such as bridge abutments, piers, dams, sea walls, light houses, etc.
2.	Trap and basalt (green stone, white stone, blue basalt)	Igneous	Suitable for road metal and concrete aggregate. Its red and yellow varieties are used for decorative features in structures.
3.	Serpentine	Igneous	Suitable for ornamental works to quality building works.
4.	Syenite	Igneous	Most suitable for road metal.
5.	Sandstone	Sedimentary	In the form of flag stone for paving, tile stone for roofing, natural stone for ornamental work and grit for heavy engineering works.
6.	Limestone	Sedimentary	Suitable for flooring, paving and roofing and in the manufacture of lime and cement.
7.	Kankar (Impure limestone)	Sedimentary	Black kankar is hard and is used as building material. Nodular kankar is used to produce hydraulic lime.
8.	Mooram (Decomposed laterite)	Sedimentary	Most suitable for surfacing fancy paths in gardens and bungalows.
9.	Gneiss (Stratified granite)	Metamorphic	Suitable for rough stone masonry works, stone pitching and road metal.

10.	Laterite (Sandy clay stone)	Metamorphic	Suitable for rough stone masonry work. The nodular variety yields road metal.
11.	Marble	Metamorphic	Most suitable for monuments, statutes flooring, decorative and ornamental works.
12.	Slate	Metamorphic	Most suitable for roof coverings, floorings, damp proofing and partitions.

Que 1.11. What is the method of preservation of completed stonework ?

Answer

1. Stonework after construction also needs careful attention if they are to be preserved in their natural condition. The art of preserving ancient stone statues in museum consists of special techniques.
2. For preserving stonework in buildings which tend to deteriorate with time, coating on the stone should be done with one of the following preservatives :

i. **Linseed Oil :** Raw linseed oil is light in colour while boiled linseed oil is dark and hence discolour the stone.

ii. **Solution of Alum and Soap :** Alum and soap in 40 to 60 proportions respectively dissolved in water can be applied on the stone to act as a protective coating.

iii. **Solution of Barium Hydroxide (Baryta) :** If the decay is due to $CaSO_4$, then this treatment is effective. The reaction is as follows :

$$Ba(OH)_2 + CaSO_4 \longrightarrow BaSO_4 + Ca(OH)_2$$

Barium sulphate is insoluble and the $Ca(OH)_2$ absorbs carbon dioxide and gives strength to the stonework.

iv. **Paraffin :** It is used alone or dissolved in naphtha as a paint medium. It may change colour of stone.

v. **Paint :** Painting preserves the stone but changes the colour of the stone. If applied under pressure, it can fill the pores in the stone. Paint should be neutral and should not react with the stone.

vi. **Coal Tar :** It is listed as preservative but not generally used. It completely changes the colour of the stone.

PART-3

***Bricks :** Manufacturing Process of Clay Bricks, Classification of Clay Bricks, Properties of Clay Bricks, Testing Methods for Clay Bricks, Problems of Efflorescence and Lime bursting in bricks and tiles.*

CONCEPT OUTLINE : PART-3

Bricks : Bricks can be defined as artificial stones which are usually made of clay. These are obtained by moulding clay in rectangular moulds and then by drying and burning these blocks.

Ingredients of Brick : Following are the ingredients of brick :

i. Alumina, ii. Silica,
iii. Lime, iv. Oxides of iron, and
v. Magnesia.

Testing Methods of Brick : Following are the various test for brick :

i. Dimension test, ii. Water absorption test,
iii. Compressive strength test, iv. Warpage test, and
v. Efflorescence test.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 1.12. What are the characteristics of a good brick ? Write also the ingredients with function of each.

Answer

A. Characteristics of a Good Brick :

Following are the main characteristics of good brick :

1. **Size and Shape :** The bricks should have uniform size and plane, rectangular surfaces with parallel sides and sharp straight edges.
2. **Colour :** The brick should have a uniform deep red or cherry colour as indicative of uniformity in chemical composition and thoroughness in the burning of the brick.
3. **Texture and Compactness :**

i. The surfaces should not be too smooth to cause slipping of mortar. The brick should have precompact and uniform texture.

ii. A fractured surface should not show fissures, holes grits or lumps of lime.

4. **Hardness and Soundness :**

i. The brick should be so hard that when scratched by a finger nail no impression is made.

ii. When two bricks are struck together, a metallic sound should be produced.

5. **Water Absorption :** It should not exceed 20 per cent of its dry weight when kept immerged in water for 24 hours.

6. **Crushing Strength :** It should not be less than 10 N/mm^2.

7. **Brick Earth :** It should be free from stones, kankars, organic matter, saltpetre, etc.

B. Ingredients of Brick :

Following are the constituents / ingredients of good brick earth :

1. **Alumina :**

i. It is the chief constituent of every kind of clay.

ii. A good brick earth should contain about 20 % to 30 % of alumina.

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

2. **Silica :**

i. It exists in clay either as free or combined. As free sand, it is mechanically mixed with clay and in combined form, it exists in chemical composition with alumina.

ii. A good brick earth should contain about 50 % to 60 % of silica.

iii. The presence of this constituent prevents cracking, shrinking and warping of raw bricks. It thus imparts uniform shape to the bricks.

3. **Lime :**

i. A small quantity of lime not exceeding 5 per cent is desirable in good brick earth.

ii. It should be present in a very finely powdered state because even small particles of the size of a pin-head cause flaking of the bricks.

iii. The lime prevents shrinkage of raw bricks.

iv. The sand alone is infusible. But it slightly fuses at kiln temperature in presence of lime. Such fused sand works as a hard cementing materia for brick particles.

4. **Oxide of Iron :**

i. A small quantity of oxide of iron to the extent of about 5 to 6 per cen is desirable in good brick earth.

ii. It helps as lime to fuse sand. It also imparts red colour to the bricks.

5. **Magnesia :** A small quantity of magnesia in brick earth imparts yello tint to the bricks and decreases shrinkage. But excess of magnesi leads to the decay of bricks.

Que 1.13. Discuss the manufacturing process of clay bricks and their uses. **AKTU 2014-15, Marks 05**

Answer

A. Manufacturing Process : The main operations involved are as follows :

1. **Preparation of Clay :** The clay is prepared in following order :

i. **Unsoiling :** The top layer of soil (200 mm) is taken away and thrown away due to impurities.

ii. **Digging :** Clay is then dug out from the ground. It is spread on the leveled ground, a little deeper than the general level.

iii. **Cleaning :** The clay obtained should not contain stones, pebbles, vegetable matter etc. and if it is not, the clay should be washed and screened.

iv. **Weathering :** Clay is then exposed to atmosphere for softening or mellowing.

v. **Blending :** If any ingredient is to be added to it, it is spread out at its top. Blending indicates harmonious mixing.

vi. **Tempering :** The tempering should be done exhaustively to obtain homogenous mass of clay of uniform character.

2. **Moulding :** The clay prepared above is then sent for the next operation of moulding. There are two ways of moulding :

i. **Hand Moulding :** In this method the wooden moulds or metal moulds are used with pallet boards. This method is classified as :

   a. Ground moulding.

   b. Table moulding.

ii. **Machine Moulding :** Large number of bricks can be manufactured by machine. About 2000 bricks can be moulded per day by machine.

3. **Drying :** The period of drying varies from a few hours to several days depending on the characteristics of clay, moulding and method of drying. Aim of drying is to reduce the moisture content.

4. **Burning :** It is extremely important process in determining the properties of bricks. This process can be dealt in three stages.

   i. Dehydration (400 – 650° C).

   ii. Oxidation period (650 – 900° C).

   iii. Vitrification.

B. Uses : Clay bricks are used for building-up exterior and interior walls, partitions, piers, footings and other load bearing structures.

Que 1.14. Classify bricks of various categories.

Answer

The bricks can broadly be divided into two categories as follows :

1. **Unburnt or Sun Dried Bricks :** These are dried with the help of heat received from sun after the process of moulding.
2. **Burnt Bricks :** Bricks used in construction works are burnt bricks, they are classified into four categories :

i. **First Class Bricks :** These are table moulded and of standard shape and burnt in kilns. Surfaces and edges of the bricks are sharp square and smooth. These are used for superior work.

ii. **Second Class Bricks :** These are ground moulded and burnt in kilns. The surface of bricks is somewhat rough and irregular. They may have hair cracks and nonuniform edges. Bricks are used where brickwork is to be provided with coat of plaster.

iii. **Third Class Bricks :** There are ground moulded and burnt in clamps. These bricks are not hard, they have rough and irregular edges. They are used for temporary structures.

iv. **Fourth Class Bricks :** There are over burnt bricks with irregular shape and dark colour. These are used in foundations, floors, roads, etc.

Que 1.15. Enumerate the chief characteristics of clay as material used for manufacture of bricks. **AKTU 2013-14, Marks 05**

Answer

1. Clayware is subjected to considerable stress in moulding, handling and drying, and high tensile strength.
2. Vary fine grained clays free from sand are more plastic and shrink more than those containing coarser material.
3. The shrinkage in drying is dependent upon pore space within the clay and upon the amount of mixing water.
4. Fire shrinkage is dependent upon the proportion of volatile elements, upon texture and the way that clay burns.
5. Clay is cohesive in nature.

Que 1.16. What are the various test carried out on brick to find out its suitability.

Answer

Following tests are applied to brick :

1. **Compressive Strength :**

i. Bricks to be used for different works should not have compressive strength less than that is desired.

ii. Any unevenness observed in the bed faces should be grounded first to have two smooth and parallel faces. The bricks are then immersed in water for 24 hours at normal temperature.

iii. After 24 hours bricks are drained off of surplus water, and voids should be filled with mortar of ratio 1 : 1 with maximum size of sand and should be stored under damp jute bags for 24 hours followed by immersion in clean water for 3 days.

iv. Bricks are then placed with flat faces horizontal and mortar filled face facing upward between two plywood sheets of 3 mm thickness and carefully centered between plates of testing machine.

v. Axial load is applied at a uniform rate of 14 N/mm² per minute till failure occurs. The load at failure is the maximum load.

Compressive strength of brick in N/mm²

$$= \frac{\text{Maximum load at failure in N}}{\text{Average area of the bed face in mm}^2}$$

2. **Water Absorption Test :**

i. Bricks should not absorb more water. Bricks to be tested should be dried in an oven at a temperature of 105°C to 115°C till it attains constant weight.

ii. Cool the bricks at a room temperature and weight (W_1), then immerse in clean water for 24 hours at temperature of 27 ± 2°C.

iii. Remove the bricks and wipe out and weight immediately (W_2).

$$\text{Water absorption in \% by weight} = \frac{W_2 - W_1}{W_1} \times 100$$

3. **Efflorescence Test :**

i. In brick work water moves along its pores by capillary action and carries with it dissolved salts.

ii. The solution evaporates from exposed surface of the brick work, the salts are left as white deposits on the surfaces. These white deposits of salts are known as efflorescence.

iii. The test procedure to test the efflorescence consists of dipping the ends of, brick in distilled water placed in a dish.

iv. Then this whole arrangement should be kept in a warm, well ventilated room at a temperature of 20–30°C until all the water in dish is absorbed by brick and surplus water evaporates.

v. When the water is completely absorbed and evaporated, place similar quantity of water in dish and allow it, to absorb and evaporate as before.

vi Examine the brick after this and find out the percentage of white spots to the surface area of brick.

4. Warpage Test :

i. Bricks with parallel and plain faces are desirable to keep the mortar consumption a minimum when placed in masonry.

ii. Brick with curved surfaces will consume more mortar, difficult to work, and will involve more labour cost.

iii. Warpage of the brick is measured with the help of a flat steel or glass surface and measuring ruler graduated in 0.5 mm divisions or wedge of steel 60 × 15 × 15 mm.

iv. For warpage test, the sample consists of 10 bricks from a lot.

Que 1.17. As a site engineer in which manner you will face the efflorescence problem in brick and the lime bursting problem in tiles ? Also give the solution to avoid these problems.

AKTU 2012-13, Marks 05

OR

Discuss the problem of lime bursting and efflorescence in bricks.

AKTU 2014-15, Marks 05

OR

Write the efflorescence in bricks and how will you classify the presence of efflorescence in bricks ? **AKTU 2013-14, Marks 05**

Answer

A. Lime Bursting Problem :

1. A common defect of bricks and tiles is a weakening or breaking of bricks / tiles, which is caused by the hydration of quick lime particles derived from limestone in brick / tiles making clays.
2. By mixing common salt in black cotton soils, lime bursting can be prevented, 0.5 % sodium chloride is sufficient.
3. Second method is to put all the bricks in water just after they are removed from the kiln. This process is called docking.

B. Efflorescence :

1. This defect is caused because of alkalis present in bricks. When bricks come in contact with moisture, water is absorbed by them.
2. This absorbed water dries out by evaporation from the exposed faces, and as it does so, the soluble salts it contains crystallize out on the surface. On drying grey or white powder patches appear on the brick surface.
3. The process often continues for many years depending on the quantity of salts present in the bricks and their solubility.

4. The less soluble salts, such as calcium sulphate, take much longer period to be leached out.
5. Magnesium salts are very soluble and are the most destructive.
6. Bricks which have been saturated before their placement in masonry will be more prone to efflorescence than those under dry conditions.
7. Efflorescence can be minimized by selecting proper clay materials for brick manufacturing, preventing moisture to come in contact with the masonry.
8. This can be achieved by providing waterproof coping and by using water repellent materials in mortars and by providing damp proof course.

Que 1.18. As a civil engineer which clay products you will use as the construction material in the construction site ?

AKTU 2012-13, Marks 05

Answer

Following are the different clay products used as construction material :

1. Fire clay :

i. Fire clay, also called refractory clay, is a term, loosely applied, to include those sedimentary or residual clays which vitrify at a very high temperature and which, when so burnt, possess great resistance to heat.

ii. These are pure hydrated silicates of alumina and contain a large proportion of silica 55-75 %, alumina 20-35 %, iron oxide 2-5 % with about 1 per cent of lime, magnesia and alkalis.

iii. Fire clays are capable of resisting very high temperatures up to 1700 °C without melting or softening and resist spalling.

iv. The fire clay is used for manufacturing fire bricks used in furnace linings, hollow tiles, and crucibles.

2. Terracotta :

i. It is an Italian word, Terra means clay and Cotta means burnt. Terracotta is refractory clay product and is used in ornamental parts of buildings.

ii. The clay used for its manufacture should be of superior quality and should have sufficient iron and alkaline matters.

iii. The clay is mixed with powdered glasses, pottery and sand ground to fine powder and pugged several times till it gets uniform and soft for moulding.

iv. Terracotta is impervious, hard and cheap.

3. Porcelain :

i. A high grade ceramic ware having white colour, zero water absorption and glazed surface which can be soft or hard, consists of finely dispersed

clay, kaolin, quartz and felspar, baked at high temperature and covered with a coloured or transparent glaze.

ii. Because of white colour, it is called whiteware which is of two types : soft porcelain and hard porcelain.

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

4. Stoneware :

i. A hard ceramic material resembling porcelain with a different colour, usually grey or brownish is made from refractory clay mixed with crushed pottery, stones and sand burned at high temperatures and cooled slowly.

ii. The clay used for making stoneware consists of about 75 per cent silica and 25 per cent alumina. Iron oxide is added to give colour.

iii. It is used for wash basins, water closets, drain pipes and fittings, etc.

5. Majolica :

i. It is Italian earthenware coated with opaque white enamel, ornamented with metallic colour.

ii. It is manufactured from low-heat clays to which up to 20 per cent calcium carbonate is added in the form of chalk.

iii. It is used in doorways, window casings, and facing tiles.

6. Brick :

i. Common brick is one of the oldest building materials and it is extensively used at present as a leading material of construction because of its durability, strength, reliability, low cost etc.

ii. As bricks are of uniform size, they can be properly arranged and further, as they are light in weight, no lifting appliance is required for them.

iii. The bricks do not require dressing and the art of laying bricks is so simple.

PART-4

***Gypsum** : Properties of Gypsum Plaster, Building Products made of Gypsum and their uses. **Lime** : Manufacture of Lime, Classifications of Limes, Properties of Lime.*

CONCEPT OUTLINE : PART-4

Gypsum : It is a non-hydraulic binder occurring naturally as a soft crystalline rock or sand. Pure gypsum is a white translucent crystalline mineral.

Gypsum Products : Following are the common products made from gypsum :

i. Plaster of paris, ii. Gypsum wall plaster,
iii. Hard finish plaster, iv. Gypsum plaster boards, etc.

Lime : Lime is used as a binding material in the construction of a structure. The composition of lime is CaO.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 1.19. What do you understand by gypsum ? Discuss different properties and uses of gypsum.

Answer

A. Gypsum :

1. Gypsum is one of the most important and extensively used materials. It is white crystalline substance.
2. In composition it is calcium sulphate (79.1 %) with water (20.9 %) of crystallization and it is found in the form of mineral in nature.
3. It is colorless. In presence of impurities it may be white gray, brown or reddish brown in colour.
4. Gypsum is either soluble in HCl or in water. Its specific gravity is 2.3.
5. About 90 % of gypsum produced in India is found in Rajasthan.

B. Properties : Following are the properties of gypsum :

1. It is a fire resisting material and it does not allow heat to pass easily. Thus it is used as insulating material.
2. It is light in weight.
3. It is practically not affected by bacteria.
4. It is slightly soluble in water so cannot be adopted for damp conditions and external work.
5. It sets by natural process of crystallization, hence can be applied with ease.
6. It sets with little change of volume, negligible shrinkage.
7. It shows good adhesion to the fibrous material.

C. Uses :

1. It is mainly used in the manufacturing of cement.
2. It is used to prepare gypsum board and plaster of paris.
3. It is also used as a filler material in paint.
4. It is used for ornamental plaster work and for preparation of boards and blocks.

5. The plaster of paris is used in artwork, pottery, dentistry etc.
6. It is used for making gypsum wall plaster, hard finish plaster, gypsum plaster board, etc.

Que 1.20. What are the different building products made from gypsum ? Explain briefly.

Answer

Following are the common products made from gypsum :

1. Plaster of Paris :

i. It is produced by incompletely dehydrating pure finely ground gypsum at a temperature somewhat lower than 185 °C.

ii. Most plasters approach $CaSO_4 + \frac{1}{2}H_2O$ which contains about 6.2 % of water.

iii. The setting of plaster of paris is attributed to the formation of gypsum crystals from a supersaturated aqueous solution.

iv. When substances of colloidal nature are mixed with the plaster, the formation of crystals is hindered and the time of set retarded.

v. In hardening, plaster of paris first shrinks then expands.

vi. It should be used for indoor work only and its use in structure is limited to ornamental works.

2. Gypsum Wall Plaster :

i. Gypsum wall plaster gains one half of their one month strength in a day.

ii. Gypsum and sand mortars of 1 : 1 proportions may be expected to develop 80 % of the neat strength at corresponding ages, while those of 1 : 2 proportion generally possess one half to two-third of the neat strength.

iii. The gypsum to sand neat plaster in proportion of 1 : 3 should set in 2 to 32 hours and 1.5 to 8 hours when mixed with wood fibres.

iv. The dry set density of gypsum wall plaster is 850–1040 kg/m^3, and compressive strength of 1 : 2 gypsum wall plaster is 6 to 15 N/mm^2.

v. Gypsum wall plaster are divided into four categories :
   a. Gypsum neat plaster,
   b. Gypsum wood fibre plaster,
   c. Calcined gypsum, and
   d. Gypsum ready sanded plaster.

3. Gypsum Plaster Boards :

i. It is a gypsum product made of thin layers of cardboard or wood cemented together with wall plaster and ceiling of buildings.

ii. The boards may be strengthened by incorporating fibres as fibrous gypsum plaster boards.

iii. Sisal or coconut fibres are generally used. They are very light weight and have high fire resisting properties.

iv. Gypsum plaster boards can be sawn to desired size and shape.

v. They are classified as :
   a. Gypsum wall boards.
   b. Gypsum plaster base boards.
   c. Gypsum wall boards with improved core cohesion.
   d. Gypsum plaster base boards with improved cohesion.

Que 1.21. What do you understand by term lime ? Write down its uses and characteristics.

Answer

A. Lime :

1. Lime is used as a binding material which is used in construction industry. It is very useful for preparing mortar.
2. The composition of lime is CaO. It exists in nature in combination with carbonic acid and with others.
3. It is strongly alkaline and soluble to small extent in water. Lime and quicklime are calcium oxide.
4. Various famous temples, monuments and various historical buildings were built with the lime-surki mortar.

B. Uses of Lime : Some important uses of lime are as follows :

1. For making mortar for brick and stone masonry.
2. In production of artificial stones, sand lime bricks.
3. In the manufacturing of cement, paint, glass.
4. For plastering and white washing.
5. For making lean lime concrete in foundations and flooring works.
6. Used as a refractory material, in lining of furnaces.
7. Used as lime terracing for water proofing roofs.
8. Used in sugar industry, petroleum refining, water and sewage treatment plants.

C. Characteristics of Good Lime : A good lime should have following characteristics :

1. It should slake easily in water.
2. It should be free from fuel ashes and unburnt particles.
3. It should not contain impurities, more than 5 percent.

4. It should have good setting power under water.
5. It should be insoluble in acids.
6. It should harden rapidly.

Que 1.22. Write a brief note on classification of lime.

Answer

The limes obtained by calcination of limestone are broadly classified into the following three categories :

1. Fat Lime :

i. This type of lime is known as the white lime, rich lime, pure lime, or high calcium lime.

ii. It is popularly known as the fat lime as it slakes vigorously and its volume is increased to about 2 to 2.5 times.

iii. It is 95 % CaO. The impurities are less than 5 %.

iv. This lime is used for plastering and white washing of walls, preparing lime mortar with sand.

v. With surkhi it develops lime mortar which is good setting and has hydraulic properties. Surkhi is nothing but well ground burnt bricks.

2. Hydraulic Lime :

i. This lime contains clay and some amount of ferrous oxide.

ii. Depending upon the percentage of clay the hydraulic lime is divided into following categories :

a. Feebly hydraulic lime,

b. Moderately hydraulic lime, and

c. Eminently hydraulic lime.

iii All the hydraulic limes set under water and are also known by name water lime.

3. Poor Lime :

i. This is also known as lean lime or impure lime.

ii. It slakes slowly and contains more than 30 % of clay.

iii. It has poor binding properties and its colour is muddy white.

iv. This lime makes very poor mortar which can be used for inferior type of works or at places where good lime is not available.

PART-5

***Cement :** Raw materials used,, Process of Manufacturing, Chemical Composition, Compounds Formed and their effect on strength, Types of Cement, Testing of Cement Properties, Uses of Cement.*

CONCEPT OUTLINE : PART-5

Cement : Cement is a binding material. It is differ from lime by the property that it does not slake but sets readily.

Manufacturing of cement : Cement can be produced by two process :

i. Dry process.

ii. Wet process.

Tests on Cement : Following are the various test for cement :

i. Fineness test,

ii. Setting time test,

iii. Compressive strength test, etc.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 1.23. Describe cement and the basic chemical constituent of its raw material.

Answer

A. Cement :

1. Cement is a commonly used binding material in the construction.
2. The cement is obtained by burning a mixture of calcareous (calcium) and argillaceous (clay) material at a very high temperature and then grinding the clinker so produced to a fine powder.

B. Chemical Composition of Raw Material :

1. The three constituents of hydraulic cements are lime, silica and alumina.
2. In addition, most cement contains small proportions of iron oxide, magnesia, sulphur trioxide and alkalis.
3. There has been a change in the composition of Portland cement over the years, mainly reflected in the increase in lime content and in a slight decrease in silica content.
4. An increase in lime content beyond a certain value makes it difficult to combine completely with other compounds.
5. Consequently, free lime will exist in the clinker and will result in unsound cement.
6. An increase in silica content at the expense of alumina and ferric oxide makes the cement difficult to fuse and form clinker.

7. The approximate limits of chemical composition in cement are given in Table 1.23.1.

Table 1.23.1 : Chemical composition of Portland cement

Oxide	Function	Composition (%)
CaO	Controls strength and soundness. Its deficiency reduces strength and setting time.	60 – 65
SiO_2	Give strength. Excess of it causes slow setting.	17 – 25
Al_2O_3	Responsible for quick setting, if in excess, it lowers the strength.	3 – 8
Fe_2O_3	Gives colour and helps in fusion of different ingredients.	0.5 – 6
MgO	Imparts colour and hardness. If in excess, it causes cracks in mortar and concrete and unsoundness.	0.5 – 4
$Na_2O + K_2O$ TiO_2 P_2O_5	These are residues and if they are in excess cause efflorescence and cracking.	0.5 – 1.3 0.1 – 0.4 0.1 – 0.2
SO_3	Makes cement sound.	1 – 2

Que 1.24. Write down the process of manufacturing of cement and their uses. **AKTU 2014-15, Marks 05**

Answer

A. Manufacturing of Cement : Cement can be manufactured either by dry process or wet process.

1. Dry Process :

i. The dry process is adopted when the raw materials are quite hard. The process is slow and the product is costly.

ii. Limestone and clay are ground to fine powder separately and are mixed. Water is added to make a thick paste.

iii. The cakes of this paste, which contain about 14 per cent of moisture, are dried and are charged into rotary kiln.

iv. The product obtained after calcination in rotary kiln is called clinker.

v. The clinker is obtained as a result of incipient fusion and sintering at a temperature of about 1400°-1500°C. Because ferric oxide has lower melting point than the other oxides, it acts as a flux.

vi. Aeration of cement clinker, which is commonly practiced to slake free lime, also causes absorption of some moisture and carbon dioxide.

vii. Absorption of moisture tends to decrease the setting whereas that of carbon dioxide accelerates setting.

viii. The clinker is cooled rapidly to preserve the metastable compounds and their solid solutions - dispersion of one solid in another - which are made as the clinker is heated.

ix. Clinker is then cooled and ground in tube mills where 2-3 % of gypsum is added. Generally, cement is stored in bags of 50 kg.

x. The purpose of adding gypsum is to coat the cement particles by interfering with the process of hydration of the cement particles. This retards the setting of cement.

2. Wet Process :

i. The operations in the wet process of cement manufacture are mixing, burning and grinding.

ii. The crushed raw materials are fed into ball mill and a little water is added.

iii. On operating the ball mill, the steel balls in it pulverize the raw materials which form slurry with water.

iv. This slurry is passed to silos (storage tanks), where the proportioning of the compounds is adjusted to ensure desired chemical composition.

v. The corrected slurry having about 40 per cent moisture content is then fed into rotary kiln where it loses moisture and forms into lumps or nodules.

vi. These are finally burned at 1500-1600°C. The nodules change to clinker at this temperature.

vii. Clinker is cooled and then ground in tube mills. While grinding the clinker, about 3 per cent gypsum is added.

viii. The cement is then stored in silos from where it is supplied.

B. Uses : Cement is used widely for the construction of various structures. Some of them are as follows :

1. Cement slurry is used for filling cracks in concrete structures. Cement mortar is used for masonry work, plastering and pointing.
2. Cement concrete is used for the construction of various structures like buildings, bridges, water tanks, tunnels, docks, harbours etc.
3. Cement is used to manufacture lamp posts, telephone posts, railway sleepers, piles etc.

4. For manufacturing cement pipes, garden seats, dust bins, flower pots etc., cement is commonly used.
5. It is useful for the construction of roads, footpaths, courts for various sports etc.

Que 1.25. What are the different types of Cement ? Explain in brief.

Answer

In addition to ordinary portland cement there are many varieties of cement. Important varieties are briefly explained below :

1. Quick Setting Cement :

i. Quick setting cement is produced by reducing the percentage of gypsum and adding a small amount of aluminium sulphate during the manufacture of cement.

ii. This cement starts setting within 5 minutes after adding water and becomes hard mass within 30 minutes.

iii. This cement is used to lay concrete under static or slowly running water.

2. Rapid Hardening Cement :

i. This cement can be produced by increasing lime content and burning at high temperature while manufacturing cement.

ii. Though the initial and final setting time of this cement is the same as that of Portland cement, it gains strength in early days.

iii. This property helps in earlier removal of formworks and speed in construction activity.

3. Low Heat Cement :

i. In mass concrete works like construction of dams, heat produced due to hydration of cement will not get dispersed easily. This may give rise to cracks.

ii. This cement contains low percentage (5 %) of tricalcium aluminate (C_3A) and higher percentage (46 %) of dicalcium silicate (C_2S).

4. Pozzolana Cement :

i. It can be processed from shales and certain types of clay also. In this cement pozzolana material is 10 to 30 per cent.

ii. Its tensile strength is high but compressive strength is low.

iii. It is used for mass concrete works. It is also used in sewage line works.

5. High Alumina Cement :

i. It is manufactured by calcining a mixture of lime and bauxite. It is more resistant to sulphate and acid attack.

ii. It develops almost full strength within 24 hours of adding water.

iii. It is used for under water works.

6. Blast Furnace Cement :

i. In the manufacture of pig iron, slag comes out as a waste product. By grinding clinkers of cement with about 60 to 65 per cent of slag, this cement is produced.

ii. The properties of this cement are more or less same as ordinary cement, but it is cheap, since it utilize waste product.

iii. This cement is durable but it gains the strength slowly and hence needs longer period of curing.

7. Sulphate Resistant Cement :

i. By keeping the percentage of tricalcium aluminate C_3A below five percent in ordinary cement this cement is produced.

ii. It is used in the construction of structures which are likely to be damaged by alkaline conditions.

8. Fly Ash Blended Cement :

i. Fly ash is a byproduct in thermal stations. The particles of fly ash are very minute and they fly in the air, creating air pollution problems.

ii. It is found that one of the best ways to dispose fly ash is to mix it with cement in controlled condition and derive some of the beneficiary effects on cement.

Que 1.26. What is cement ? Explain the various tests needed to be performed to ensure the suitability of cement.

AKTU 2015-16, Marks 15

OR

Describe the various tests on cement. **AKTU 2016-17, Marks 05**

Answer

A. Cement : Refer Q. 1.23, Page 1–28C, Unit-1.

B. Tests on Cement : Following are the various test needed for cement :

1. Setting Time :

i. Initial setting time and final setting time are the two important physical properties of cement.

ii. Initial setting time is the time taken by the cement from adding of water to the starting of losing its plasticity.

iii. Final setting time is the time lapsed from adding of the water to complete loss of plasticity.

iv. Vicat's apparatus is used for finding the setting times. Vicat's apparatus consists of a movable rod to which any one of the three needles can be attached.

v. Before finding initial and final setting time it is necessary to determine water to be added to get standard consistency. For this 300 gm of cement is mixed with about 30 % water and cement paste prepared is filled in the mould which rests on non porous plate.

vi. If the penetration is 5 mm to 7 mm from the bottom of the mould, then cement is having standard consistency. If not, experiment is repeated with different proportion of water fill water required for standard consistency is found.

2. Soundness Test :

i. This test is conducted to find free lime in cement, which is not desirable.

ii. Le Chatelier apparatus is used for conducting this test. It consists of a split brass mould of diameter 30 mm and height 30 mm.

iii. On either side of the split, there are two indicators, with pointed ends. The ends of indicators are 165 mm from the centre of the mould.

iv. Properly oiled Le Chatelier mould is placed on a glass plate and is filled completely with a cement paste having 0.78 times the water required for standard consistency.

v. It is then covered with another glass plate and a small weight is placed over it. Then the whole assembly is kept under water for 24 hours.

vi. The temperature of water should be between 24°C and 50°C. Note the distance between the indicators.

vii. Then place the mould again in the water and heat the assembly such that water reaches the boiling point in 30 minutes.

viii. Boil the water for one hour. The mould is removed from water and allowed to cool. The distance between the two pointers is measured.

ix. The difference between the two readings indicates the expansion of the cement due to the presence of unburnt lime. This value should not exceed 10 mm.

3. Crushing Strength Test :

i. For this 200 gm of cement is mixed with 600 gm of standards and confirming to IS 650-1966.

ii. After mixing thoroughly in dry condition for a minute distilled potable water $(P/4) + 3$ percentage is added where P is the water required for the standard consistency.

iii. They are mixed with trowel for 3 to 4 minutes to get uniform mixture.

iv. The mix is placed in a cube mould of 70.6 mm size (Area 5000 mm^2) kept on a steel plate and prodded with 25 mm standard steel rod 20 times within 8 seconds.

v. Then the mould is placed on a standard vibrating table that vibrates at a speed of 12000 ± 400 vibration per minute.

vi. A hopper is secured at the top and the remaining mortar is filled. The mould is vibrated for two minutes and hopper removed. The top is finished with a knife or with a trowel and leveled.

vii. After 24 ± 1 hour, mould is removed and cube is placed under clean water for curing.

viii. After specified period cubes are tested in compression testing machine, keeping the specimen on its level edges. Average of three cubes is reported as crushing strength.

ix. The compressive strength at the end of 3 days should not be less than 11.5 N/mm^2 and that at the end of 7 days not less than 17.5 N/mm^2.

4. Fineness Test :

i. The degree of fineness of cement is the measure of the size of the grains in it.

ii. There are three methods for testing fineness : the sieve method – using 90 micron (9 No.) sieve, the air permeability method – Nurse and Blains method and the sedimentation method – Wagner turbidimeter method.

iii. The last two methods measure the surface area, whereas the first measures grain size.

iv. Since cement grains are finer than 90 micron, the sieve analysis method does not represent true mean size of cement grains.

v. Also the tiny cement grains tend to conglomerate into lumps resulting in distortion in the final grains size distribution curves.

vi. Considering these demerits, fineness is generally expressed in terms of specific area, which is the total surface area of the particles in unit weight of material.

PART-6

***Cement Concrete :** Constituent Materials and their Properties, Grades of Concrete, Factors Affecting Strength, Properties of Concrete at Fresh and Hardened Stage, Testing of Concrete, Methods of Curing of Concrete.*

CONCEPT OUTLINE : PART-6

Cement Concrete : It is a mixture of cement, sand, aggregates and water. It can be easily moulded into durable structural members.

Production Stages of Concrete : The stages of concrete production are :

i. Batching, ii. Mixing,
iii. Transporting, iv. Placing,
v. Compacting, vi. Curing, and
vii. Finishing.

Methods of Curing : Following methods are used for curing :

i. Water curing, ii. Steam curing,
iii. Curing by infrared radiation, iv. Electrical curing, etc.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 1.27. **What do you mean by cement concrete ? Discuss properties and uses of cement concrete.**

Answer

A. Cement Concrete :

1. Cement concrete is the mixture of cement, sand, aggregates and water. It can be easily moulded into durable structural members.
2. The volume of aggregates in concrete varies from 66 to 78 percent.
3. In concrete, sand is used as a fine aggregate, gravels and crushed stones are used as coarse aggregates.
4. The cement acts as a binding material which forms a paste with water and on hardening this cement paste holds coarse and fine aggregates together to form a solid mass.

B. Properties : The cement concrete possesses the following properties;

1. The thermal expansion of concrete is approximately 0.4 mm per metre.
2. It binds rapidly with steel and as it is weak in tension, the steel reinforcement is placed in cement concrete at suitable places.
3. It has tendency to be porous.
4. It has high degree of abrasion resistance and electrical resistance.
5. It has a high compressive strength.
6. It is free from corrosion so as it has no effects of atmospheric agents on it.
7. It hardens with time and the process of hardening continues for a long time after the concrete has attained sufficient strength.

C. Uses : There are different uses of concrete :

1. Concrete is extensively used in construction of various structures such as buildings, bridges, dams, canals, barrages, reservoirs, pavements, railway sleepers, tanks, retaining walls, tall structures, under water structures, chimneys, tower, docks and harbours etc.
2. Concrete is used for construction of various architectural compositions such as vaults, domes, shells, bridges etc.
3. Concrete is also used in prestressed construction.

Que 1.28. **What is the role of functions of various ingredients of concrete ?**

OR

What are the different grades of concrete ? Also explain the major constituents of concrete.

Answer

A. Grades of Concrete : Depending upon the strength (N/mm²) of concrete cubes (150 mm side) at 28 days, concrete is classified as given in Table 1.28.1.

Table 1.28.1. Grades of Cement Concrete.

Grade	M5	M7.5	M10	M15	M20	M25	M30	M35	M40	M45	M50	M55
Characteristic Strength	5	7.5	10	15	20	25	30	35	40	45	50	55

B. Constituents : Following are the main constituents of cement concrete :

1. Cement :

i. Cement is the binding material. After addition of water it hydrates and binds aggregates and the surrounding surfaces like stone and bricks.

ii. Generally richer mix (with more cement) gives more strength.

iii. Concrete should be laid in its mould before 30 minutes of mixing of water and should not be subjected to any external forces till final setting takes place.

2. Aggregate :

i. Coarse aggregate consists of crushed stones. It should be well graded and the stones should be of igneous origin.

ii. They should be clean, sharp, angular and hard. They give mass to the concrete and prevent shrinkage of cement.

iii. Fine aggregate consists of river sand. It prevents shrinkage of cement.

iv. When surrounded by cement it gains mobility enters the voids in coarse aggregates and binding of ingredients takes place.

v. It adds density to concrete, since it fills the voids. Denser the concrete higher is its strength.

3. Water :

i. Water used for making concrete should be clean. It activates the hydration of cement and forms plastic mass. As it sets completely concrete becomes hard mass.

ii. Water gives workability to concrete which means water makes it possible to mix the concrete with ease and place it in final position. More the water better is the workability.

iii. However excess water reduces the strength of concrete. Fig. 1.28.1 shows the variation of strength of concrete with water cement ratio.

iv. To achieve required workability and at the same time good strength a water cement ratio of 0.4 to 0.45 is used, in case of machine mixing and water cement ratio of 0.5 to 0.6 is used for hand mixing.

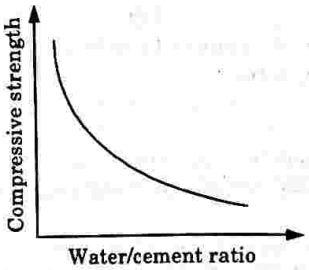


Fig. 1.28.1. Variation of strength.

Que 1.29. Describe the process of production of concrete.

AKTU 2016-17, Marks 10

Answer

The stages of concrete production are :

1. Batching or measurement of materials,
2. Mixing,
3. Transporting,
4. Placing,
5. Compacting,
6. Curing, and
7. Finishing.

1. Batching or Measurement of Materials :

i. For good quality concrete a proper and accurate quantity of all th ingredients should be used.

ii. The aggregates, cement and water should be measured with an accurac of ± 3 percent of batch quantity and the admixtures b ± 5 percent of the batch quantity.

iii. There are two prevalent methods of batching materials, the volum batching and the weigh batching.

2. Mixing :

i. The object of mixing is to make the concrete mass homogeneous an uniform in color and consistency.

ii. All the aggregate particles should have a coat of cement paste and a the ingredients of the concrete should blend into a uniform mass.

iii. The mixing is done either by hand or by machine called mixer.

3. Transporting :

i. Concrete should be transported to the place of deposition at the earlie without the loss of homogeneity obtained at the time of mixing.

ii. A maximum of 2 hours from the time of mixing is permitted if truck with agitator and 1 hour if trucks without agitators are used f transporting concrete.

iii. It should be ensured that segregation does not take place during transportation and placement.

iv. The methods adopted for transporting concrete depend upon the size and importance of the job, the distance of the deposition place from the mixing place, and the nature of the terrain.

4. Placing :

i. To achieve quality concrete it should be placed with utmost care securing the homogeneity achieved during mixing and the avoidance of segregation in transporting.

ii. A delayed placing of concrete results in a gain in ultimate compressive strength provided the concrete can be adequately compacted.

iii. For dry mixes in hot weather delay of half to one hour is allowed whereas for wet mixes in cold weather it may be several hours.

iv. The best method of placing concrete underwater is by the use of tremie pipe.

5. Compaction :

i. After concrete is placed at the desired location, the next step in the process of concrete production is its compaction.

ii. Compaction consolidates fresh concrete within the moulds or frameworks and around embedded parts and reinforcement steel.

iii. Considerable quantity of air is entrapped in concrete during its production and there is possible partial segregation also.

iv. It has been found that 5 percent voids in hardened concrete reduce the strength by over 30 percent and 10 percent voids reduce the strength by over 50 percent.

v. Therefore, the density and consequently the strength and durability of concrete largely depend upon the degree of compaction.

vi. The compaction of concrete can be achieved by the following methods :

a. Hand compaction. b. Compaction by spinning.
c. Compaction by jolting. d. Compaction by rolling.

6. Curing :

i. The process of keeping concrete damp is known as curing.

ii. The object is to prevent the loss of moisture from concrete due to evaporation or any other reason, supply additional moisture or heat and moisture to accelerate the gain of strength.

iii. Curing must be done for at least three weeks and in no case for less than ten days.

iv. Following are some of the prevalent methods of curing :

a. Water curing, b. Steam curing,
c. Electrical curing, d. Chemical curing, etc.

7. **Finishing :**

i. Concrete is basically used because of its high compressive strength. However, the finish of the ultimate product is not that pleasant.

ii. In past couple of decades efforts have been made to develop surface finishes to give a better appearance to concrete surfaces and are as follows :

a. Form work finishes, b. Surface treatments,

c. Applied finishes.

Que 1.30. What are the major factors affecting strength of concrete ?

Answer

Following are the factors which affect the strength of concrete :

1. **Gain in Strength with Age :** Concrete gains strength with age. Initially strength developed is more. However, the ratio of gain in strength diminishes with age. It is customary to assume the 28 days strength as full strength of concrete.

2. **Cement Aggregate Ratio :** Provided other factors are kept constant, cement-aggregate will greatly influence concrete strength. With an increase in cement to aggregate ratio the ultimate strength will increase to some extent.

3. **Effect of Water Cement Ratio :** The aim is generally to use the lowest water cement ratio which will give a concrete sufficiently plastic to place in position. For concrete which is to be compacted by vibrator a lower water to cement ratio may be used.

4. **Type and Size of Aggregate :**

i. The crushed stone and gravels give higher strength.

ii. A rounded spherical or cubical shaped aggregate when compacted contains less voids than an irregular and flaky aggregate of the same nominal size. Therefore, the former gives higher strength.

iii. The large aggregates have lower total surface area and require lower water to cement ratio resulting in higher strength.

5. **Degree of Compaction :** In adequate compaction leading to air void contents of 5 per cent and of 10 per cent result in a loss of strength of 30 per cent and 55 per cent, respectively.

6. **Mixing Time :** The strength of concrete increases with increase in time of mixing up to two minutes beyond which no significant improvement is observed.

7. **Curing Time :** The higher the temperature, the greater is the rate of hardening of concrete. 10 hours curing at temperatures of about 90°C, concrete may attain 70 per cent of its 28 day strength.

Que 1.31. Discuss in detail properties of both green and hardened Concrete.

Answer

Concrete has completely different properties when it is the plastic stage (green stage) and when hardened concrete.

A. Properties of Green Concrete :

1. **Workability :** This is defined as the ease with which concrete can be compacted fully without segregating and bleeding. The workability depends upon the quantity of water, grading, shape and the percentage of the aggregates present in the concrete.

2. **Segregation :** Separation of coarse particles from the green concrete is called segregation. This may happen due to lack of sufficient quantity of finer particles in concrete or due to throwing of the concrete from greater heights at the time of placing the concrete.

3. **Bleeding :** This refers to the appearance of the water along with cement particles on the surface of the freshly laid concrete. This happens when there is excessive quantity of water in the mix or due to excessive compaction.

4. **Harshness :** Harshness is the resistance offered by concrete to its surface finish. Harshness is due to presence of lesser quantity of fine aggregates, lesser cement mortar and due to use of poorly graded aggregates.

B. Properties of Hardened Concrete :

1. **Strength :** The characteristic strength of concrete is defined as the compressive strength of 150 mm size cubes after 28 days of curing below which not more than 5 per cent of the test results are expected to fail. The unit of stress used is N/mm^2.

2. **Dimensional Change :** Concrete shrinks with age. The total shrinkage depends upon the constituents of concrete, size of the member and the environmental conditions. Total shrinkage is approximately 0.0003 of original dimension.

3. **Durability :** Environmental forces such as weathering, chemical attack, heat, freezing and thawing try to destroy concrete. The period of existence of concrete without getting adversely affected by these forces is known as durability. Generally dense and strong concretes have better durability.

4. **Impermeability :** This is the resistance of concrete to the flow of water through its pores. Since the permeability reduces the durability of concrete, it should be kept very low by using low water cement ratio, dense and well graded aggregates, good compaction and continuous curing at low temperature conditions.

Que 1.32. **What are the various tests of concrete ?**

Answer

The following are some of the important tests conducted on concrete :

1. **Slump Test :**

i. This test is conducted to determine the workability of concrete. It needs a slump cone for test.

ii. Slump cone is a vessel in the shape of a frustum of a cone with diameter at bottom 200 mm and 100 mm at top and 300 mm high.

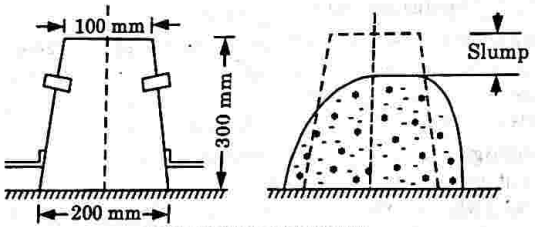


Fig. 1.32.1. Slump test.

iii. This cone is kept over a impervious platform and is filled with concrete in four layers.

iv. Each layer is stamped with a 16 mm pointed rod for 25 times. After filling completely the cone is gently pulled up.

v. The decrease in the height of the concrete is called slump. Higher the slump, more workable is the concrete.

2. **Compaction Factor Test :**

i. The test equipment consists of two hoppers and a cylinder fixed to a stand, the dimensions and the distances between the three vessels being standardized.

ii. Vessel *A* and *B* are having hinged bottoms whereas cylinder *C* is having fixed bottom. Top vessel *A* is filled with the concrete to be tested.

iii. As soon as it is filled, the hinged door is opened. Concrete is collected in vessel *B*. Then the hinged door of *B* is opened to collect concrete in cylinder *C*.

iv. The concrete in cylinder *C* is weighted. Let it be W_1. Now cylinder is again filled with the sample of concrete in 50 mm layers, which is compacted by ramming and vibrating.

v. Then the weight of compacted concrete is determined. Let this weight be W_2. The ratio W_1/W_2 is termed as compaction factor.

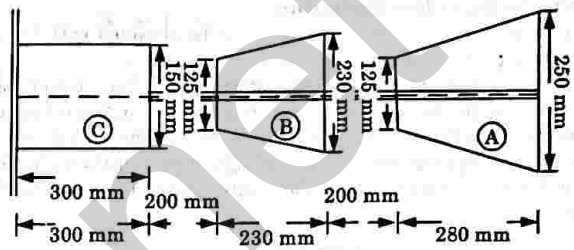


Fig. 1.32.2. Compaction factor test.

3. **Crushing Strength Test :**

i. Metallic moulds of size 150 mm × 150 mm × 150 mm are used for casting concrete cubes. Before filling mould, it is properly oiled on its inner surfaces, so that cubes can be easily separated.

ii. Fresh cube is filled with concrete to be tested in 3 layers and kept in the room.

iii. After 24 hours, cube is removed from the mould and kept under water for curing. After 28 days of curing, cubes are tested in the compression testing machine.

iv. In this test cubes are placed over the smooth surface which is in contact with side plates of mould.

v. The crushing load is noted and crushing strength is found as load divided by surface area (150 × 150 mm^2).

Que 1.33. **What are the various methods of curing concrete structure ?**

Answer

Following are some of the prevalent methods of curing :

1. **Water Curing :**

i. Is done by covering the concrete surface with gunny bags and then sprinkling water over them regularly or with water proof paper.

ii. When sprinkling of water is done at intervals, care must be taken that the concrete does not dry out between applications to prevent the possibility of crazing – the fine cracks that may occur in the surface of new concrete as it hardens.

2. **Steam Curing :**

i. Curing can be also accomplished by artificial heat while the concrete is maintained in moist condition.

ii. Both of these conditions can be fulfilled by the use of steam curing.

iii. This method of curing is also known as accelerated curing since an increased rate of strength development can be achieved.

3. **Curing by Infra Red Radiation :**

i. A much more rapid gain of strength can be obtained with the help of infra red radiation than even with steam curing.

ii. It is particularly suitable for the manufacture of hollow concrete products in which case the heaters are placed in the hollow spaces of the product.

4. **Electrical Curing :** Concrete products can be cured by passing alternating current of low voltage and high amperage through electrodes in the form of plates covering the entire area of two opposite faces of concrete.

PART-7

***Puzzolana :** Chemical Composition and Requirements for Uses, Natural and Artificial Fly Ash, Surkhi(Burnt Clay Puzzolana), Rice Husk and Ash Puzzolana, Properties and Specifications for use in Construction. **Timber :** Classification and Identification of Timber, Fundamental Engineering Properties of Timber, Defects in Timber, Factors Affecting Strength of Timber, Methods of Seasoning and Preservation of Timber. Wood Based Products.*

CONCEPT OUTLINE : PART-7

Puzzolana : It is finely ground siliceous material which by itself does not possess any cementing property but in presence of water it reacts with calcium hydroxide and form a compound of low solubility having cementation properties.

Types of Puzzolana : Following are two types of puzzolana :

i. Natural Puzzolana, ii. Artificial puzzolana.

Timber : Timber is the term which denotes wood, suitable for building or carpentry or other engineering purposes.

Defects in Timber : Following are some important defects in timber.

i. Star shakes, ii. Cup shakes, iii. Heart shakes,
iv. Bow, v. Rind galls, vi. Knots.

Seasoning of Timber : Seasoning is the process of reducing the moisture content of timber in order to prevent the timber from possible fermentation and making it suitable for use.

Wood Based Products : Following are some common wood products used :

i. Veneers and plywood, ii. Timber concrete decks,
iii. Building boards, iv. Hard boards,
v. Wood wool boards, vi. Rubber wood.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 1.34. **What is puzzolana ? Explain the various puzzolanic materials.** **AKTU 2015-16, Marks 10**

OR

Give any three types of puzzolanic materials used at the site with the help of their properties. **AKTU 2012-13, Marks 05**

Answer

A. Puzzolana : It is finely ground siliceous material which by itself does not possess any cementing property but in presence of water it reacts with calcium hydroxide *i.e.*, lime at normal conditions and form compound of low solubility having cementation properties.

Types of Puzzolana : Puzzolana occurs in two forms :

1. **Natural Puzzolana :**

i. It occurs as natural material as-volcanic tuffs, pumicite, diatomaceous earth, shales.

ii. Natural clay and shales before used are required to be calcined at about 425 °C to 1100 °C to make them active puzzolana.

2. **Artificial Puzzolana :**

i. It is produced as by products for example fly ash, slag, surkhi etc.

ii. The chemical composition and physical requirement required for a suitable puzzolana material are :

Silica + Alumina + Iron oxide > 70 %, Silica alone > 40 %, Calcium oxide < 10 %, Magnesium oxide < 3 %

B. Puzzolanic Materials : There are various types of puzzolanic materials used in construction. Some of these are as follows :

1. **Fly Ash :**

i. Fly ash is finely divided residue produced in large quantities at various thermal power plants in India.

ii. It is a puzzolana material which consists of small spheres of glassy phase of complex chemical composition.

iii. Chemical composition of Indian fly ash is :

SiO_2 – 45 to 65 %, Al_2O_3 – 20 to 30 %, Fe_2O_2 – 4 to 20 %, SO_3 – 0.2 %

Specific gravity – 2.3 to 2.8, Bulk density – 600 to 750 kg/m^3,

Loss of ignition – 0.8 to 10 %

iv. It can be used for :

a. Brick manufacture : It results in 15 % to 20 % of saving in fuel of bricks. Also it improves quality of bricks.

b. For concrete mix as replacement of cement.

c. As part replacement of cement in cement concrete.

d. It reduces the amount of air entrained by a given quantity of air entraining agent.

2. Surkhi :

i. Calcined clay puzzolana is manufactured by grinding the brick bat in the grinding mills until an impulpable powder is obtained. This puzzolona is known as surkhi.

ii. This material was very much used in India for-economic construction work.

iii. It is used only as a replacement to aggregate than that to cement in present trend for light weight construction.

iv. Surkhi is extensively used in making mortar and concrete as an adulterant for economy. But its chief function is to impart strength and hydraulic properties to mortar.

v. When mixed with cement to react with lime liberated during the setting and hardening of cement it makes, dense, compact and impermeable concrete.

3. Rice Husk Ash :

i. The combustion of agricultural residues volatises the organic matter and a silica-rich ash is produced.

ii. If rice husk is burned under suitable conditions, highly reactive black non-crystalline silica residue duration of combustion are of utmost importance for good quality rice husk ash.

iii. Rice husk ash when mixed with lime, gives black cement.

iv. Rice husk ash cement containing not more than 20 % of lime are acid resisting.

v. Rice husk ash can also be used with lime sludge obtained from sugar refineries.

vi. Rice husk ash when mixed with soil (20 %), instead of lime sludge, produces excellent binding properties.

vii. This binder when used as 30 % in mixture with portland cement gives the properties of portland puzzolana cement.

viii. Concrete produced with rice husk ash has low permeability and no bleeding at all.

Que 1.35. Explain the different types and identification of timber.

AKTU 2016-17, Marks 05

Answer

A. Types of Timber : Timber can be classified as :

1. On the Basis of its Position :

i. Standing timber implies a living tree.

ii. Rough timber forms a part of the felled tree.

iii. Converted timber or lumber are logs of timber sawn into planks, posts, etc.

2. On the Basis of Modulus of Elasticity :

The species of timber recommended for constructional purpose are classified as :

i. **Group A :** Modulus of elasticity in bending above 12.5 kN/mm^2.

ii. **Group B :** Modulus of elasticity in bending above 9.8 kN/mm^2 and below 12.5 kN/mm^2.

iii. **Group C :** Modulus of elasticity in bending above 5.6 kN/mm^2 and below 9.8 kN/mm^2.

3. On the Basis of Availability :

According to availability, timber can be of three grades, namely *X*, *Y* and *Z*.

i. *X*—Most common, 1415 m^3 or more per year.

ii. *Y*—Common, 355 m^3 to 1415 m^3 per year.

iii. *Z*—Less common, below 355 m^3 per year.

4. On the Basis of Durability :

Timbers are classified based upon durability as follows :

i. High durability—average life of 120 months and over.

ii. Moderate durability—average life of less than 120 months but of 60 months or more.

iii. Low durability—average life of less than 60 months.

5. On the Basis of Seasoning Characteristics :

Timbers are classified depending upon their behaviour to cracking and splitting during normal air-seasoning practice under three categories.

i. High refractory (Class A) are slow and difficult to season-free from defects.

ii. Moderately refractory (Class B) may be seasoned free from surface defects, etc, if some protection is given against rapid drying.

iii. Non-refractory (Class C) : These can be rapidly seasoned free and defects.

6. On the Basis of Treatability :

This classification is based upon the resistance offered by the heartwood of a species to preservatives under a working pressure of 1.05 N/mm^2 as :

i. Easily treatable.

ii. Treatable but complete preservation not easily obtained.

iii. Only partially treatable.

iv. Refractory to treatment.

v. Very refractory to treatment, penetration of preservative being practically nil from the sides and ends.

B. Identification of Timber : By seeing the specimen of wood, the identification regarding its family, genes, species, and even of its variety can be made. It is not easy to identify a wood by simply seeing its physical properties like color, odour, grains etc.

1. Colour and Lustre :

i. Wood possesses a variety of colours ranging from white to black. By appearance of colours, a possibility regarding group can be made.

ii. Lustre is also variable feature but sometimes help in distinguishing certain species.

2. Odour and Taste :

i. Odour occurs due to certain chemical deposits. It is more pronounced in heartwood than that of sapwood.

ii. Taste is closely related to odour, sugarpine derives its name from the sweet exudations found on wounds on the living trees.

3. Grain : It is applied to the adjustment of cells and tissues. These are further classified as :

i. **Coarse and Fine :** It refers to size of annual rings. If the rings are wide, wood is called coarse grained, if they are narrow called as fine grained.

ii. **Open and Close :** If a wood is having large pores, it is called open grained wood while a wood having fine pores is called as close grained wood.

iii. **Even and Uneven :** If wood shows a marked difference in the characteristics of spring wood and summer wood, the wood is said to be uneven grained. If the properties are much alike wood is called even grained.

iv. **Rough and Smooth :** A wood may be quite smooth but if it has rough appearance, it is called rough grained.

Que 1.36. Explain the different components of an exogenous tree. Also show its cross-section. **AKTU 2012-13, Marks 05**

Answer

Fig. 1.36.1 shows a cross-section of an exogenous tree in which names of all the parts have been given. The components of an exogenous tree can be explained as :

1. Pith :

i. The innermost core of the tree is called pith or medulla. It varies in size and shape for different types of trees and also with age of the tree.

ii. When the tree becomes old the pith dies up and decays and the sap is then, transmitted by the woody fibres deposited round the pith.

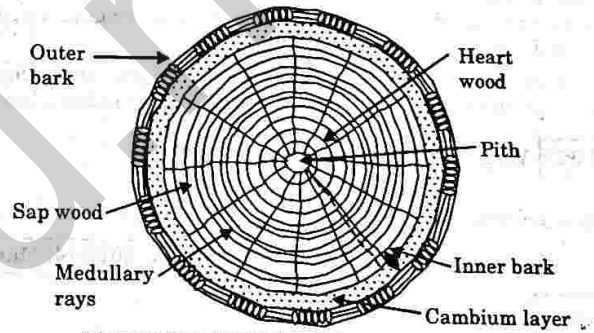


Fig. 1.36.1. Cross-section of an exogenous tree.

2. Heart Wood :

i. Dark coloured timber surrounding the pith is known as heart wood.

ii. In fact it is the dead portion of the tree and as such it does not take active part in the growth of tree. It is strong part of the timber obtained from a tree.

3. Sap Wood :

i. The part of timber lying between heart wood and cambium layer is known as the sap wood. It indicates recent growth and contains lot of sap.

ii. It takes active part in the growth of tree. Sap wood is also known as the alburnum.

4. Cambium Layers :

i. A thin layer of fresh sap lying between sap wood and the inner bark is known as the cambium layer. It is sap which has get not been converted into sap wood.

ii. If the bark is removed, the cambium layer is exposed and the cells cease to be active which result in the death of the tree.

5. Inner Bark : The layer or skin covering the cambium layer is known as the inner bark. It provides protection to the cambium layer.

6. **Outer Bark :** The outer skin of the tree is known as the outer bark. This layer may contain cracks and fissures.

7. **Medullary Rays :**

i. The thin radial fibres extending from pith to cambium layer are known as the medullary rays.

ii. The function of these rays is to hold together the annual rings of heart wood and sap wood.

8. **Annual Rings :**

i. They are the concentric circular rings formed around the pith. One such ring is added every year. Number of annual rings in the section of a tree denotes its age in years.

ii. The spacing of rings is very close in the heart wood but spacing opens more and more as we extend from pith towards cambium layer.

Que 1.37. **What are the major defects in timber ?**

OR

What are dry and wet rots ? How are they caused and prevented ?

AKTU 2013-14, Marks 05

Answer

There are number of reasons that cause defects in timber. These defects occurring in timber can be classified as follows :

1. **Defects due to Abnormal Growth :** These defect occurred during the growth of the tree itself. Following types of defects come in this category :

i. **Knot :** Knots in any timber result from cutting the tree across a branch or limbs embedded in tree. When a branch or limb of a tree is cut, it dries and it forms a knot.

ii. **Druxiness :** These are white spots occur due to assess of fungi, through a broken branch. These white spots occur as the presence of lignin and is destroyed by these fungi and the only remaining portion cellulose gives a whitish appearance. It occurs due to early decay of wood.

iii. **Rindgall :** This defect occurs due to growth of sapwood over a wounds, caused by falling branch. As a result the new growth does not write with older ones and hence leaves a cavity. The decaying action starts in the cavity. This cavity is called bark pocket and defect is known as rindgall.

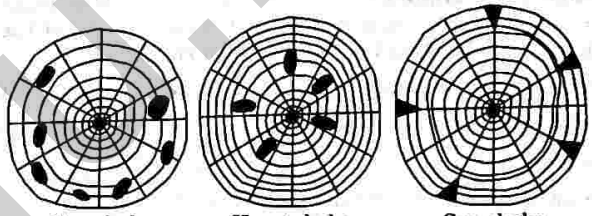
iv. **Grains :** Arrangement of grains play a very important role. The tensile strength of a timber log in the direction along the grains is 40 times than that of parallel to grains. The strength of timber reduces considerably according to the change in arrangement of grains.

2. **Defects due to Rupture of Tissues :** Due to rupture of tissues of the tree some cavities are formed in tree either along the medullary rays or along annual rings and form different shape and these defects are denoted according to their shape.

i. If this cavity forms due to excess of moisture supplied by roots it is called as cup shake or ring shake. If this defect grows in heartwood only it is called heart shake.

ii. This cavity starts from pith and extends towards sap wood and occurs due to shrinkage of inner part.

iii. A shake which start from bark and extends towards the pith along medullary rays is called as star shake.



Star shake Heart shake Cup shake

Fig. 1.37.1.

3. **Defects after Falling of Tree :**

1. **Dry Rot :**

i. It is decomposition of felled timber caused by the action of various fungi. The fungus reduces fibres to fine powder and the timber loses its strength.

ii. This disease is highly infectious and causes tremendous destruction. It occurs when the timber is imperfectly seasoned and placed in a moist, warm and confined atmosphere having no free access of air.

iii. Fungus rapidly dies when exposed to air or sunlight. The best remedy is to cut away the affected part and paint the remaining part.

2. **Wet Rot :**

i. When timber is subjected to alternate wet and dry conditions, decomposition of tissues takes place. This is not caused by fungal attack.

ii. In a living tree, it is set up by the access of water through wounds in the bark and causes the decomposition of sap and fibres of the tree.

iii. This may also occur when timber is seasoned by exposing it to moisture.

iv. To avoid wet rot, well seasoned timber is used with preservatives and paints.

4. **Defects occurring during Seasoning and Conversion of Log :**

i. The most common defect during conversion is wane which is an original rounded surface remaining on piece of converted timber.

ii. End splits which are also caused by shrinkage is an important defect occurs during conversion. Splitting and warping result from seasoning.

iii. Bowing is the permanent deflection caused by piling of the stacks of wood.

Que 1.38. What do you mean by seasoning of timber ? What are the advantages and fundamental engineering properties of timber ?

AKTU 2014-15, Marks 10

Answer

A. Seasoning of Timber : Seasoning is the process of reducing the moisture content (drying) of timber in order to prevent the timber from possible fermentation and making it suitable for use.

B. Advantages : Following are the advantages of seasoning of timber :

1. It reduces the shrinkage and warping after placement in structure.
2. It increases strength, durability and workability.
3. It reduces the timber tendency to split and decay.
4. It makes the timber suitable for painting.
5. It reduces the weight of timber.

C. Properties : As a building material timber has many valuable properties as :

1. **Density :** Strength of the timber depends largely upon density. It is always determined on air dry basis which is defined as 12 % moisture content based upon over dry weight.
2. **Moisture Content :** It changes in timber due to absorption of water by cell walls. More moisture content softens the wood and thus reduces its mechanical strength.
3. **Thermal Expansion :** Its coefficient of linear expansion is very low as compared to other metals.
4. **Heat Insulation :** Wood is a good heat insulating material being porous in structure. It increases with increase in moisture content.
5. **Electrical Conductivity :**

i. Wood is a poor conductor of electricity. Its conductivity highly depends on change in moisture content.

ii. At zero percent moisture wood is considered to be the best insulator.

Que 1.39. Explain the different methods of seasoning of timber briefly.

Answer

Following are different methods of seasoning of timber :

A. Natural Seasoning : Following are two methods of natural seasoning :

i. Air Seasoning :

a. In this method, water or the moisture is driven out from the timber by a very slow process of evaporation. In this process, the timber balks are stacked under a shed.

b. The timber balks should be kept perfectly horizontal, to avoid twisting of timber during seasoning.

c. The stack should be made on damp proof materials, preferably on cast iron, stones, concrete block etc. The stacks should be kept up from ground at least by 30 cm.

B. Artificial Seasoning : There are different methods of artificial seasoning :

i. Water Seasoning :

a. In this method, the logs are kept immersed in ponds or in running streams with the root ends upstream for three to four weeks. Maximum sap is washed out by this process.

b. The logs should be kept entirely down under water by chaining them. Now after that these logs are kept under shed for free air circulation.

c. It is a quick process but the elastic properties and strength of the wood are reduced.

ii. Mc Neills Seasoning :

a. Timber seasoned by this method is rendered harder, denser and proof against dry rot. But, it is a costly method of seasoning timber.

b. The time required varies with the nature of the timber, usually from 15 days to two months.

c. In this process, the timbers are stacked in a chamber with one-third air space and containing a large water surface to produce vapour by various hot gases as the products of combustion of fuel in the fireplace within the chamber.

iii. Hot Air Seasoning :

a. In this process, the timbers are stacked in racks in a hot chamber heated with steam pipes on the floor.

b. Within the hot chamber the timbers are subjected to a swifty moving current of air passing over the hot pipes.

c. The timbers are kept there for about three days at a constant temperature of 90 °C. The hot air absorbs sap or moisture content of the timbers.

iv. **Seasoning by Boiling in Water :**

a. Water-seasoning can be hastened by using boiling water. The timber is kept immersed in boiling water for four hours.

b. By this process the strength and elasticity of the timber is reduced although there is less shrinkage.

v. **Seasoning by Steaming :** This is similar to seasoning by boiling, but the timber dries soon after the steaming. Steaming prevents dry rot in timber, but it is expensive.

Que 1.40. **Discuss all the important wood based product.**

Answer

1. **Veneers and Plywood :**

i. Veneers are thin sheets of wood which are cut by knife edge or by sawing and are used for decorative purposes. Walnut is very suitable wood for it.

ii. Plywood in its simplest form consists of three layers of thin veneers glued together with the grains of middle ply being perpendicular to the grain of the face veneer.

2. **Timber Concrete Decks :** Concrete is sufficiently strong in compression further it is hard and can wear resistance. Wood is strong in bending. Thus by combining concrete and wood, timber concrete is constructed which can resist the properties of both.

3. **Building Boards :** Insulating boards composed of various fibres glued together and made into sheets and slabs of a considerable range of sizes and thickness. They are mainly used to provide a degree to thermal and sound insulation and to prevent condensation.

4. **Wood Wool Board :** It is a material made from wood fibres (wood wool) and cement. It is used in buildings as a cladding material for walls, in partition and as a permanent shuttering for concrete and in ceiling.

5. **Coir Waste :** About 50% of coconut husk is used in making of coir mats, ropes and cushions and remaining is used as fuel. This material has been used to produce good quality sheets with OPC.

Que 1.41. **What is plywood and where is it used with advantage ? State its uses in modern buildings.** **AKTU 2013-14, Marks 05**

Answer

A. **Plywood :**

1. A wood panel glued under pressure from an odd number of layers/plies of veneers is known as plywood.

2. These plies are heated upto 150°C and then glue is applied and pressed at a pressure about 10–12 kg/cm².
3. Due to this the glue melts and veneers stick to each other. These are then cooled.

B. **Advantages :**

1. It has good strength both along as well as across the grains.
2. The wood shrinks or swells more across the grains. Since plywood has cross-grained construction, the tendency to shrink or swell is reduced.
3. It has better splitting resistance due to the grains in adjacent veneers in cross direction as such nailing can be done very safely even near the edges.
4. Plywood can be curved into desired shapes.
5. High-grade plywood is superior to most metals in strength-to-weight ratio.

C. **Uses :** These are extensively used for partitions, ceilings, doors, concrete formwork, plywood boards, lamin boards, block boards etc.

PART-8

Asphalt, Bitumen and Tar : Terminology, Specifications and uses, Bituminous Materials.

CONCEPT OUTLINE : PART-8

Asphalt : It is a mixture of bitumen with a substantial proportion of inert mineral matter. Bitumen is the binding material in asphalt.

Bitumen : It is the product obtained by the fractional distillation of crude petroleum as an end product. It becomes soft at moderate temperatures.

Tar : It is a dark viscous liquid produced by destructive distillation of organic material such as coal, oil, lignite and wood.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 1.42. **What do you mean by asphalt ? Discuss it types and uses.**

Answer

A. **Asphalt :** It is defined as a mixture of bitumen with a substantial proportion of inert mineral matter. Bitumen is the binding material in asphalt.

B. **Types of Asphalt :** Following are the common types of asphalt :

1. **Natural Asphalt :** It occurs as fossil deposits in places at depths of 3 to 60 m. It contains 40 to 70 % pure bitumen with about 30 % water content.
2. **Residual Asphalt :** It is obtained from distillation of petroleum oil with an aspheric base. The residue left will also be asphalt.
3. **Mastic Asphalt :** It is prepared by mixing the required mineral filler (like limestone dust, sand or grit and coarse aggregate) with black bitumen heated to a liquid form. On cooling it consolidates to a hard elastic block.
4. **Asphaltic Cement :** It is bitumen or asphalt or their blend with flux oils having adhesive qualities suitable for making mastic asphalt.

C. **Uses of Asphalt :** Asphalt is used in buildings for the following works :

i. Roof covering, flashing, water proofing of roofs.
ii. Damp proof courses.
iii. Flooring material.
iv. Tanking of basement floors (building water barriers in basements).

Que 1.43. What is bitumen ? Describe also its forms and uses.

Answer

A. **Bitumen :** It is the product obtained by fractional distillation of crude petroleum as an end product. Bitumen becomes soft at moderate temperatures.

B. **Forms of Bitumen :** It is available in the following forms :

1. **Straight Run Bitumen :** It does not require further treatment.
2. **Penetration Grade :** It is the basic form of bitumen.
3. **Cutback Bitumen :** Bitumen combined with petroleum distillates.
4. **Bitumen Emulsion :** Product in liquid form.
5. **Plastic Bitumen :** Consists of bitumen thinner and into plastic form.
6. **Residual Bitumen :** Solid substance at normal temperature.

C. **Uses :** There are many uses of bituminous materials in civil engineering work. Some of them are as follows here :

1. **For Paints :** Industrial blown or R grade bitumen is mainly used for manufacturing of bituminous paints and other surface treatments.

2. **Roofing :** Roofing felts and coverings of roof are made of fibres and coated with blown-grade bitumen.
3. **Damp Proofing :** Prefabricated mats sprayed with blown bitumen are used for damp proofing.
4. **Tanking of Basement :** Used for water proofing of basement.
5. **Protection of Structures :** Used as protective coating for concrete elements.
6. **Pavements :** Used for construction of roads, run ways etc.
7. **Preservation of Stones :** Used for preservation of stonework from attack by salts and other substances present in the ground.

Que 1.44. Classify the different types of fine grades of road tar as per the Indian Standard Code IS : 215 – 1961.

AKTU 2012-13, Marks 05

OR

Discuss in brief about tar and its types.

Answer

A. **Tar :**

It is dark (deep black) viscous liquid produced by destructive distillation of organic material such as coal, oil, lignite and wood. Tar is restraint to petroleum-based solvents.

B. **Types of Tar :** Following are different types of tar :

1. **Coal Tar :** It is obtained by heating coal in closed iron vessels to form coke. On condensation of the escaping gases we get coal tar is produced. It is used for roads.
2. **Wood Tar :** It obtained by distillation of pine wood. It repels termites if applied on wooden posts buried in the ground.
3. **Mineral Tar :** It is obtained by distilling bituminous shales. It has less volatile matter than the wood tar. It is also used as water proofing paint.

C. **Grades of Road Tar :** Following are five grades of road tars :

1. **RT-1 :** For surface painting under exceptionally cold weather conditions, hill roads at very high elevations.
2. **RT-2 :** For standard surface painting under normal climatic conditions.
3. **RT-3 :** For surface painting and renewal coats and is also used for premixing chips in top courses.
4. **RT-4 :** For premixing tar macadam (base course).
5. **RT-5 :** For grouting.

VERY IMPORTANT QUESTIONS

Following questions are very important. These questions may be asked in your SESSIONALS as well as UNIVERSITY EXAMINATION.

Q. 1. What are the factors influencing the choice of a building material ?

Ans: Refer Q. 1.3, Unit-1.

Q. 2. Explain the different characteristics of a building stone and their method of testing.

Ans: Refer Q. 1.8 and Q. 1.9, Unit-1.

Q. 3. What are the characteristics of a good brick ? Write also the ingredients with function of each.

Ans: Refer Q. 1.12, Unit-1.

Q. 4. What are efflorescence and lime bursting problems in brick ? What are the causes and remedies of these problems ?

Ans: Refer Q. 1.17, Unit-1.

Q. 5. What do you understand by gypsum ? Discuss different properties and uses of gypsum.

Ans: Refer Q. 1.19, Unit-1.

Q. 6. What is cement ? Explain the various test needed to be performed to ensure the suitability of cement.

Ans: Refer Q. 1.26, Unit-1.

Q. 7. What are the constituent materials and properties of cement concrete ? Also discuss the methods of curing of cement concrete.

Ans: Refer Q. 1.28, Q. 1.31, and Q. 1.33, Unit-1.

Q. 8. What is puzzolana ? Explain the various puzzolanic materials.

Ans: Refer Q. 1.34, Unit-1.

Q. 9. What are the major defects in timber ? Also explain the engineering properties of timber.

Ans: Refer Q. 1.37 and Q. 1.38, Unit-1.

Q. 10. What is plywood ? Discuss its advantages and uses in modern buildings.

Ans: Refer Q. 1.41, Unit-1.

Q. 11. What is bitumen ? Describe its forms and uses.

Ans: Refer Q. 1.43, Unit-1.

Q. 12. Discuss in brief about tar and its types.

Ans: Refer Q. 1.44, Unit-1.

2 UNIT

Plastic Manufacturing Process

PART-1

Chemistry of Plastics Manufacturing Process : Classification, Advantages of Plastics, Mechanical Properties and Use of Plastic in Construction, Paints.

CONCEPT OUTLINE : PART-1

Plastic : It may be defined as a natural or synthetic organic material which has the property of being plastic at some stage of their manufacture.

Types of Plastic : Following are two types of plastic :

i. Thermosetting plastics, ii. Thermoplastics.

Paints : The paints are coatings of fluid materials and they are applied over the surfaces of timber and metals.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 2.1. What do you mean by plastic ? What are the basic constituents of plastic ?

Answer

A. Plastic :

1. Plastic is an organic material prepared out of resin. It may or may not contain fillers, plasticizers and solvents.
2. Plastic may be defined as a natural or synthetic organic material which has the property of being plastic at some stage of their manufacture when they can be moulded to required size and shape.
3. Shellac and bitumen are the natural resins used as plastic for a long time. In 1907, Blackland produced synthetic resin from the reaction of phenol and formaldehyde.
4. The resin was hardened under pressure and heated to produce useful plastic articles.

B. Constituents of Plastic :

The constituents of plastic are resin, plasticizer, filler, pigment and dye, lubricant and catalyst.

1. **Resin :** It acts as binder for holding different constituents together. Thermosetting resins are usually supplied as linear polymer of a comparatively low molecular weight being fusible and mouldable.

2. **Plasticizer :**

i. It modifies plastic to impart desirable combination of strength, flexibility and toughness.

ii. Plasticizers, which are mostly liquids, are usually organic compounds or resins possessing very low vapour pressure.

iii. Plasticizer is supposed to neutralize a part of the intermolecular force of attraction between macromolecules of resins.

iv. Some of the examples of plasticizers are vegetable oils (non-drying type), camphor, esters of stearic and oleic acids, tricresyl phosphate, tributyl phosphate, tetrabutyl phosphate and triphenyl phosphate.

3. **Filler :**

i. It is added up to 50 per cent of the moulding mixture to increase the hardness, tensile strength, bond, opacity, finish and workability besides reducing the cost, shrinkage on setting, and brittleness of the final product.

ii. Some of the fillers are wood flour, asbestos fibres, mica, diatomaceous earth, saw dust, ground cork, paper pulp, corn husk, carbon black, cotton fibre, metallic oxides, metal powder (Al, Cu, Pb).

iii. Carbon and graphite impart chemical resistance and also serve as internal lubricants.

4. **Pigment :** It is added to achieve desired colour of the plastic and should be resistant to the action of sunlight.

5. **Lubricant :** It is used to make the moulding of plastic easier to prevent sticking of materials to the mould for a flawless finish. The examples are stearates, oleates and soaps.

6. **Catalyst :** It is added only in the case of thermosetting plastics to accelerate the polymerization of fusible resin during moulding operation into cross-linked infusible form.

7. **Blowing Agent :** Sodium bicarbonate and ammonium carbonate are sometimes added to plastics to produce porous articles.

Que 2.2. **How are plastics classified ? State the role of plastic as a building material.** **AKTU 2013-14, Marks 05**

Answer

A. **Classification of Plastics :** Primarily there are two types of plastics :

1. **Thermosetting Plastics :**

i. It needs momentary heated condition and great pressure during shaping.

ii. When heated cross linkage is established between the molecules and chemical reaction takes place.

iii. During this stage shape can be changed with pressure. This change is not reversible.

iv. The scrap of such plastic is not reusable.

v. Bakelite is an example of such plastic.

2. **Thermoplastic :**

i. In this variety, the linkage between the molecules is very loose.

ii. They can be softened by heating repeatedly.

iii. This property helps for reuse of waste plastic. These plastics need time to cool down and harden.

iv. These plastics are to be kept in moulds till cooling takes place completely.

v. Bitumen, cellulose and shellac are the examples of this variety of plastics.

B. **Role of Plastic :**

Following are the uses of plastic as a building material :

1. Corrugated and plain sheets for roofing.
2. For making jointless flooring.
3. Flooring tiles, and overhead water tanks.
4. Bath and sink units, cistern hall floats.
5. Decorative laminates and mouldings.
6. Window and door frames and shutters for bathroom doors.
7. Lighting fixtures, electrical conduits, electrical insulators.
8. Pipes to carry cold water.

Que 2.3. **What are the mechanical and physical properties of plastics ?** **AKTU 2012-13, Marks 05**

Answer

A. **Mechanical Properties :**

Following are the mechanical properties of plastics :

1. **Strength :** They have low tensile strength. Their strength in compression is better than in tension. Tensile strength of thermoplasts generally ranges between 15 to 90 MPa.
2. **High Temperature Suitability :** They have low melting point, therefore are unsuitable for high temperature usage, generally above 100°C.
3. **Dimensional Stability :** It is poor due to creep effect at room temperature. At higher temperatures, this is poorer due to softening in them.
4. **Weather Effect :** They are susceptible to weather conditions. They suffer from distortions in moist conditions, and are highly affected by chemical (acidic and alkaline) environments.

5. **Impact Strength :** It is low which further decreases at higher temperatures due to softening.
6. **Thermal and Electrical Conductivity :** They are poor conductors of heat and electricity. Therefore, they are used as insulators also.

B. Physical Properties :

Plastics have the following physical properties :

1. **Colour :** Some plastics are completely transparent. Using pigments, plastics of any attractive colour can be produced.
2. **Durability :** Plastic offer great resistance to moisture and chemicals and hence are more durable.
3. **Fire Resistance :** The phenol-formaldehyde and urea-formaldehyde plastics resist fire to a great extent and hence they are used as fire proofing materials.
4. **Specific Gravity :** The specific gravity of plastics is very low and hence convenient to handle.
5. **Ductility :** The plastics are not ductile and hence they fail without giving warning.
6. **Fixing :** Plastics can be bolted, drilled, glued, clamped or simply push fitted in position.
7. **Light Weight :** The density of plastic is usually between 0.8-2.2 gm/cm^3. This not only allows it to lessen the labor intensity, but also to reduce the dead weight of the building.

Que 2.4. Explain the desirable properties and types of paints.

Answer

A. Desirable Properties : Following are the properties of paint :

1. It should be possible to apply easily and freely.
2. It should dry in reasonable time.
3. It should form hard and durable surface.
4. It should not be harmful to the health of workers.
5. It should not be easily affected by atmosphere.
6. It should possess attractive and pleasing appearance.
7. It should form a thin film of uniform nature *i.e.*, it should not crack.
8. It should possess good spreading power.
9. It should be cheap.

B. Types of Paints : Following are the commonly used paints :

1. **Oil Paint :**

i. These paints are applied in three coats—primer, undercoat and finishing coat.

ii. This paint is cheap and easy to apply.

2. **Enamel Paint :**

i. It contains white lead, oil, petroleum spirit and resinous material.

ii. The surface provided by it resists acids, alkalis and water very well.

3. **Emulsion Paint :**

i. It contains binding materials such as polyvinyl acetate, synthetic resins etc.

ii. It dries in 1 to 2 hours and it is easy to apply.

iii. It is more durable and can be cleaned with water.

4. **Cement Paint :**

i. It is available in powder form. It consists of white cement, pigment and other additives.

ii. It is durable and exhibits excellent decorative appearance.

5. **Bituminous Paint :**

i. This type of paint is manufactured by dissolving asphalt or vegetable bitumen in oil or petroleum.

ii. It is used for painting iron works under water.

6. **Synthetic Rubber Paint :**

i. This paint is prepared from resins. It dries quickly and is little affected by weather and sunlight.

ii. It resists chemical attack very well.

7. **Aluminium Paint :**

i. It contains finely ground aluminium in spirit or oil varnish.

ii. It is widely used for painting gas tanks, water pipes and oil tanks.

8. **Anti-corrosive Paint :**

i. It consists essentially of oil, a strong dier, lead or zinc chromate and finely ground sand.

ii. It is cheap as well as resists corrosion. It is black in colour.

Que 2.5. Show the role of various ingredients of all the paints with the help of their different properties.

AKTU 2012-13, Marks 05

OR

Discuss in detail essential constituents of paints. Give examples.

AKTU 2016-17, Marks 10

Answer

The essential constituents of paints are as follows :

1. Bases :

i. It is a principal constituent of paint. It also possesses the binding properties and forms an opaque coating.

ii. Commonly used bases for paints are white lead, red lead, zinc oxide, iron oxide, titanium, white aluminium powder and lithopone.

iii. A lead paint is suitable for painting iron and steel works, as it sticks to them well. However it is affected by atmosphere action and hence should not be used as final coat.

2. Vehicles :

i. The vehicles are the liquid substances which hold the ingredients of paint in liquid suspension and allow them to be applied on the surface to be painted.

ii. Linseed oil, tung oil and nut oil are used as vehicles in paints. Of the above three oils, linseed oil is very commonly used as vehicles.

iii. Boiling makes the oil thicker and darker.

iv. Linseed oil reacts with oxygen and hardens by forming a thin film.

3. Pigment :

i. Pigments give required colour for paints. They are fine particles and have a reinforcing effect on thin film of the paint.

ii. They protect the paint film by reflecting the destructive ultra violet light which acts as a catalytic agent for the destructive oxidation of the film.

iii. They also improve the impermeability of the paint film.

4. Drier :

i. These are the compounds of metal like lead, manganese, cobalt.

ii. The function of a drier is to absorb oxygen from the air and supply it to the vehicle for hardening.

iii. The drier should not be added until the paint is about to be used.

iv. The excess drier is harmful because it destroys elasticity and causes flaking.

5. Thinner :

i. It is known as solvent also. It makes paint thinner and hence increases the coverage.

ii. It helps in spreading paint uniformly over the surface. Turpentine and naphtha are commonly used thinners.

iii. After paint applied, thinner evaporates and paint dries.

Que 2.6. Write a short note on cement based paints.

Answer

1. White or coloured Portland cement with (OPC minimum 65 per cent) forms the base. They are thinned with water during application.

2. Proper curing is necessary for strength and durability.
3. Cement paints are durable, strong and display better water-proofing qualities and are used on exterior surfaces of buildings.
4. Mixed with boiled linseed oil, they are also used over corrugated iron sheets.
5. To get good results, an aqueous solution of sodium silicate and zinc sulphate is applied as primary coat on the surface to be painted.

PART-2

Varnishes and Distempers : Common Constituents, types and Desirable Properties, Cement Paints.

CONCEPT OUTLINE : PART-2

Varnish : It is the solution of resins or resinous substances like amber, copal, shellac, gum resin etc., in solvents like oil, turpentine, alcohol etc.

Types of Varnish : Following are the different types of varnish :

i. Oil varnish, ii. Spar varnish,
iii. Flat varnish, iv. Spirit varnish,
v. Asphalt varnish, and vi. Water varnish.

Distemper : Distemper is made with base as white chalk and thinner as water. It is used to create the smooth surfaces.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 2.7. What are varnishes ? Discuss its common constituents.

AKTU 2015-16, Marks 10

OR

Write down the desirable characteristics, objectives and uses of varnish.

Answer

A. Varnish :

1. Varnish is the solution of resins or resinous substances like amber, copal, shellac, gum resin etc., in solvents like oil, turpentine, alcohol etc.
2. Depending upon the solvents used varnishes are classified as, oil varnishes, turpentine varnishes, spirit varnishes and water varnishes.

3. The desirable characteristics of an ideal varnish are :
   i. It should render the surface glossy.
   ii. It should dry rapidly and present a finished surface which is uniform in nature and pleasing in appearance.
   iii. The colour of varnish should not fade away when the surface is exposed to atmospheric actions.
   iv. The protecting film developed by varnish should be tough, hard and durable.
   v. It should not shrink or show cracks after drying.
4. It is commonly used on wooden surfaces. Varnishes provide a protected coating and gloss to the surface and intensify the wood grains.
5. The objectives of varnishing a surface are to :
   i. Brighten the appearance of the grain in wood.
   ii. Render brilliancy to the painted surface.
   iii. Protect painted surface from atmospheric actions.

B. Constituents of Varnish : A varnish has the following essential ingredients :

1. Resins or Resinous Substances :
   i. The quality of varnish depends largely on the type of resin used.
   ii. Various types of resins in use are copal, lac or shellac, resin, amber, mastic, gum dammer etc.
   iii. Copal is a hard and lustrous resin obtained from ground where pine tree existed in past.

2. Solvents :
   i. Different types of solvents are available, but each is used only in conjunction with some specific resin.
   ii. The following table gives the solvents for different resins :

S.No.	Types of Solvent	Type of Resin
1.	Boiled linseed oil	Amber, copal
2.	Methylated spirit of wine	Lac or shellac
3.	Turpentine	Mastic, gum dammer, resin
4.	Wood naphtha	Raw copal and other cheap varieties of resin.

3. Driers :
   i. These accelerate the process of drying of a varnish.
   ii. Common driers used in varnishes are litharge, white copper and lead acetate.

Que 2.8. What are the different types of varnishes ?

Answer

Varnishes are classified as oil, spar, flat, spirit and asphalt varnishes.

1. Oil Varnish :
   i. It uses linseed oil and takes about 24 hours to dry. Hard resins such as amber and copal are dissolved in linseed oil.
   ii. If the varnish is found unworkable, a small amount of turpentine oil may be added.
   iii. It is suitable both for internal and external work.

2. Spar Varnish :
   i. It derives its name from its use on spars and other parts of ships.
   ii. It gives sticky effect in warm weather and is not used indoors.

3. Flat Varnish : Materials such as wax, metallic soap or finely divided silica when added to varnish produce a dull appearance on drying and are known as flat varnish.

4. Spirit Varnish :
   i. This is resins of soft variety such as lac or shellac dissolved in spirit. The examples are French polish, lacquer and shellac varnish.
   ii. It dries very quickly. These are not durable and are easily affected by weathering action.

5. Asphalt Varnish :
   i. It is made by dissolving melted hard asphalt in linseed oil with a thinner such as turpentine or petroleum spirit.
   ii. It is used over shop fabricated steel works.

6. Water Varnish :
   i. This is shellac dissolved in hot water to which enough quantity of either ammonia or borax or soda or potash is added.
   ii. These are used for varnishing maps and pictures.

Que 2.9. Briefly discuss the method of varnishing.

Answer

Varnish is applied as under :

1. Preparation of surface : The wood work is made smooth by rubbing it with sand paper and the surface is cleaned.

2. **Knotting :** This is the process of covering the knots in the wood work, using any of the following methods.

i. **Size Knotting :** A coat of red lead ground in water mixed with glue size is applied. After it dries, another coat of red lead ground in oil and thinned by boiled turpentine oil is applied.

ii. **Patent Knotting :** Two coats of varnish prepared by dissolving shellac in methylated spirit or wine, are used.

3. **Stopping :** The surface of the wood work is then rubbed again and cleaned. Before rubbing, the surface is applied with size of hot, weak glue.

4. **Varnish Coat :** Varnish is then applied in two coats. The second coat is applied after the first has dried.

Que 2.10. **Write a note on distempers and its properties.**

Answer

A. Distemper :

1. Distemper is made with base as white chalk and thinner as water. Some colouring pigments and glue are also added.
2. They are available in powder and paste forms and are substantially cheaper than paints.
3. They are most suitable for plastered surfaces as well as white washed surfaces of interior walls.
4. Oil bound washable distemper, washable oil free distemper, and non-washable distemper or emulsion paints are some of the types of distemper.

B. Properties of Distemper :

1. They are generally light in colour.
2. The coatings are generally thick.
3. They give reflective coating.
4. They are less durable than oil paints but are cheaper.
5. The coatings are thick and more brittle compared to paints.
6. They are workable and easy in application.
7. The film being porous can be applied on even newly plastered surface.

Que 2.11. **Distinguish between varnishes and distempers.**

AKTU 2016-17, Marks 05

Answer

S.No.	Varnish	Distemper
1.	Varnish is nearly homogeneous solution of resin in oil, alcohol or turpentine.	These are water paints made with base as white chalk and thinner as water.
2.	Varnishes are classified as oil, spar, flat, spirit and asphalt varnishes.	These are available in powder form or paste form.
3.	These are more durable.	These are less durable.
4.	These are more costly.	These are cheaper than varnishes.
5.	It does not shrink or shows cracks after drying.	These generally shrink on drying.
6.	The protecting film developed by varnish should be tough, hard and durable.	The film being porous can be applied on even newly plastered surface.

PART-3

***Ferrous Metals** : Desirable Characteristics of Reinforcing Steel, Principles of Cold Working, Reinforcings Telemechanical and Physical Properties, Chemical Composition, Brief Discussion on Properties and uses of Aluminum and Lead.*

CONCEPT OUTLINE : PART-3

Ferrous Metals : A ferrous material is the one in which iron is a main constituent.

Common Iron Products : Following three products are widely used :

i. Cast iron, ii. Wrought iron, and
iii. Steel.

Cold Working : Cold working is the process that steel is processed at the room temperature. The common cold working modes for construction steel includes : cold stretching, cold drawing, cold rolling, cold twisting and notching.

Non Ferrous Metals : Following are the non ferrous metals :

i. Aluminium, ii. Copper,
iii. Zinc, iv. Lead, etc.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 2.12. **Explain the properties and characteristic of reinforcing steel.**

AKTU 2014-15, Marks 05

OR

Discuss about desirable characteristics of reinforcing steel.

AKTU 2016-17, Marks 05

Answer

A. Properties : Important properties of different steel are as follows :

1. Properties of Mild Steel :

i. It is malleable and ductile.

ii. It is more elastic.

iii. It can be magnetized permanently.

iv. Its specific gravity is 7.8.

v. Its Young's modulus is 2.1×10^5 N/mm^2.

2. Properties of Carbon Steel :

i. It is tougher and elastic compared to mild steel.

ii. Welding is difficult.

iii. It can be magnetized permanently.

iv. It is stronger in compression than in tension.

v. It withstands shocks and vibrations better.

3. Properties of High Tensile Steel :

i. It contains 0.8 % carbon and 0.6 % manganese.

ii. The strength of this steel is quite high.

iii. High tensile steel wires are used in prestressed concrete works.

B. Characteristics :

1. Good steel should not have carbon content of more than 0.25 %, sulphur content of more than 0.05 % and phosphorus content of more than 0.05 %.

2. Effectiveness of concrete reinforcement may be enhanced by the use of low-alloy steel, or by mechanical strengthening, or by heat treatment.

3. Mechanical strengthening of steel is done by drawing, stretching, twisting; the yield point of steel rises by about 30 %.

4. Heat treatment increases strength and improves mechanical properties of steel and affects 30 to 40 % savings on reinforcement.

Que 2.13. **Discuss about cold working.**

Answer

1. Cold working is the process that steel is processed at the room temperature.

2. The common cold working modes for construction steel includes : cold stretching, cold drawing, cold rolling, cold twisting, notching.

3. At the room temperature, beyond the elastic range of the steel, the plastic deformation strength and rigidity of the steel have increased and its plasticity and toughness have decreased, which is called cold-working strengthening.

4. As shown in Fig. 2.13.1, the stress-strain curve of steel is *OBKCD* ; if the steel is stretched to point *K* and release the tension, the steel will recover to point *O'* ; and if it is stretched again, the stress-strain curve will be *O'KCD* , and the new yield point (*K*) is higher than the original yield point (*B*), but the elongation decreases.

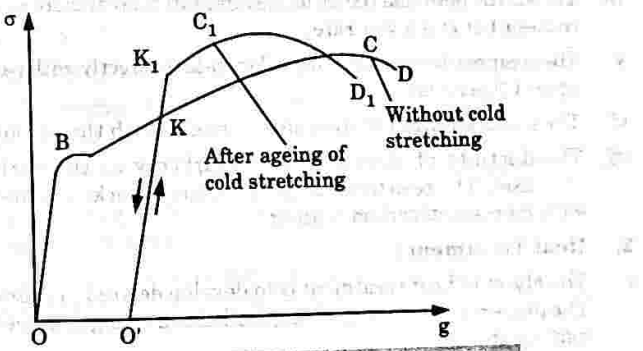


Fig. 2.13.1. The curve of cold stretching of steel bar.

5. Within a certain range, the bigger the cold-working deformation is the greater the yield strength increases, and more the plasticity and the toughness decreases.

6. Cold working increases the yield stress of mild steel. Higher yield strength of reinforcing steel bars lowers the steel requirement and thus the cost of reinforcement and its fixing is reduced.

7. The major drawback of cold working is the introduction of internal stresses in steel bars.

8. Some of the other disadvantages of cold working are reduced ductility of steel, and reduced shear strength of RCC beams; the longitudinal tensile reinforcement is reduced.

9. Heating of cold worked steel to high temperatures results in annealing of steel causing loss of increased strength due to cold working.

Que 2.14. Give the details of any two factors which greatly influenced the physical properties like ductility, elasticity and tensile strength of the reinforcing steel. AKTU 2012-13, Marks 05

Answer

The factors influencing the properties of steel are chemical composition, heat treatment, and mechanical work.

1. Chemical Composition :

i. The presence of carbon in steel gives high degree of hardness and strength.

ii. The addition of carbon to iron decreases the malleability and ductility of the metal, and reduces its permeability to magnetic forces.

iii. The tensile strength of hot rolled steel bars is maximum between 1.0 and 1.2 per cent carbon.

iv. The elastic limit and the ultimate strength of steel increase with carbon content but at a lower rate.

v. The compressive strength of steel increases directly with carbon content up to 1.0 per cent.

vi. The shear strength of steel also increases with the carbon content.

vii. The ductility of steel decreases markedly as the carbon content increases. The resistance of steel to heavy shocks or blows decreases with increase of carbon content.

2. Heat Treatment :

i. The object of heat treatment is to develop desired properties in steel. The properties of steel can be controlled and changed as well by various heat treatments.

ii. A steel of given composition may be made soft, ductile and tough by one heat treatment, and the same steel may be made relatively hard and strong by another.

iii. Heat treatment affects the nature, amount, and character of the metallographic properties.

iv. Heat treatment influences the solubility relations of the constituents, changes the crystallization either with respect to form or degree of aggregation and introduces or relieves internal stresses in the metal.

Que 2.15. Describe the properties and uses of any two non-ferrous metals. Describe also their alloys and uses.

AKTU 2013-14, Marks 05

OR

'Aluminium' is widely used for the construction work. Give its utility with the help of their properties. AKTU 2012-13, Marks 05

Answer

There are following two non-ferrous metals :

A. Aluminium :

1. Properties of Aluminium :

i. It has silver colour and bright luster.

ii. It is very light in weight.

iii. It is good conductor of electricity.

iv. It has very good resistance to corrosion.

v. It melts at 66°C.

vi. It is highly ductile and malleable.

2. Uses of Aluminium :

i. It is used to make door and window frames.

ii. Aluminium structural members are becoming popular.

iii. Aluminium wires are used as conductors of electricity.

iv. It is used as a foil.

v. Aluminium powder serves as pigments in paints.

3. Alloys : Following are the aluminium alloys :

i. Magnalium :

a. Magnalium is an alloy of aluminium and magnesium (6 percent).

b. It has got very good mechanical properties and is a little lighter than pure aluminium.

c. It is easy to work, exceptionally strong, and ductile and is widely used as deoxidizers in copper smelting operations.

ii. Aldural : When a coating of aluminium is given to duralumin it is known as aldural and has better corrosion resisting properties.

iii. Y-Alloy :

a. It invented during World War II contains 4 percent copper, 20 percent nickel and 1.5 percent magnesium.

b. Toughness and hardness are achieved by heating it to 500° C for six hours and then cooling it down in boiled water.

c. Its relative density is 2.80 and resists corrosion better than duralumin.

d. Y-alloy has good thermal conductivity and can sustain high temperature.

e. It is used for making pistons of IC engines, cylinder head, connecting rod and propeller blades.

B. Lead :

1. Properties of Lead :

i. Pure lead can be scratched even with finger nail, highly malleable and can be rolled, into thin foils.

ii. It has a blue grey colour and dull metallic luster when freshly fractured.

iii. When exposed to moist air it loses luster due to oxidation.

iv. Its relative density is 11.34 and melting temperature is 327° C.

2. Uses : It use in paints as base, lead pipes and joints in sanitary fittings and in batteries.

3. Alloys : Some of the important lead alloys are as follows :

i. Lead Antimony Alloy :

a. It is also known as high lead alloy made by alloying 15-20 % antimony with lead.

b. The antimony serves as hardener and the alloy so produced is used for making bearings.

c. Lead antimony tin alloys containing 10-20 % antimony, 5-20 % tin and the remainder lead are used for bearings subjected to moderate loads.

d. Magnolia metal is one of the common bearing metals of this class.

ii. Lead Tin Alloy :

a. These are used in making solder and toys.

b. By adding tin to lead the strength and hardness are considerably increased.

c. The alloy carrying more than 50 percent lead remains pasty over a considerable range of temperature before solidifying.

d. It is suitable for plumbers solder.

e. Additions of tin to lead increase the strength and hardness.

iii. Fusible Alloy :

a. A wide variety of compositions are used to obtain alloys that melt at specific low temperatures.

b. These are frequently binary or ternary alloys of lead, tin, bismuth, and cadmium,

c. Considerable use of these alloys is made in automatic sprinkles systems, fire alarm and safety devices to prevent overheating.

Que 2.16. Explain the three commercial form of iron products.

AKTU 2015-16, Marks 10

Answer

A ferrous material is the one in which iron is a main constituent. Iron ore is first converted into pig iron and then pig iron is subjected to various metallurgical processes to mix different percentage of carbon and to get the following three useful ferrous materials :

1. **Cast Iron**—carbon content 1.7 % to 4.5 %
2. **Wrought Iron**—carbon content 0.05 % to 0.15 %
3. **Steel**—carbon content 0.15 % to 1.5 %.

All ferrous materials contain about 0.5 to 3 % silica, less than 2 % manganese, 0.15 % sulphur and 0.6 % phosphorous.

1. Cast Iron : Important properties of cast iron are :

i. Compressive strength is 700 N/mm² and tensile strength is 150 N/mm².

ii. It is brittle and does not absorb shocks.

iii. Its specific gravity is 7.5.

iv. Its structure is coarse, crystalline and fibrous.

v. It has low melting point of about 1200 °C.

Uses of Cast Iron :

i. It is used for making rain water and sanitary pipes, sanitary fittings and manhole covers.

ii. It is used for making railings and spiral stair cases.

iii. Fire gratings, cover for pumps and motors and brackets are made with cast iron.

2. Wrought Iron : It is almost pure iron. It contains less than 0.15 % carbon. Attempts are made to reduce the other impurities during the process of manufacturing.

Properties of Wrought Iron :

i. Its ultimate compressive strength is 200 N/mm² and ultimate tensile strength is 375 N/mm².

ii. It is ductile and brittle.

iii. Its unit weight is 77 kN/m³.

iv. It melts at about 1500°C. It becomes so soft at 900°C that two pieces can be joined by hammering.

v. It can absorb shocks very well.

Uses of Wrought Iron :

i. It is used for making nails, nuts and bolts, wires and chains.

ii. It is used for making roofing sheets, grills, fences, window guards etc.

3. Steel : It is extensively used building material. The following three varieties of steel are extensively used :

i. **Mild Steel :** It contains a maximum of 0.25 % carbon, 0.055 % of sulphur and 0.55 % of phosphorus.

Properties of Mild Steel : Refer Q. 2.12, Page 2–13C, Unit-2.

Uses of Mild Steel :

a. Round bars are extensively used as reinforcement in RCC works.

b. Rolled sections like I, T, L, C, plates etc., are used to build steel columns, beams, trusses etc.

c. Tubular sections are used as poles and members of trusses.

d. Plain and corrugated mild steel are used as roofing materials.

e. Mild steel sections are used in making parts of various machineries.

ii. **High Carbon Steel :** The carbon content in this steel is 0.7 % to 1.5 %.

Properties of Carbon Steel : Refer Q. 2.12, Page 2–13C, Unit-2.

Uses of High Carbon Steel :

a. It is used for making tools such as drills, files, chisels.

b. Many machine parts are made with high carbon steel since it is capable of withstanding shocks and vibrations.

iii. **High Tensile Steel :** Refer Q. 2.12, Page 2–13C, Unit-2.

Que 2.17. What are the effects of different types of impurities in iron on its physical and mechanical properties ?

AKTU 2013-14, Marks 05

Answer

Effects of Impurities : Following impurities affects the properties of iron :

1. **Carbon :**

i. The proportion of carbon and its form more or less influence most of the physical and mechanical properties of cast iron.

ii. The melting temperature of cast iron is reduced as the carbon content or the percentage of combined carbon is increased.

iii. Consequently white cast iron has a lower melting point than grey cast iron.

iv. Shrinkage varies inversely as the carbon content.

2. **Silicon :**

i. In small percentages (0.5-3 %) silicon increases the fluidity of the molten iron, decreases blow holes and increases the density of castings.

ii. It also reduces the solubility of carbon in iron and shrinkage.

iii. When silicon is increased up to 6 percent the iron becomes hard and has a mirror-like fracture.

3. **Sulphur :**

i. Sulphur is an undesirable element in cast iron and is limited to less than 0.1 percent.

ii. It combines with manganese to form the sulphide (MnS) or, if the manganese is very low and not sufficient to satisfy the sulphur, iron sulphide (FeS) may be formed.

iii. Since these sulphides solidify at considerably lower temperatures, than cast iron, they tend to make castings brittle and weak at higher temperatures.

iv. High sulphur content also increases shrinkage and causes hard, brittle iron.

4. **Phosphorous :**

i. When phosphorous is less than 0.5 %, it has no marked effect on cast iron.

ii. Usually it is present to the extent of 0.1 to 1.5 %.

iii. If it is more than 2 %, the iron is embrittled and its strength diminishes.

iv. High phosphorous irons are much more fluid and shrink less, which make them suitable for ornamental castings.

5. **Manganese :**

i. When present in range of 0.4 to 1.2 %, manganese combines with sulphur, and having satisfied sulphur with carbon to form manganese carbide.

ii. It increases the tensile strength and hardness of iron.

iii. Manganese increases the solubility of carbon in iron and opposes the liberation of graphite, which is a cementite stabilizer.

iv. High percentage of manganese increases shrinkage and hardness. Thus in grey iron which is to be machined manganese should be kept low.

PART-4

Glass : Ingredients, Properties, Types and use in Construction. Insulating Materials : Thermal and Sound Insulating Material, Desirable Properties and types of Insulating Materials.

CONCEPT OUTLINE : PART-4

Glass : Glass is an amorphous substance having homogeneous texture. It is a hard, brittle, transparent or translucent material.
Thermal Insulation : The term thermal insulation is used to indicate the construction by which the transmission of heat from or in the room is retarded.

Sound Insulation : The term sound insulation is used to indicate the reduction in the level of sound when it passes through a building component.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 2.18. **What are the constituents of glass ? Give the functions of each of them.** **AKTU 2013-14, Marks 05**

Answer

Following are the constituents of glass with their functions :

i. **Silica :**
   a. It is used in the form of pure quartz, crushed sandstone and pulverised flint; should be free from iron contents for best quality glass.
   b. Since it melts at very high temperature (1710° C) carbonates of sodium or potassium are added to lower down the fusing temperature to about 300° C. These also make liquid silica more viscous and workable.

ii. **Lime :**
   a. It is used in the form of limestone, chalk or pure marble and sometimes marl.
   b. The addition of lime makes the glass fluid and suitable for blowing, drawing, rolling, pressing or spinning.
   c. It also imparts durability and toughness to glass.
   d. Excess of lime makes the molten mass too thin for fabrication.

iii. **Soda :** It acts as an accelerator for the fusion of glass and an excess of it is harmful.

iv. **Potash :** It renders glass infusible and makes glass fire resistant.

v. **Lead Oxide :**
   a. It imparts colour, brightness and shine.
   b. When 15-30 % of it added to substitute lime it lowers the melting point, imparts good workability, while its transparency is lost with the glass becoming brittle and crystalline.

vi. **Cullets :**
   a. These are broken glasses added to act as a flux to prevent loss of alkali by volatization during the process of forming glass and also to lower the fusion temperature.
   b. However, flux may reduce the resistance of glass to chemical attack, render it water-soluble or make it subject to partial or complete devitrification (crystallization) on cooling.
   c. These crystalline areas are extremely weak and brittle.
   d. Stabilizers are added to overcome these defects. Titanic acid, oxides of Nickel and Cobalt are used for chromatic neutralization.

Que 2.19. **Explain different types of glasses and its uses.** **AKTU 2016-17, Marks 05**

OR

Write in brief the various properties and their relative uses of different categories of glass. **AKTU 2012-13, Marks 05**

Answer

A. Important Properties of Glass :

1. It absorbs, refracts or transmits light. It can be made transparent or translucent.
2. It can take excellent polish.
3. It is an excellent electrical insulator.
4. It is strong and brittle.
5. It can be blown, drawn or pressed.
6. It is not affected by atmosphere.
7. It has excellent resistance to chemicals.
8. It is available in various beautiful colours.

B. Classification : The glass may be broadly classified as :

1. Soda Lime Glass :

i. It is mainly a mixture of sodium silicate and calcium silicate.
ii. It is fusible at low temperature. In the fusion condition it can be blown or welded easily.
iii. It is colourless. It is used as window panels and for the laboratory tubes and apparatus.

2. Potash Lime Glass :

i. It is mainly a mixture of potassium silicate and calcium silicate. It is also known as hard glass.
ii. It fuses at high temperature.

iii. It is used in the manufacture of glass articles which have to withstand high temperatures.

3. Potash Lead Glass :

i. It is mainly a mixture of potassium silicate and lead silicate. It possesses bright luster and great refractive power.

ii. It is used in the manufacturing of artificial gems, electric bulbs, lenses, prisms etc.

4. Common Glass :

i. It is mainly a mixture of sodium silicate, calcium silicate and iron silicate. It is brown, green or yellow in colour.

ii. It is mainly used in the manufacture of medicine bottles.

5. Special Glasses :

i. Properties of glasses can be suitably altered by changing basic ingredients and adding few more ingredients.

ii. It has now emerged as versatile material to meet many special requirements in engineering.

iii. The following is the list of some of the special glasses :

a. Fibre glass. b. Foam glass.
c. Bullet proof glass. d. Structural glass.
e. Glass black. f. Wired glass.
g. Ultravoilet ray glass. h. Perforated glass.

Que 2.20. What do you understand by thermal insulation ? Also describe the general principles of thermal insulation.

Answer

A. Thermal Insulation :

1. The temperatures inside and outside a building are different. Some building materials allow heat to pass rapidly while others do not allow passage of heat smoothly.
2. The term thermal insulation is used to indicate the construction by which the transmission of heat from or in the room is retarded.

B. Principles :

Thermal insulation of buildings is done by adopting following general principles :

1. More of thermally insulated materials should be used in the construction of the building.
2. The building should be designed and oriented in such a way that minimum of its area is exposed to direct sun and that also for a shortest, possible duration in summer.

3. Effect of direct winds should be reduced by adopting suitable means such as providing chhajjas over windows and doors and also by providing veranda on the side of the wind direction.
4. Provision of air gaps in the outside exposed walls prove a very effective measure for making structure thermally insulated.
5. The thermal resistance of the material directly varies with its thickness and hence adequate thickness of material should be installed.

Que 2.21. What are the different types of thermal insulating materials ?

Answer

Following are the different types of thermal insulating materials :

1. Slabs and Blocks :

i. These are small rigid units about 2.5 cm thick and 60 cm × 120 cm in area. Slab insulators are also known as blocks or boards.

ii. They are available in form of cork board slabs, mineral wool slabs, vermiculite slabs, cellular glass slabs, cellular rubber slabs, saw dust and cement boards.

2. Blanket Insulation :

i. They are flexible fibrous materials, which are supplied mostly in rolls.

ii. They are mainly made from mineral wool, processed wood fibres, cotton and animal hair.

iii. They are available in thickness varying from 12 mm to 8 cm.

3. Loose Fill Insulation :

i. Loose fill insulation materials are fibrous materials like rock wool, slag wool, glass wool cellulose or wood fibre wool.

ii. They may also be granular loose materials of mineral or vegetable nature.

iii. Mineral wool is a fibrous material which is obtained from rock, slag, and glass.

4. Vermiculite : It is a light weight granular insulating material manufactured by exploding aluminium magnesium silicate.

5. Bat Insulating Materials :

i. These are more or less similar to blanket insulation materials except that they are available in smaller sizes and greater thicknesses.

ii. Common thicknesses being 5 cm, 7.5 cm and 9 cm.

iii. They are available in small sizes, suitable for framing units. Structural insulating board is manufactured by first making a pulp of wood, cane, or other materials and then pressing them in form of boards by adding suitable adhesive to it.

iv. Various types of insulating boards are available in market in different sizes and thicknesses.

6. **Reflective Insulations :**

i. In this case heat resistance through materials is obtained entirely by giving exposed surfaces or bright metallic surface finishes.

ii. Solar energy striking reflective surfaces get reflected and amount of heat which may get transmitted is greatly reduced.

7. **Light Weight Aggregates :** Heat resistance of the concrete can be greatly increased by adopting light weight aggregates like blast furnace slag, burnt clay aggregates, vermiculite, in place of usual aggregates.

Que 2.22. **What are the various advantages of using the thermal insulating material in building construction works ?**

AKTU 2012-13, Marks 05

Answer

Following are the advantages of using thermal insulating materials :

1. Thermally insulated buildings or rooms remain cool in summer and warm in winter than outside. This results in comfortable conditions for the occupants, inside the building.
2. Thermally insulated buildings require less consumption of power to maintain desired temperature conditions inside the building.
3. These are environment friendly and easy to maintain.
4. These materials are light weight than concrete which reduces the dead weight on the roof slab.
5. Thermal insulating materials are manufactured from recycled materials.
6. These are fire resistant and easy to install.

Que 2.23. **Define the term sound insulation. What are the different types of sound insulating material ?**

Answer

A. Sound Insulation :

1. The term sound insulation or sound proofing is used to indicate the reduction in the level of sound when it passes through a building component.
2. It has become necessary to give attention to the sound insulation of buildings because of various factors such as increase in population densities, change in habits of the community, improvement in building construction practices etc.

B. Types of Sound Absorbing Materials :

Some of the sound absorbing materials are as follows :

1. **Straw Board :** It has sound absorption coefficient of 0.30 at 500 cycle/sec with 12 mm thickness.
2. **Pulp Board :** These are manufactured from pulp. Its coefficient of absorption is 0.17.
3. **Acoustic Plaster :** It consists of granulated insulated material mixed with cement 20 mm thick plaster having density of 0.1 gm/cm^3 has sound absorbing coefficient of 0.3 of 500 cycles/sec. Acoustic plaster is also known as fibrous plaster.
4. **Compressed Fibre-Board :**

i. This material is available in perforated or unperforated forms.

ii. Perforated form has sound absorption coefficient of nearly 0.3.

iii. Imperforated types have the value of coefficient as high as 0.52.

5. **Wood Wool Board :** This material is normally available in thickness of 2.5 cm. Its absorption coefficient is 0.20.
6. **Compressed Wool Particle Board :** Its absorption coefficient with 13 mm thickness is about 0.40. This material has perforations and if required it can be painted also.

Que 2.24. **Describe the requirements, properties and uses of sound insulating materials.**

Answer

A. Requirements :

Basic requirements for selecting sound-absorbing materials are as follows :

1. One must choose material with open and connected pores in order that it can work well. If the pores are more closely connected together, the sound absorbing property will become better.
2. Most of the sound absorbing materials have weak strength, so they should be fixed above the height of wall protective plate to avoid being damaged. For the sound absorbing materials that are easy to absorb heat, the resulting expansion and shrinkage have to be taken into consideration.
3. It is advisable to choose material with high sound absorption coefficient, so that a fewer amount will do.
4. Attention should be paid to the differences between sound-absorbing material and sound insulation shield.

B. Properties :

1. A good sound insulator should have low density, porous texture, resistance to moisture and pleasing look.

2. It should be incombustible, light in weight and easy to handle and fix, resistant to attacks of vermin, insect, termite and dry rot.

C. Uses :

1. The sound insulating materials are used for sound absorption *i.e.*, the transmission of sound/noise from inside to outside or (vice-versa) or from one room to be other is prevented.
2. These can be used in residential, such as home office, home theater etc, commercial, such as auditorium, restaurant, recording studio etc, and institutional buildings.

VERY IMPORTANT QUESTIONS

Following questions are very important. These questions may be asked in your SESSIONALS as well as UNIVERSITY EXAMINATION.

Q. 1. How are plastic classified ? Explain the different properties of plastic material.

Ans. Refer Q. 2.2 and Q. 2.3, Unit-2.

Q. 2. Explain desirable properties, constituents and types of paints.

Ans. Refer Q. 2.4 and Q. 2.5, Unit-2.

Q. 3. Write down the desirable characteristics, objectives and uses of varnish.

Ans. Refer Q. 2.7, Unit-2.

Q. 4. Explain the properties and characteristics of reinforcing steel.

Ans. Refer Q. 2.12, Unit-2.

Q. 5. Describe the properties and uses of any two non-ferrous metals with their alloys.

Ans. Refer Q. 2.15, Unit-2.

Q. 6. What are the different types of impurities in iron ? Also discuss their effects.

Ans. Refer Q. 2.17, Unit-2.

Q. 7. What are the different types of glass ? Explain the important properties of glass.

Ans. Refer Q. 2.19, Unit-2.

Q. 8. What are the different types of thermal insulating materials ? Also explain advantages of thermal insulation.

Ans. Refer Q. 2.21 and Q. 2.22, Unit-2.

Q. 9. What are the different types of sound insulating materials ? Explain properties and uses of these materials.

Ans. Refer Q. 2.23 and Q. 2.24, Unit-2.

☺☺☺

3 UNIT

Components of Building

PART-1

Components of Building : Area Considerations, Construction Principle and Methods for Layout.

CONCEPT OUTLINE : PART-1

Components of Building : Following are the structural components of a building :

i. Foundation, ii. Plinth,
iii. Walls and piers, iv. Floors,
v. Doors and windows, vi. Sills, lintels and weather sheds,
vii. Roofs, viii. Steps and stairs, etc.

Principles for Planning the Building : The principles of planning are as follows :

i. Aspect, ii. Prospect,
iii. Furniture requirements, iv. Roominess,
v. Grouping, vi. Circulation,
vii. Privacy, viii. Sanitation,
ix. Economy, x. Practical considerations, etc.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 3.1. Give the classification of building as per NBC with suitable examples. **AKTU 2015-16, Marks 10**

Answer

According to National Building Code of India, 1970, the buildings on the basis of occupancy are classified into following groups :

1. **Group A : Residential Buildings :**

i. All those buildings in which sleeping accommodation is provided for residing permanently or temporary with or without looking or dinning or both facilities are termed as residential building.

ii. Example : Apartments, flats, bungalows, dormitories, private houses, hotels, hostels, cottages, clubs, inns etc.

iii. These buildings are further subdivided into five groups :

A1 – Lodging houses.

A2 – Family private dwellings.

A3 – Dormitories.

A4 – Flats.

A5 – Hotels.

2. Group B : Educational Buildings :

i. All those buildings which are meant for education from nursery to university are included in this group.

ii. Example : schools, colleges, universities, training institutes, etc.

3. Group C : Institutional Buildings :

i. This group includes any building or part thereof, which is used for the purposes such as medical, health, recovering health after illness, physical or mental diseases, care of infants or aged persons, panel detention etc.

ii. These buildings normally provide sleeping accommodation for the occupants.

4. Group D : Assembly Buildings :

i. This group includes any building or part of a building where groups of people assemble or gather for amusement, recreation, social, religious, patriotic or similar purposes.

ii. For example : Theatres, cinema halls, museums, gymnasiums, restaurants, places of worship, dance halls, club rooms, passenger stations, public transportation services, open air theatres, swimming pools etc.

5. Group E : Business Buildings :

i. This group includes any building or part of a building which is used for purposes such as transaction of business, keeping of accounts and records etc.

ii. Example : Dispensaries and clinics, banks, city halls, court halls, libraries etc.

6. Group F : Mercantile Buildings :

i. This group includes any building or part of a building which is used for shops, stores, market, for safe and display of products or waves either whole sale or retail.

7. Group G : Industrial Buildings :

i. This group includes any building or part of a building or structure in which product of different kinds and properties are fabricated, assembled or processed.

ii. For example : Laboratories, assembly plants, laundries, gas plants, power plants, refineries, diaries etc.

8. Group H : Storage Buildings :

i. This group includes those building structures which are primarily used for the storage or sheltering of goods, waves or merchandise vehicles or animals.

ii. For example : Warehouses, cold storages, freight depots, store houses, transit sheds, truck terminals, garages etc.

9. Group J : Hazardous Buildings :

i. This group includes those building structures which are used for the storage, handling, manufacturing or processing of materials which are liable to burn with extreme rapidity and prove hazards to health, building or building contents.

ii. Buildings used for storage of gases under high pressure or for storage and handling of highly flammable liquids or explosives, fireworks etc., are included in this group.

Que 3.2. Discuss all the structural components of a building.

Answer

A building in general made of the following structural components :

1. Foundation :

i. The foundation is the most critical part of any structure and most of the failure is probably due to faulty foundations rather than any other cause.

ii. The purpose of foundation is to transmit the anticipated loads safety to the soil.

2. Plinth :

i. This is the portion of structure between the surface of the surrounding ground and surface of the floor, immediately above the ground.

ii. As per Byelaws, the plinth should not be less than 45 cm.

3. Walls and Piers in Super Structure :

i. The primary function of walls is to enclose or divide space.

ii. A load-bearing wall in the super structure should satisfy the following requirements :

Strengths, stability, weather resistance, fire resistance, heat insulation, sound insulation, privacy and security.

4. Ground Basement and Upper Floors :

The main function of a floor is to provide support of occupants, furniture and equipment of a building and the function of providing different floors is to divide the building into different levels for the purpose of creating more accommodation within the limited space.

5. Doors and Windows :

i. The main function of doors in a building is to serve as a connecting link between internal parts and also to allow the free movement outside the building.

ii. Windows are generally provided for the proper ventilation and lighting of a building.

6. Sills, Lintels and Weather Shades :

i. Window sills are provided between the bottoms of window frame and wall below, to protect the top of wall from wear and tear.

ii. The actual frame of door or window is not strong enough to support the weight of the wall above the openings and a separate structural element has, therefore to be introduced. This is known as lintel and is similar to a beam.

iii. Weather shades or chhajjas are generally combined with lintels of windows to protect from the weather elements such as sun, rain, frost etc.

7. Roofs :

i. A roof is the uppermost part of the building whose main function is to enclose the space and to protect the same from the effects of weather elements such as rain, sun, wind, heat, snow etc.

ii. A good roof is just as essential as a safe foundation.

8. Steps and Stairs : A stair is a structure consists of number of steps leading from one floor to another. The main functions of stairs are :

i. To provide means of communication between the various floors for everyday use.

ii. To escape from upper floors in the case of fire.

9. Finishes for Walls : The finishes of several types such as pointing, plastering, painting, distempering, decorative colour washing etc., applied on the walls.

10. Utility Fixtures :

i. These are the built in items of an unmovable nature, which add considerably to the utility of a building and hence termed as utility fixtures.

ii. The most common of such built-in fixtures are : cupboards, shelves, smokeless chulas etc. These features are generally provided in the recesses for storing valuable articles, clothes etc.

iii. The recesses in wall structure reduce its strength, so they are avoided in the modern construction of houses.

Que 3.3. Discuss in detail the various principles for planning the building. **AKTU 2015-16, Marks 10**

OR

Suppose you are going to construct your own residential building, then which construction principles you will follow for its construction ? **AKTU 2012-13, Marks 10**

Answer

The principles of planning are as follows :

1. Aspect,
2. Prospect,
3. Furniture requirements,
4. Roominess,
5. Grouping,
6. Circulation,
7. Privacy,
8. Sanitation,
9. Elegance,
10. Economy,
11. Flexibility, and
12. Practical considerations.

1. Aspect :

i. Aspect means the peculiarity of the arrangement of doors and windows in the external walls of a building, which allow the occupants to enjoy the natural gifts such as sunshine, breeze, scenery etc.

ii. A room receiving light and air from any particular direction is said to have aspect of that direction. All the rooms of a dwelling need particular aspect. The living rooms should have southern or south-east aspect.

iii. The sun is towards south during coolers days and the living rooms with south aspect will be benefitted by the sunshine when it is desired in winter and obviate automatically during summer as the sun would be on northern side, over head or at high altitude, towards south.

iv. All the bedrooms should have west or south west aspect, as the breeze required particularly in summer would prevail from this side.

v. A kitchen should have eastern aspect so as to admit morning sun to refresh and purify the air. The kitchen would remain cool during the latter part of the day.

2. Prospect :

i. Prospect is found by the views desired from certain rooms of the house. It is dictated by surrounding peculiarities of the selected site.

ii. Prospect of building also demands the disposition of doors and windows like aspect, in the external wall at particular places and in particular way but prospect also means both the revealing of some notable, pleasant, or redeeming features and concealment of some undesirable views, in a given outlook.

iii. The outside influence forms a powerful factor in human affairs and ought to be recognized as such. However a good layout should not be disturbed for the sake of good prospect only.

iv. Certain projecting windows are of great use either for concealment or revealing of the inside views.

v. A blind face of bay with window openings at sides would help in concealment of certain inside views of the building.

3. **Privacy :**

i. Unless an optimum privacy is secured, all the principles of planning of a building are bound to fail, particularly in case of residential building.

ii. Privacy may be from one part to other of the same building or it may be privacy as a whole from neighbouring buildings, public streets or by-ways.

iii. The extent or privacy of a building from the streets, by-ways and neighbouring buildings, depends mainly on its functions.

iv. Sometimes, it may be the privacy of part that is desired from the exterior yet the building as a whole may be required to arrest attention of the public.

v. In the case of residential buildings, privacy can be secured by careful planning the entrance, path ways, and drives.

4. **Economy :**

i. The economy may not be a principle of planning but definitely a factor affecting it. Economy restricts the liberties, which otherwise, would have been enjoyed by the planner.

ii. To fit the proposed scheme within the limitations of the resources certain alterations and omissions in the original plan have to be affected.

iii. A strong solid masonry wall will prove economical than thin weak wall, as in the long run stronger wall does not require repairs and maintenance.

iv. Reducing the storey height to bare-minimum is also a measure of economizing.

v. Standardization of sizes of various components, and materials, also help in minimizing the costs.

5. **Practical Consideration :** Following practical points should be considered :

i. Provisions for future extensions without dismantling should be made in the planning.

ii. The building should be strong and capable to withstand the likely adverse effects of natural agencies.

iii. Strength, stability, convenience, and comfort of the occupants, should be the first consideration in planning.

iv. Elevation should be simple but attractive. Too many porches may give good elevation for some time, but ultimately simple designs fit better for generations.

v. As far as possible sizes of rooms should be kept large. Larger room can be shortened by providing movable partitions but smaller rooms cannot be enlarged easily.

Que 3.4. Explain in detail with suitable sketches the setting out work that is needed to be carried out for a building.

AKTU 2015-16, Marks 10

Answer

1. A building is set out in order to clearly define the outline of the excavation and the centre line of the walls, so that construction can be carried out exactly according to the plan.

2. The centre line method of setting out is generally preferred and adopted. Setting out plan is also known as ground tracing.

3. Detailed plans and drawings are prepared before actual execution of any project is taken in hand.

4. For ground tracing, detailed plan of the building and site plan of the area are required.

5. Site plan and detailed plan are studied thoroughly and out of various walls, the longest outer wall is chosen as the base line.

6. Now with the help of site plan and detailed plan, lengths of centre lines of all the walls are calculated and centre-line plan of the building prepared.

7. Distances of centre points of outer corners of the building walls from property lines are noted on the centre line plan.

8. For example (Fig. 3.4.1), we have to set out the plan on the ground. For this, we have to follow the given procedure :

i. From the plan the centre line of the walls are calculated. Then the centre lines of the rooms are set out by setting perpendiculars in the ratio 3:4:5. Suppose the corner points are a, b, c, d, e, f and g which are marked by pegs with nails on top.

ii. The setting of the corner point is checked according to diagonals ac, bd, cf and eg.

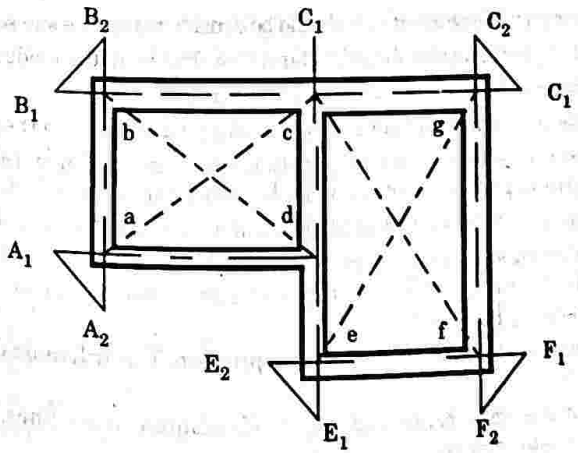


Fig. 3.4.1.

iii. During excavation, the centre points a, b, c, d, e, f and g may be removed. Therefore, the centre lines are extended and the centre points are marked about 2 m away from the outer edge of excavation.

iv. Thus, the points A_1, A_2, B_1, B_2 and likewise, are marked outside the trench. Centre line is shown clearly by stretching thread or rope. The centre points fixed 2 m away from the excavation are marked with set out pegs.

v. From the plan details, the width of excavation to be done is also marked by thread with pegs at appropriate positions.

vi. The excavation width is then marked by lime or by with furrow with spade.

vii. If the plan is much complicated and follows a zig-zag pattern, then the centre pegs are kept at suitable positions according to site conditions.

9. After ground tracing has been completed with respect to centre lines of the walls, diagonals of rectangular or square rooms should be measured to check the correctness of the work.

10. Lengths of both diagonals of a rectangular or square room should be equal. If they are not found equal, adjustments are done at the site before pegs are driven finally.

11. Right angles in ground tracing may be set using 3.4 and 5 m lengths of the tape or mason's square. In the case of important buildings, theodolite may be used to set right angles.

Que 3.5. Discuss the main points which should be considered for the site selection of a building.

Answer

Following are the points which should be considered for the site selection :

1. Soil at the building site should as far as possible be not of made up type.
2. The site should not be very much undulating.
3. The site should have its general slope, slopping away from the site.
4. Civic services such as water supply mains, electric lines, telephone lines, drainage sewers, etc., should be very near to the selected site.
5. The site should be such that the ground water table is not very high.
6. The selected site should be large enough, both to ensure the building abundant light and air and to prevent any over dominance by the neighbouring buildings.
7. Building site should not be chosen in depression. This will cause drainage problems.
8. The site should be connected with good communication lines, such as good system of roads, railways etc.
9. Good foundation soil should be available at reasonable depth. This will save in the cost of the building.

10. Selected site should be adequate to accommodate all the essential accessories of the building.

PART-2

Damp Proofing, Anti-termite Treatment in Buildings.

CONCEPT OUTLINE : PART-2

Dampness : It is the presence of hygroscopic or gravitational moisture.

Techniques of Damp Proofing : Following are the different techniques of damp proofing :

i. Use of DPC, ii. Damp proof treatment,
iii. Cavity wall or hollow walls, iv. Guniting, and
v. Pressure grouting.

Termite Proofing : The term termite proofing is used to indicate the treatment which is given to a building so as to prevent or control the growth of termite in a building.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 3.6. What do you mean by dampness ? What are the ill effects of dampness ?

Answer

A. **Dampness :** Dampness is the presence of hygroscopic or gravitational moisture. Dampness gives rise to unhygienic conditions, apart from reduction in strength of structural components of the building.

B. **Effects :** The various effects caused due to dampness in buildings mainly results in poor functional performance, ugly appearance and structural weakness of the buildings.

1. A damp building creates unhealthy living and working conditions for the occupants.
2. Presence of damp condition causes efflorescence on building surfaces which ultimately results in the disintegration of bricks stones, tiles etc., and hence reduction of strength. It may result in softening and crumbling of plaster.
3. It may cause bleaching and flaking of the paint which results in the formation of coloured patches on the wall surfaces and ceilings.
4. It may result in the corrosion of metals used in the construction of buildings.

5. The materials used as floor coverings such as tiles are damaged because they lose adhesion with the floor bases.
6. Timber when in contact with damp condition gets deteriorated due to the effect of warping, buckling and rolling of timber.
7. All the electrical fittings get deteriorated, causing leakage of electric current with the potential danger of a short circuit.
8. Dampness promotes the growth of termites and hence creates unhygienic conditions in buildings.

Que 3.7. Write the sources of dampness in a building. What are the techniques and methods of damp prevention ?

AKTU 2013-14, Marks 10

Answer

A. Sources of Dampness : Dampness in building is generally due to one or more of the following causes :

1. Faulty design of structure.
2. Faulty construction or poor workmanship.
3. Use of poor materials in construction.

B. Techniques of Damp Proofing : Following are the different techniques and methods of damp proofing :

1. Use of Damp-Proof Courses (DPC) :

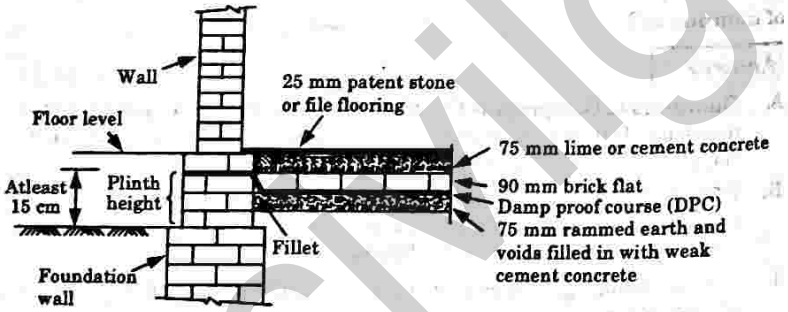


Fig. 3.7.1.

i. These are layers or membranes of water repellent materials such as bituminous felts, mastic asphalt, plastic sheets, cement concrete mortar, metal sheets, stones etc., which are interposed in the building structure at all locations wherever water entry is anticipated or suspected.

ii. The best location or position of DPC in the case of building without basement lies at plinth level or structures without any plinth level, it should be laid at least 15 cm above ground level.

iii. The damp proof course provided horizontally and vertically in floors, walls etc. In the case of basements, laying of DPC is known as taking as shown in Fig. 3.7.1.

2. Water Proof Surface Treatments :

i. The surface treatment consists in filling up the pores of the material exposed to moisture by providing a thin film of water repellent material over the surface (internal/external).

ii. External treatment is effective in preventing dampness. Many surface treatments, like pointing, plastering, painting, distempering etc., are given to the exposed surfaces and also to the internal surface.

iii. The most commonly used treatment to protect the walls against dampness is cement lime plaster (1 : 6) (1-cement, 6-lime) mix proportion.

iv. Generally employed as water proofing agent in surface treatments are sodium or potassium silicate.

3. Integral Damp Proofing Treatments :

i. The integral treatment consists of adding certain compounds to the concrete or mortar during the process of mixing, which when used in construction acts as barriers to moisture penetration under different principles.

ii. Compounds like chalk, talc, fuller's earth etc., have mechanical action principle *i.e.*, they fill the pores present in the concrete or mortar and make them dense and water proof.

iii. Compounds like denser and water proof sulphates, calcium chlorides etc., work on chemical action principle *i.e.*, they react chemically and fill the pores to act as water-resistant.

iv. The compounds like soaps, petroleum, oils fatty acids compounds such as stearates of calcium, sodium, ammonium etc., work on the repulsion principle *i.e.*, they are used as admixture in concrete to react with it and become water repellent.

4. Cavity Walls or Hollow Walls :

i. A cavity wall consists of two parallel walls or leaves or skins of masonry separated by a continuous air space or cavity.

ii. The cavity prevents the moisture from travelling from outer skin to the inner main wall.

iii. Cavities function satisfactorily only if they are clear from droppings and are also well ventilated.

5. Guniting (Shot Concrete) :

i. The technique of guniting consists in forming an impervious layer of rich cement mortar (1 : 3) or fine aggregate mix for water proofing over the exposed concrete surface or over the pipes, cisterns etc., for resisting the water pressure.

ii. By this technique, an impervious layer of high compressive strength (600 to 700 kg/cm²) is obtained and hence this is also very useful for reconditioning or repairing old concrete works.

Que 3.8. What are the requirements of an ideal material for damp proofing ?

Answer

An ideal damp proofing material should have the following requirements :

1. The material should be perfectly impervious and it should not permit any moisture penetration or travel through it.
2. The material should be durable, and should have the same life as that of the building.
3. The material should be strong, capable of resisting superimposed loads/ pressure on it.
4. Material should be flexible, so that it can accommodate the structural movements without any fracture.
5. The material should not be costly.
6. The material should be such that leak-proof jointing is possible.
7. The material should remain steady in its position when once applied. It should not allow any movement in itself.

Que 3.9. What are the advantages of a cavity wall ? Explain general features of a cavity wall with the help of neat sketches.

AKTU 2013-14, Marks 10

Answer

A. Advantages : Following are the advantages of cavity wall :

1. A cavity wall reduced the possibility of moisture penetration.
2. A cavity wall prevents the transmission of heat through wall.
3. A cavity wall offers good insulation against sound.
4. The cavity wall tends to reduce the nuisance of efflorescence.
5. The cavity wall also provides benefits such as economy, better comfort and hygienic conditions in buildings.

B. General Features of a Cavity Wall :

1. Fig. 3.9.1 shows the vertical sections of various types of cavity walls for flat and inclined roofs.
2. In the case of brick cavity wall each leaf is half brick thick. Such a wall is capable of taking load of two storeyed building of the domestic type.

3. However, if heavier loads are to be supported, the thickness of inner leaf can be increased in the multiple of half brick thickness.
4. The cavity should neither be less than 40 mm nor more than 100 mm in width.

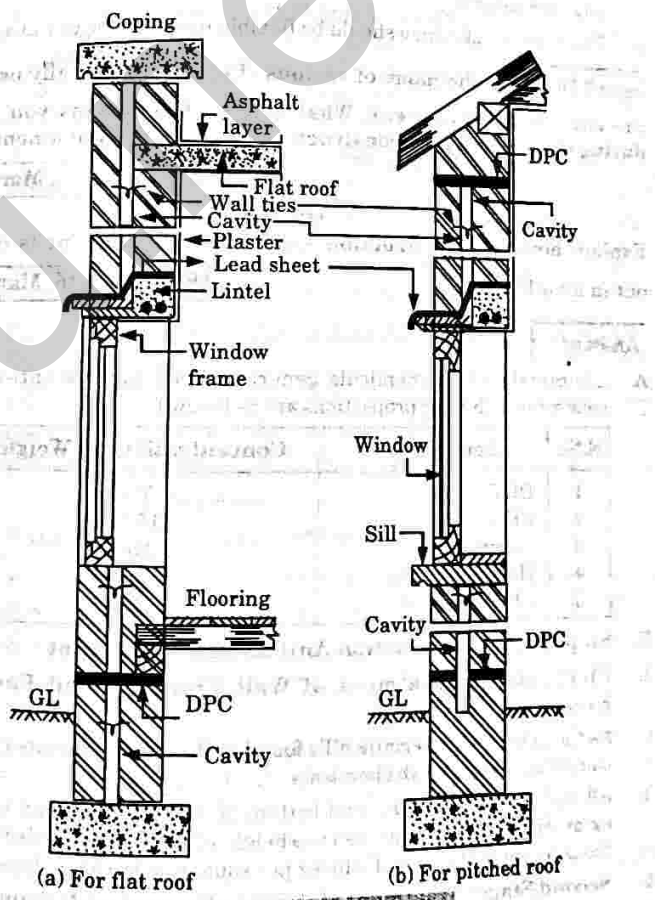


Fig. 3.9.1. Brick cavity walls.

5. The inner and outer skins are adequately tied together by means of special wall ties placed in suitable arrangement, at the rate of at least five ties to a square meter of wall area.
6. According to Building Regulations of UK, the ties must be placed at distances apart not exceeding 900 mm horizontally and 450 mm vertically.

7. The ties are staggered and must be placed at 300 mm vertical intervals at all angles and doors and window jambs to increase stability.
8. Since the cavity separates the two leaves of the wall, to moisture to enter, it is essential to provide a vertical damp proof course at window and door reveals.
9. The damp proof course should be flexible in such type of walls.

Que 3.10. **Give the name of various chemicals generally used for the anti-termite treatment. What are the basic steps you follow during the pre and post construction anti-termite treatment ?**

AKTU 2012-13, Marks 10

OR

Explain how post-construction anti-termite treatment is carried out in a building ?

AKTU 2015-16, Marks 10

Answer

A. Chemicals : The chemicals generally used for the anti-termite treatment with their proportions are as follows :

S.No.	Chemicals	Concentration by Weight
1.	DDT	5 %
2.	BHC	0.5 %
3.	Aldrin	0.25 %
4.	Heptachlor	0.25 %
5.	Chlordane	0.5 %

B. Steps in Pre-construction Anti-termite Treatment :

1. First Stage : Treatment of Wall Trenches and Basement Excavation :

i. As the first step, all termite hills found at the site during site clearance should be sprayed with chemicals.

ii. All surfaces of pits (sides and bottom of wall trenches and basement excavations) should be treated to a height of 30 cm from the bottom with the solution at the rate of 5 litres per square metre of surface area.

2. Second Stage : Treatment of Refill in Contact with Foundation :

i. All the refill earth in the excavation immediately in contact with both sides of the wall footing and all four sides of a column footing should be treated for a distance of 30 cm at the rate of 3 to 5 litres per linear metre vertical surface of the wall.

ii. If water is used for ramming the earth, then treatment should be done after the consolidation by rodding (making holes) in the consolidated earth at close intervals of 15 cm close to the wall or columns and applying the chemical close to the wall.

iii. It is preferable to treat all the earth adjacent to the foundation for a width of 30 cm.

iv. Similarly in framed structures, excavations for the plinth beams should also be treated.

3. Third Stage : Treatment of Soil below Floors : The earthfill below the floors up to the plinth level has also to be treated after the fill has been made by putting holes 5 to 7.5 cm deep at 15 cm centres in a grid pattern and filling the holes with the solution at the rate of 5 litres per square metre of treated surface.

4. Fourth Stage : Treatment of Junction of Floor and Wall : Before laying the subgrade, channels of 3 cm wide and 3 cm deep are dug along the junctions of floor and wall and treated at 15 litres per square metre of wall surface by putting holes at 15 cm apart along the channel and allowing the chemical to seep through to the bottom. The soil is tamped back in position after the operation.

5. Fifth Stage : Treatment of Soil Along External Perimeter of Building :

i. After the building is completed, holes are made along the external perimeter at intervals of 15 cm and depth of 30 cm.

ii. These holes are filled with the chemical emulsion at the rate of 5 litres per metre length of wall.

6. Sixth Stage : Treatment of Other Locations :

i. Anti-termite treatment should be made at expansion joints after the subgrade has been laid at 2 litres per linear metre of expansion joint.

ii. Similarly, when pipes and conduits enter the building, the soil around them for a distance of 15 cm and depth of 7.5 cm should be loosened and treated.

7. Seventh Stage : Treatment of Wood Surfaces : It is also a good practice to paint all fresh wood surfaces, such as door and window posts which will be in contact with masonry, with two coats of the chemical in kerosene oil before it is installed in the building.

C. Post-Construction Anti-Termite Treatment of Building Foundation :

For post-construction operation, a pressure pump will be required for proper penetration of chemicals into the surface to be treated. The following procedure is usually adopted :

1. Treatment of Foundation of Outside Walls Around the Building :

i. If there is no apron, we make trenches 50 cm deep and equal to the width of a shovel, exposing the foundation near the external walls.

ii. Holes 15 cm apart and 50 cm deep are made by an iron rod.

iii. Emulsion at the rate of 5 litres per square metre of vertical surface of substructure is to be used for each side of the floor.

iv. One-half of the quantity is pumped through the holes and the other half is poured along the trench.

v. If there is a concrete apron, 12 mm diameter holes are dug as close to the wall as possible about 30 cm apart and the chemical is pumped into these holes at the rate of 5 litres per linear metre.

vi. Similar treatment is to be made for column and plinth beams.

2. Treatment of Soil under Floors :

i. For this purpose, 12 mm diameter holes 30 cm apart are made deep enough to reach the soil below along the junctions of wall and floor, along cracks in the floor and along the construction joints.

ii. The emulsion with water is pumped into these holes to soak the soil or at the rate of one litre per hole.

iii. The holes are then sealed with cement mortar 1 : 2.

3. Treatment of Masonry at Plinth Level :

i. The movement of termites through the walls can be stopped by drilling holes in the masonry at plinth level at an angle of 45° on both sides of the wall at 30 cm centres.

ii. The emulsion is pumped till the masonry is soaked or at a maximum of one litre per hole.

iii. The holes are then sealed with 1 : 2 cement mortar.

4. Post-Construction Treatment of Woodwork :

In post-construction, we may have to deal with buildings in which the woodwork such as doors or fittings (such as shelves) have been attacked by termites :

i. It is better to treat woodwork with the chemical mixed in kerosene oil.

ii. First the masonry around the wood is treated with the chemical and secondly the wood itself is treated by drilling 6 mm diameter holes at 15 cm intervals and infusing it with the kerosene-based chemical.

iii. Two coats of the chemical can also be applied on the surface of the wood before applying the paint.

PART-3

Vertical Circulation Means : Staircases and their Types, Design and Construction.

CONCEPT OUTLINE : PART-3

Vertical Circulation : Vertical circulation comprises major subsystems that provide a means in multistorey building for movement of people and goods between floors.

Stair Case : Stair is a structure having series of steps and affords the means of ascent and descent between the floors or landings. The encloser or room in which stair is located is known as a stair case.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 3.11. What is vertical circulation ? Discuss their types.

Answer

A. Vertical Circulation :

1. Circulation, as usually applied in architecture, is the movement of people and goods between interior spaces in buildings and to entrances and exits.
2. Safe, convenient, rapid circulation is essential for all buildings under both normal and emergency conditions.
3. Such circulation may be channeled through any of several different types of passage ways, such as lobbies, corridors, ramps, stair ways, and elevator hoist ways.
4. Vertical circulation of traffic in a multistorey building is the key to successful functioning of the design, both in normal use and in emergencies.
5. Traffic may pass from level to level in a multistorey building by ramps, stairs, elevators, or escalators.
6. In addition to conventional elevators, other types of human lifts are occasionally installed in residences, factories, and garages.

B. Classification of Vertical Circulation Systems : Vertical circulation systems may be divided into two classes.

1. Class I systems are intended for movement of both people and goods and include ramps, stairs, escalators, and elevators.
2. Class I systems may be divided into two subclasses, A and B.
3. Class I A systems can be used by people both under normal and emergency conditions as a means of egress. This class includes ramps, stairs, and escalators (powered stairs).

4. Systems not acceptable as an emergency means of egress comprise Class I B. (Such systems nevertheless may be used for emergency evacuation of a building).
5. Class II systems, including dumbwaiters and vertical conveyors; in contrast, may not be used for movement of people.

Que 3.12. What are the different technical terms used in the design of a stair case ?

Answer

Fig. 3.12.1 shows the section of a stair, with its components. The technical terms associated with the design and construction of stairs are defined below :

1. **Step :** It is a portion of stair which permits ascent or descent. It is comprised of a tread and a riser. A stair is composed of a set of steps.

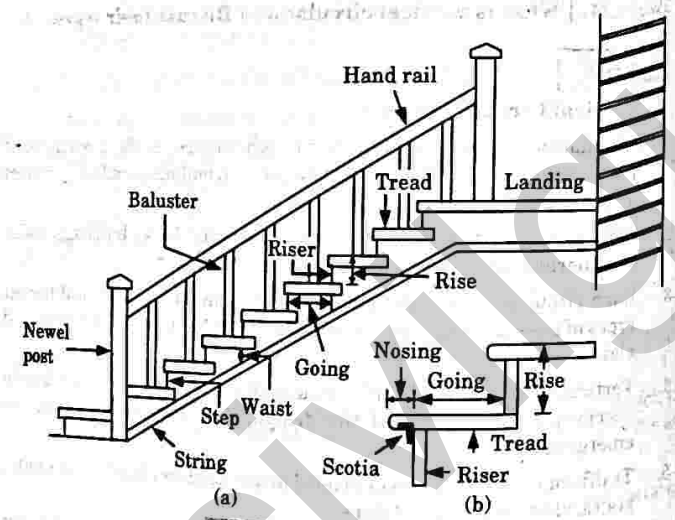


Fig. 3.12.1. Terms used in stairs.

2. **Tread :** It is the upper horizontal portion of a step upon which the foot is placed while ascending or descending.
3. **Riser :** It is the vertical portion of a step providing a support to the tread.
4. **Flight :** This is defined as an unbroken series of steps between landings.
5. **Landing :** It is the level platform at the top or bottom, of a flight between the floors. A landing facilitates change of direction and provides an opportunity for taking rest during the use of the stair.

6. **Rise :** It is the vertical distance between two successive tread faces.
7. **Going :** It is the horizontal distance between two successive riser faces.
8. **Nosing :** It is the projecting part of the tread beyond the face of the riser. It is usually rounded off from architectural considerations.
9. **Scotia :** It is a moulding provided under the nosing to improve the elevation of the step, and to provide strength to nosing.
10. **Soffit :** It is the underside of a stair.
11. **Line of Nosings :** It is an imaginary line parallel to the strings and tangential to the nosings. It is useful in the construction of hand rails, giving the line with which the under-surface of the hand rail should coincide.
12. **Pitch or Slope :** It is the angle which the line of nosing of the stair makes with the horizontal.
13. **Strings or Stringers :** These are the sloping members which support the steps in a stair. They run along the slope of the stair.
14. **Newel Post :** Newel post is a vertical member which is placed at the ends of flights to connect the ends of strings and hand rail.
15. **Baluster :** It is vertical member of wood or metal, supporting the hand rail.
16. **Balustrade :** It consists of a row of balusters surmounted by a hand rail, to provide protection for the users of the stair.
17. **Hand Rail :** It is a rounded or moulded member of wood or metal following generally the contour of the nosing line, and fixed on the top of balusters.
18. **Head Room :** It is the minimum clear vertical distance between the tread and overhead structure (*i.e.*, ceiling, etc.).
19. **Run :** It is the total length of stairs in a horizontal plane, including landings.
20. **Header :** It is the horizontal structural member supporting stair stringers or landings.

Que 3.13. State briefly the requirements of a good stair case. Also write the type of various steps with their neat sketches. How are the treads and risers proportioned ? **AKTU 2013-14, Marks 10**

Answer

A. Requirements of a Good Staircase :

Following are the general requirements which a stair should fulfil :

1. **Location :**

i. It should be so located as to provide easy access to the occupants of the building.

ii. It should be so located that it is well lighted and ventilated directly from the exterior.

iii. It should be so located as to have approaches convenient and spacious.

2. **Width of Stair :**

i. It should be wide enough to carry the user without much crowd or inconvenience.

ii. Width of stairs depends up to its location in the building and the type of the building itself.

iii. In a domestic building, a 90 cm wide stair is sufficient while in public building, 1.5 to 1.8 m width may be required.

3. **Length of Flight :** From comfort point view, the number of steps are not more than 12 and not less than 3.

4. **Head Room :** The clear distance between the tread and soffit of the flight immediately above it should not be less than 2.1 to 2.3 m, so that even a tall person can use the stair with some luggage on its head.

5. **Balustrade :**

i. Open well stair should always be provided with balustrade, to provide safety to the users.

ii. Wide stair should have hand rail to both the sides.

6. **Materials of Construction :** The material used for the construction of stair should be such as to provide (i) sufficient strength, and (ii) fire resistance.

B. Types of Steps : Steps in a stair may be of the following types :

1. **Flier :** A flier is an ordinary step of uniform width and rectangular shape in plan.

2. **Bull Nose Step :** A bull nose step, generally provided at the bottom of the flight, projects in front of the newel post. Its end near the newel forms the quadrant of a circle.

3. **Round Ended Step :** A round ended step is similar to a bull nose step except that it has a semi-circular end which projects out from the stringer.

4. **Splayed Step :** A splayed step is also provided at the beginning of the flight, with its end, near the newel post splayed.

5. **Commode Step :** A commode step, as shown in Fig 3.13.1(d), has curved tread and riser.

6. **Dancing Step :** Dancing or balancing steps are the winders which do not radiate from a common centre.

7. **Winder :** Winders are tapering steps, such as those which radiate from a point usually situated at the centre of a newel.

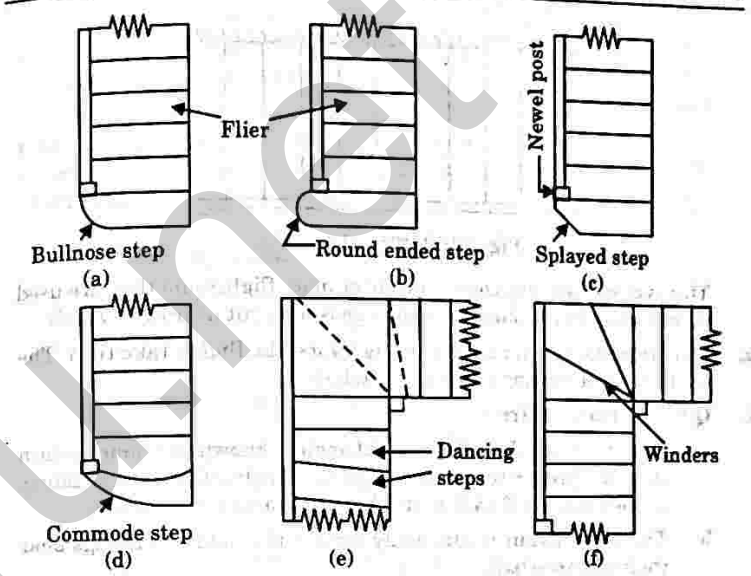


Fig. 3.13.1. Various types of steps.

C. Proportion of Treads and Risers :

1. For comfortable ascent and descent, the rise and tread of a step should be well-proportioned.

2. The following thumb rules are followed :

i. (2 × Rise in cm) + (Going in cm) = 60

ii. (Rise in cm) + (Going in cm) = 40 to 45

iii. (Rise in cm) × (Going in cm) = 400 to 450

iv. Adopt Rise = 14 cm and Going = 30 cm as standard; then for every 20 mm subtracted from going, add 10 mm to the rise.

3. Thus, other combinations for rise and going would be 15 cm × 28 cm; 16 cm × 26 cm; 17 cm × 24 cm.

4. For residential buildings, the common size of the steps is 16 cm × 26 cm. In hospital, etc., the comfortable size of the steps is 10 cm × 30 cm.

Que 3.14. Briefly describe various types of stairs.

Answer

The stairs are classified as follows :

1. **Straight Stairs :** In case of a straight stair, all steps lead in one direction only as shown in Fig. 3.14.1.

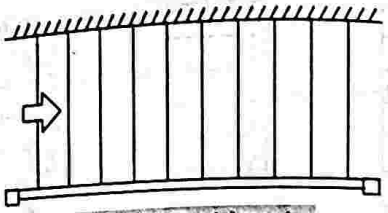


Fig. 3.14.1. Straight stair.

This type of stair may consist of one or more flights and they are used when the space available for staircase is long but narrow in width.

2. **Turning Stairs :** In case of turning stairs, the flights take turn. The usual types of turning stairs are as follows :

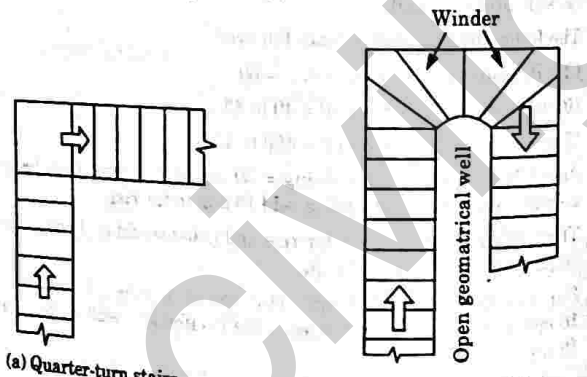
i. **Quarter-turn Stairs :**

a. A stair turning through one right angle is known as a quarter-turn stair. If a quarter-turn stair is branched into two flights at a landing, as shown in Fig. 3.14.2(a), it is known as a bifurcated stair.

b. This type of stair is commonly used in the public buildings near their entrance hall.

ii. **Half-turn Stairs :**

a. A stair turning through two right angles is known as a half-turn stair. A half-turn stair may be of dog-legged type or open newel type as shown in Fig. 3.14.2(b).



(a) Quarter-turn stairs. (b) Half-turn stairs.

Fig. 3.14.2

b. These stairs are useful where available space for staircase has a width greater than twice the width of steps.

iii. **Three Quarter Turn Stairs :**

a. A stair turning through three right angles is known as a three quarter turn stair.

b. This type of stair is used when the length of the staircase is limited and when the vertical distance between the two floors is quite large.

3. **Circular or Helical or Spiral Stairs :** In this type of stair, the steps radiate from the centre and they do not have either any landing or any intermediate newel post. Fig. 3.14.3 shows the details of a circular stair.

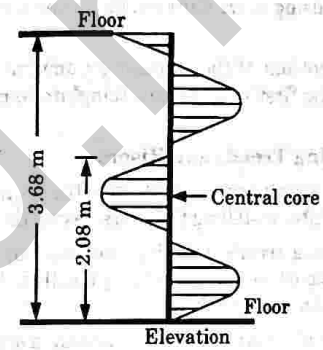


Fig. 3.14.3. Spiral stair.

4. **Geometrical Stairs :** These stairs have any geometrical shape and they require no newel posts. The handrail of a geometrical stair continues without interruption and without any angular turns.

Que 3.15. Discuss a brief note on staircase construction.

Answer

There are three main components in a typical staircase : stringers, treads and risers. Stringers are the sloped boards that support the other components and carry the weight of people walking on the stairs.

Step 1 : Calculating Rise and Run :

1. The first step in building stairs for a deck is finding the total rise or overall vertical height the stairs have to cover.
2. Lay a straight board on top of the deck, extend it from the edge, then measure down to the landing location.

Step 2 : Cutting Stringers :

1. Before laying out the steps decide how the stringers will join the deck. They are either attached directly to the rim joist so the top step is flush with the deck top, or to the framing under the deck.
2. When mounted under the deck, the stringers are either attached to the joists or to blocking placed between joists, and the stringer ends are cut long to reach the framing.
3. Mark the tread notches using a framing square fitted with stair gauges.

4. Clamp one stair gauge on the square's tongue directly at the rise dimension. Attach the other gauge to the body of the square at the run dimension.
5. Then, lay the square on the stringers with the gauges pressed against the board's edge and mark the tread and riser. Slide the square down, align it with the previously drawn notch, and add the next one.
6. Cut the notches using a circular saw, finish the cuts with a jigsaw or a handsaw.
7. Next, trim the bottom of the stringer an amount equal to the tread thickness. Use the first stringer as a template to mark the remaining stringers.

Step 3 : Installing Treads and Risers :

1. Cut the risers to length and fasten them to the stringers with trim head decking screws. After installing the risers, fasten the treads with screws.
2. Continue installing treads, working your way up the staircase. The posts used to support the stair rail are typically bolted to the stringers before installing the treads.
3. However, we completed the stairs first, and then attached the posts and built the handrail that codes usually require.

PART-4

Different Types of Floors and Flooring Materials (Ground Floor and Upper Floors).

CONCEPT OUTLINE : PART-4

Floors and Flooring : In order to sub-divide the portion between the plinth level or basement level and roof level, solid constructions are carried out. These constructions are known as floors and exposed top surface of floors are termed as floorings.

Types of Floors : Following are two types of floor :

i. Ground floor,
ii. Upper floor.

Types of Floorings : Following are the types of floorings :

i. Carpets and rugs,
ii. Vinyl flooring,
iii. Wooden flooring,
iv. Stone flooring,
v. Brick flooring, and
vi. Glass flooring.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 3.16. **Explain different types of floors and flooring materials.**

AKTU 2016-17, Marks 05

Answer

A. **Types of Floor :** Following are the different types of floor :

1. **Ground Floor :**

i. The floor of a building immediately above the ground is known as ground floor. In case, part of the building has basement, the floor is termed as basement floor.

ii. Ground floors, as their names suggest, directly rest on the ground of prepared ground and as such do not require any frame-work.

iii. The object of ground floor is to provide clean, smooth, durable and impervious-levelled surface to the users.

2. **Upper Floor :**

i. Top-most horizontal or sloped structure, covering the rooms from the top is known as roof. All the intermediate floors are known as upper floors.

ii. The upper floors have the major problems of strength and stability since they are supported only at their ends, on walls, beams, etc.

iii. If span of the room is large; wooden, steel or RCC girders are used below patties to span the large rooms.

B. **Flooring Materials :** The material used for floor covering or flooring are :

1. Mud and moorum,
2. Bricks,
3. Flage,
4. Concrete,
5. Terrazo,
6. Mosaic,
7. Tiles,
8. Marble,
9. Granolithic finish, and
10. Wood or timber etc.

Que 3.17. **Explain the factors which affect the choice of flooring materials.**

Answer

Before selecting flooring material for a particular building, following factors should be carefully considered :

1. **Appearance :** The flooring material should give pleasing appearance. It should provide colour effect in conformity with the use of the building.
2. **Durability :** The flooring material should be strong, durable, and capable to resist all the wear and tear to which it is likely to be subjected to.

3. **Noise :** No noise should be produced by the floor when in use. Noise causes discomfort to the occupants.
4. **Cost :** Cost of the flooring materials should be in conformity with the types of building and its likely use.
5. **Fire Resistant :** It should be fire resistant and damp-proof. Maintenance should be easy and cheap.
6. **Cleaning :** Floors should be easily and effectively cleanable.
7. **Slipperiness :** Surface of the flooring material should not be too much slippery. It may prove dangerous for children and old aged people.
8. **Comfortable :** Floors should give comfort to occupants under living and working conditions. Cork, rubber, plaster, linoleum etc, are preferred from comfort view point.

Que 3.18. **What are the different types of ground floor ? Describe them briefly.** **AKTU 2014-15, Marks 10**

Answer

Following are the commonly used ground floors :

1. **Mud Flooring :**

i. It is used in low cost housing, cheap, easy to construct and maintain good thermal insulation.

ii. Over a well prepared ground a 25 cm thick selected moist earth is spread and then rammed to get compacted thickness of 15 cm.

iii. To avoid cracks small quantity of straw or cow dung is mixed.

2. **Mooram Flooring :**

i. The ground floor having its topping consisting of mooram is called mooram floors.

ii. These floors are easily and cheaply repairable, it is mostly used in rural areas.

3. **Brick Flooring :**

i. Warehouses, stores, godowns subgrade is compacted properly and 7.5 cm thick layer of sand is spread. Over this a coarse of bricks laid flat.

ii. Brick flooring is laid on 12 mm thick bed of cement or lime mortar or 10 to 15 cm thick layer of lean cement concrete/lime concrete which is laid over subgrade.

4. **Flag Stone Flooring :**

i. Flag stones are laminated sandstones of 45 × 60 cm. It is called paving.

ii. Slabs are laid on concrete base of 10 - 15 cm thickness. In laying, work is started from two diagonally opposite corners and brought up from both sides.

iii. A string is stretched between two corners of slab to correct level.

iv. Mortar in the joints is raked out to a depth 15 to 20 mm. Proper slope is given for drainage.

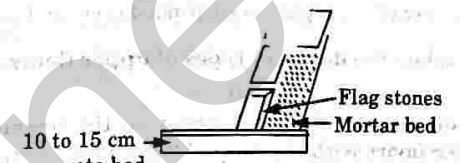


Fig. 3.18.1.

5. **Cement Concrete Flooring :**

i. It is used for residential, commercial and even industrial buildings due to cheap, durable and easy to construct.

ii. Floor consists of two components (i) base concrete, and (ii) topping.

iii. It can be constructed either monolithically-topping lay immediately after the base course is laid or non-monolithically.

6. **Terrazzo Flooring :**

i. This is the type of floor finish laid in thin layer over concrete topping.

ii. Terrazzo is a specially prepared concrete surface containing cement and marble chips in proportion to 1 : 1.25 to 1 : 2. Marble chips vary from 3 mm to 6 mm.

iii. The sub base preparation and concrete base laying is done in similar manner.

7. **Mosaic Flooring :**

i. It is made of small pieces of broken tiles of china glazed or of marble, arranged in different pattern.

ii. A concrete base of 5 to 8 cm thick lime-surkhi mortar is spread and levelled over it.

iii. On this a 3 mm thick cementing material is spread and is left to dry for about 4 hours.

8. **Tiled Flooring :**

i. It is constructed from square, hexagonal or other shapes, made of cement concrete or terrazzo.

ii. Commonly used in houses, offices, schools etc.

9. **Marble Flooring :**

i. It is superior type of flooring used in bathrooms and kitchens of residential buildings, hospitals, sanatoriums, temples etc., where extra cleanliness is essential requirement.

ii. Over the base concrete 20 mm thick mortar under the area of each individual slab is spread.

iii. Slab is then laid over it and gently pressed with wooden mallet.

10. Timber Flooring :

i. It is used in carpentry halls, dancing halls, auditorium etc., and in hilly areas. These are quite costlier.

ii. Timber floor are of two types : (*i*) suspended type, and (*ii*) solid type.

Que 3.19. Explain the different types of upper floors.

OR

On the basis of the provision of support on the beams, classify in brief, the upper floors with the help of their neat sketches.

AKTU 2012-13, Marks 10

Answer

Following are the various types of upper floors :

1. Steel Joist and Stone :

i. This type of floor is quite common in locations where flag-stones or stone slabs are readily available in spans of 1 to 3 m and widths 30 to 60 cm.

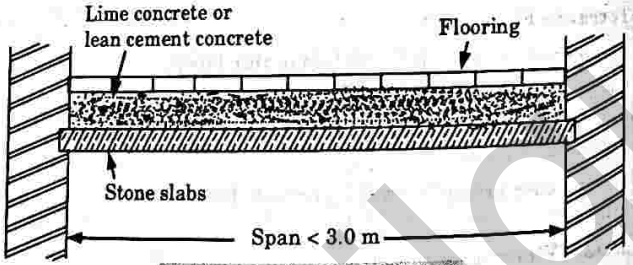


Fig. 3.19.1. Stone slab floor.

ii. Where stone slabs are not available, precast concrete slabs can be used.

iii. The slabs are placed at the lower flange of rolled steel joists (RSJ), especially where plain ceiling is required, though in this case the bearing to the slabs is small. Otherwise, the slabs can be supported on the upper flange of RSJ by inserting wide stone bedding plate, called suboti between the flange and the slab.

iv. When the slabs are placed on the lower flange of joists, the space between the top of the slab and top of RSJ is filled with lime concrete or light weight cement concrete, after encasing the steel joists completely in cement concrete so that they do not get rusted. On the top of it, regular flooring is laid.

2. Jack Arch Floors :

i. Jack arch is an arch of either brick or concrete, supported on lower flange of mild steel joists. The joists are spaced 1 to 1.5 m centre to centre, and are supported at their ends either on the walls or on longitudinal girders.

ii. The rise of the arch is kept equal to $\frac{1}{12}$ th of the span. The minimum depth of concrete at the crown is kept equal to 15 cm.

iii. Since the superimposed load is being borne by arch action, tension is developed on the supporting walls, especially at the end span. Due to this, steel tie rods are provided at the end span, at suitable spacing, usually 1.8 to 2.4 m c/c.

iv. The tie rods are 2 to 2.5 cm diameter, and are properly anchored into the wall.

v. The end arch is supported on wall by either providing rolled steel joist into the wall or simply fixing an angle iron or mild steel in the wall.

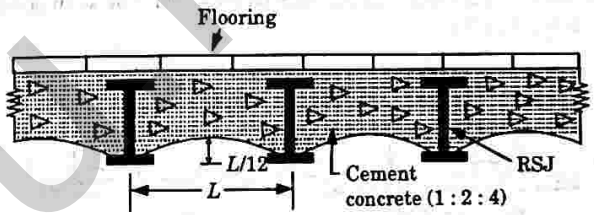


Fig. 3.19.2. Cement concrete jack arch flooring.

3. Reinforced Cement Concrete Floors :

i. Floors of modern buildings are invariably made of reinforced cement concrete (RCC), because of the inherent advantages of this type of construction.

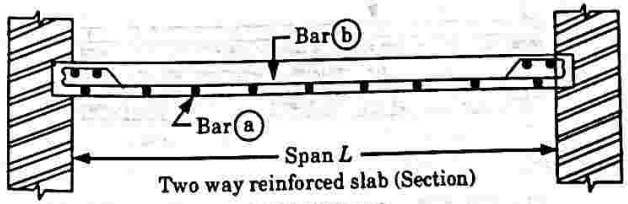


Fig. 3.19.3.

ii. Concrete, though strong in compression, is weak in tension. However, it is suitably reinforced with the help of steel bars which take the entire bending tension. Due to this, the overall thickness of RCC floors is comparatively small thereby reducing the self weight of floor itself. RCC floors are also comparatively fire proof and damp proof.

iii. The method of construction is also easy except that centering is required.

iv. These floors can also be used on large spans, and therefore, more suitable for big size rooms, halls, etc.

v. RCC floors can be classified into the following types :

a. Simple slab flooring, b. Reinforced brick flooring,

c. Beam-slab flooring, and d. Flat slab flooring.

4. Ribbed Flooring or Hollow Tiled Flooring :

i. Concrete is incapable of resisting tension which is caused in the lower part of the thickness of the slab.

ii. This lower part does not take part in load bearing, and hence part of it can be replaced by hollow tiles so that weight of the slab is reduced. This results in a ribbed floor system, as shown in Fig. 3.19.4

iii. Unlike T-beam construction, the ribs of hollow tile construction are closely spaced. The clear spacing of ribs depends upon the size of hollow blocks available, but it should normally not exceed 50 cm.

iv. The width of ribs may vary between 6 and 10 cm. The span of ribs may be as much as 7 m.

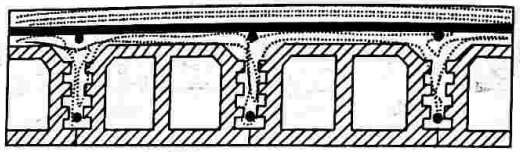


Fig. 3.19.4. Hollow tile and closed-ribbed floors.

5. Filler Joists Floors :

i. This is a typical type of composite construction in which RSJ of small sections is placed in concrete, as shown in Fig. 3.19.5.

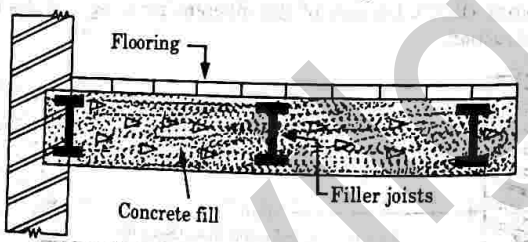


Fig. 3.19.5. Filler joists with cement concrete fill.

ii. The spacing of the joists may vary between 40 and 90 cm.

iii. The filler joists may either rest on walls (if the span is less) or on longitudinal steel beams.

iv. The joists act as reinforcement, and no separate reinforcement is provided in the concrete filled in between the joists.

v. Concrete should completely surround the filler joists and steel beams, with a minimum cover of 2.5 cm over filler joists.

6. Precast Concrete Floors :

i. With the modern developments in construction technology, precast beam-slab units are now available with the help of which the floors can be

constructed easily and expeditiously, without the aid of any form work.

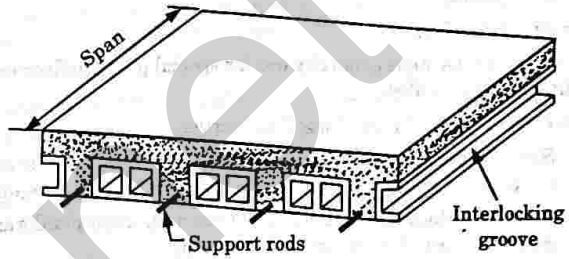


Fig. 3.19.5. Hollow precast floor units.

ii. These precast units are available in about 25 cm width various depths and various spans and can be supported either on walls or on rolled steel joists.

iii. The sides of each unit are provided with grooves to form connecting joggles for adjacent units. The joints are grouted with cement mortar, using concrete guns. Such floors are economical, light weight, sound proof and fire proof.

Que 3.20. Discuss in details about flooring and its requirements.

AKTU 2016-17, Marks 10

Answer

A. Flooring :

1. Flooring is the general term for a permanent covering of a floor, or for the work of installing such a floor covering.
2. Floor covering is a term to generally describe any finish material applied over a floor structure to provide a walking surface.

B. Types of Flooring :

Following are the different types of flooring :

1. Carpets and Rugs Flooring :

i. The terms carpet denotes a large floor covering that can be cut to suit any room.

ii. The rug means a loose-laid piece of size and design determined by the maker.

2. Vinyl Flooring :

i. Vinyl composition tile (VCT) is a finished flooring material used primarily in commercial and institutional applications.

ii. Vinyl tiles are composed of colored vinyl chips formed into solid sheets of

varying thicknesses (1/8" is most common) by heat and pressure and cut into 12" squares.

3. Wooden Flooring :

i. This type of flooring is generally use for special purpose floor example auditorium, hospital etc.

ii. There are different types of wooden flooring :

a. **Strip Flooring :** This type of flooring consists of narrow and thin strip of wood joined to each other by tongue and groove joint.

b. **Planked Flooring :** In this type of flooring, wider planks are used and these are also tongued and grooved.

c. **Heavy Wood Block Flooring :** These are made up of thicker pieces of wood cut in short lengths ranging from 5 to 10 cm.

d. **Fabricated Wood Block :** These consist of small square of rectangular block with tongue and groove joints all side.

4. Stone Flooring :

These may be consists of following materials :

i. **Granite :** This is used because of

a. There are many types and colors of granite.

b. Durable and natural with visible coarse grains.

c. Expensive as compares to marble.

d. Once polished it gives a mirror finish to the structure.

ii. **Slate :** This is used because of

a. It is resistant to wearing, discoloring or fading.

b. It is easily washable with water and soap.

c. It is less expensive than good marble.

iii. **Kotah and Sandstone :** It is used as hard flooring suited for pathways, factory sheds, offices and other common spaces.

5. Brick Flooring :

i. Brick products have been used for many centuries throughout the world for applications such as roads, flooring, monuments, sidewalks and building structures.

ii. Bricks are considered to be the oldest manufactured building material that has been trusted throughout history because of its durability, versatility and practical attributes.

6. Glass Flooring :

i. Glass floors are made with transparent glass when it is useful to view something from above or below, whereas translucent glass is used when there is no need to view through.

ii. In either case, toughened glass is usually chosen, for its durability and

resistance to breakage.

iii. Special hollow glass blocks known as "glass pavers" are often used in combination with a metal frame.

C. Requirements :

Following are the functional requirements of floorings in building :

1. Strength and Stability of Floors in Buildings :

i. The strength of floor structure should be adequate to carry dead load of the floor, finishes, fixtures, partitions, services and expected imposed loads of occupants.

ii. With regard to stability of floors, the stiffness of floor should be enough to make the floor stay stable and level under its self weight and expected dead and live loads.

2. Resistance of Floors to Weather and Ground Moisture :

i. Building ground floor specifically heated building is likely to encourage rising the moisture below the ground and make the floor wet slightly which feels cold and dissatisfying.

ii. Therefore, more heating may be required to create desired comfortable condition.

3. Durability of Floors and Free from Maintenance :

i. Generally, water tight ground floors on solid base and suspended floors secured by walls and roof must be durable for the life of the structure and require slight maintenance, repair or improvement.

ii. The durability and free from maintenance of floors are rely on the nature of materials applied and the wear they are exposed to.

4. Fire Resistance of Floors :

i. Floors should withstand fire for enough period during which the occupant can get out of the building.

ii. Reinforced concrete floors combat fire for longer period compare with timber floors.

5. Resistance to Passage of Heat :

i. Floors have to withstand heat release in situation that there are large air temperature differences on both opposite sides of the floor.

ii. For instance where an open port car is formed under buildings and the floors over the port is subjected to outside weather, so it has to be insulated.

6. Resistance to Passage of Sound :

It is considerably significant that upper floors, which separate dwellings, work as barrier and prevent transmission of sound.

PART-5

Bricks and Stone Masonary Construction, Cavity Wall Hollow Block Construction.

CONCEPT OUTLINE : PART-5

Brick Masonry : It is a unified mass obtained by systematic arrangement of laying and bonding together with mortar.
Bond in Brick Masonry : Bond is the interlacement of bricks, formed when they lay those immediately below or above them.
Stone Masonry : A construction made by using stone units and mortar is known as stone masonry. It can be classified as rubble masonry and ashlar masonry.
Cavity or Hollow Wall : It is the one which consists of two separate walls, called leaves or skins, with a cavity or gap in between.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 3.21. **Give a detail description about brick, sand, stone and masonry construction.** **AKTU 2016-17, Marks 05**

Answer

A. Brick :

1. Clay bricks are used for building-up exterior and interior walls, partitions, piers, footings and other load bearing structures.
2. Size of a standard brick (also known as modular brick) should be 19 × 9 × 9 cm and 19 × 9 × 4 cm. When placed in masonry with mortar it becomes 20 × 10 × 10 cm.
3. The essential requirements for building bricks are sufficient strength in crushing, regularity in size, a proper suction rate, and a pleasing appearance when exposed to view.

B. Sand :

1. Sand is a naturally occurring granular material composed of finely divided rock and mineral particles.
2. It is defined by size, being finer than gravel and coarser than silt.
3. It provides bulk, strength and other properties to construction materials like asphalt and concrete.

C. Stone :

1. Stone has been defined as the natural, hard substance formed from minerals and earth material which are present in rocks.
2. For structural purpose, granite, gneiss, trap, sandstone, limestone, marble, quartzite and slate are most useful.

D. Masonry Construction :

1. Masonry may be defined as the construction of building units bonded together with mortar.
2. The building units (commonly known as masonry units) may be stones, bricks or precast blocks of concrete.
3. The basic advantage of masonry construction lies in the fact that in load-bearing structures, it performs a variety of functions such as :
   i. Supporting loads,
   ii. Subdividing space,
   iii. Providing thermal and acoustic insulation,
   iv. Affording fire and weather protection etc.,

Que 3.22. **Explain the different terms used in brick masonry.**

Answer

Following are the common terms used in brick masonry :

1. **Stretcher :** This is a brick laid with its length parallel to the face or front or direction of a wall size of a stretcher is 9 × 3 inches.
2. **Header :** This is a brick laid with its breadth or width parallel to the face or front or direction of a wall. The size of a header is 4.5 × 3 inches.
3. **Bat :** Any portion of brick cut/broken across its length.

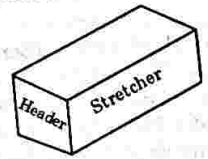


Fig. 3.22.1.

4. **Closer :** Any portion of brick cut along its length.
5. **Queen Closer :** When cutting the brick longitudinally in two equal part.
6. **King Closer :** Brick cut along midpoint of adjacent sides.
7. **Frog :** Indentation on surface.
8. **Arrises :** The edge formed by the intersection of plane surfaces of brick are called arrises and they should be sharp, square and free from damage.
9. **Bed :** The lower surface of the brick when laid flat is known as the bed.

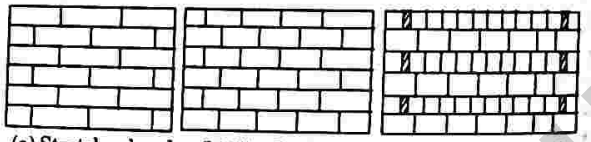
Que 3.23. **Explain the different types of brick bonds used in brick masonry.**

Answer

Classification of Bonds : The bonds can be classified as follows :

1. Stretcher bond.
2. Header bond.
3. English bond.
4. Double Flemish bond.
5. Single Flemish bond.
6. Garden wall bond.
7. Facing bond.
8. Dutch bond.
9. Raking bond.
10. Zig zag bond.
11. English cross bond.
12. Bonds in columns.
13. Brick on edge bond or soldier course.
14. Bonds at junction and squint junction.

1. **Stretcher Bond :** In this type of bond, all the bricks are laid with their lengths in the direction of the wall. This pattern is used only for wall having thickness of 9 cm only.

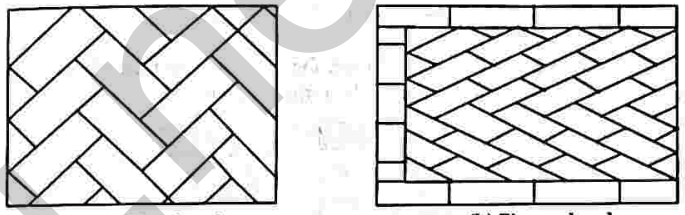


(a) Stretcher bond (b) Header bond (c) English bond

Fig. 3.23.1.

2. **Header Bond :** In this type of bond, all the bricks are laid with their ends towards the face of the wall. This arrangement is suitable for one brick wall or curved wall and footings for better load distribution.
3. **English Bond :** In this type of bond, alternate course of headers and stretchers are laid. It is necessary to place queen closer in the heading course for breaking the joints vertically.
4. **Double Flemish Bond :** In this type, alternate heads and stretchers are laid in each course. The facing and backing are of the same appearance, brick bats and queen closers, are used.
5. **Single Flemish Bond :** This type of bond is comprised of double Flemish bond facing and English bond backing in each course. This type of construction partially possesses the strength of english bond, and appearance of Flemish bond.
6. **Garden Wall Bond :** This type of bond is employed for the construction of garden walls, compound walls, boundary walls etc.
7. **Facing Bond :** In this type of bond, bricks of different thickness are used in the facing and backing of the wall. In this case, a header course is placed after several stretcher courses.
8. **Dutch Bond :** This is the modified form of english bond. The corners of the wall provided with dutch bond are quite strong. The alternate courses in this type of bond are headers and stretchers.

9. **Raking Bond :** In this type of bond, alternate courses are placed in different directions to get maximum strength in the wall. The racking courses are laid to certain interval along the height of the wall in very thick wall having number of headers more than the number of stretchers between the facing and backing.



(a) Raking bond (b) Zig zag bond

Fig. 3.23.2.

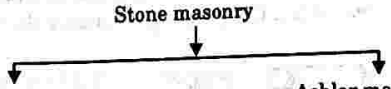
10. **Zigzag Bond :** This type of bond, very much similar to herring bone bond. The only difference is that bricks are laid in zig-zag way and used for paving the brick floor.
11. **English Cross Bond :** This type of bond is aesthetically more sound and posses greater strength than English bond. In this bond every alternate stretcher course has a header placed next to the quolin stretcher and rest of the details are similar to English bond.
12. **Brick on Edge Bond or Soldier Course :** In this type of bond, the bricks are laid on edge. The bricks are placed as headers and stretchers in alternate courses in such a manner that headers are placed on bed and the stretchers are placed an edge forming a continuous cavity.

Que 3.24. **Discuss in detail different types of stone masonry work.**

Answer

Types of Stone Masonry :

The stone masonry can be classified broadly in the following two categories :



Rubble masonry

i. Coursed rubble.
ii. Uncoursed rubble.
iii. Random rubble.
iv. Dry rubble.
v. Polygonal rubble.
vi. Flint rubble.

Ashlar masonry

i. Ashlar fine.
ii. Ashlar rough-tooled.
iii. Ashlar rock or quarry faced.
iv. Ashlar chamfered.
v. Ashlar block-in-course.

1. **Rubble Masonry :** In this category, the stones used are either undressed or roughly dressed having wider joints. This can be further subdivided as uncoursed, coursed, random, dry, polygonal and flint.

i. **Uncoursed Rubble Masonry :**

a. In this type of rubble masonry, the stones are not dressed. But they are used as they are available from the quarry, except knocking out some corners.

b. This type of masonry is used for the construction of compound walls, godowns, garages, labour quarters, etc.

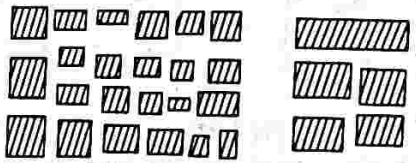


Fig. 3.24.1. Uncoursed random rubble masnory.

ii. **Coursed Rubble Masonry :**

a. In this type of rubble masonry, the heights of stones vary from 50 mm to 200 mm.

b. This type of masonry is used for the construction of public buildings, residential buildings, etc.

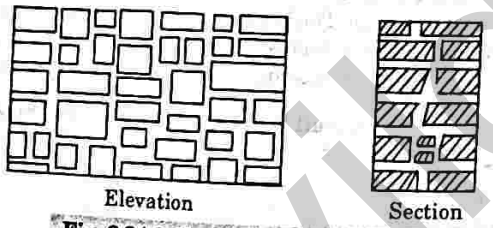


Fig. 3.24.2. Coursed rubble masonry.

2. **Ashlar Masonry :**

i. This type of masonry is built from accurately dressed stones with uniform and fine joints of about 3 mm thickness by arranging the stone blocks in various patterns.

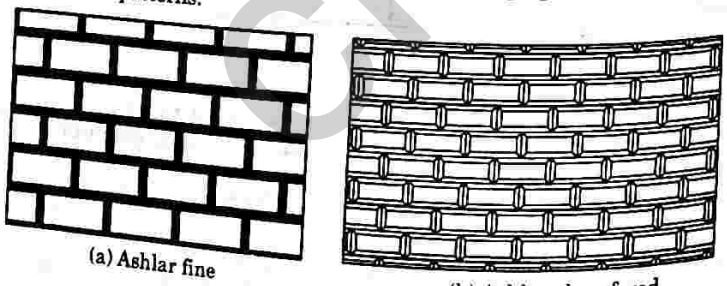


Fig. 3.24.3.

ii. The backing of ashlar masonry walls may be built of ashlar masonry or rubble masonry. The size of stones blocks should be in proportion to wall thickness.

Que 3.25. Write short notes on cavity wall and hollow block construction. **AKTU 2016-17, Marks 05**

Answer

A. Cavity Walls :

1. It is a wall made of two parallel leaves of masonry, separated by a continuous air space. Continuous air space is called cavity.
2. Cavity walls consist of three main parts :

i. The outer leaf which is the exterior part of the wall.

ii. The cavity, the continuous open air space.

iii. The inner leaf which is the interior part of the wall.

3. Width of the cavity varies from 50 mm to 75 mm. The thickness of the outer leaf of wall which is usually non-load bearing is half-brick.
4. Inner wall is always load bearing and its thickness should not be less than one brick.
5. They prevent dampness and provide good insulation from heat and sound.
6. Exterior wall is made thinner and inner wall is of sufficient thickness to take up the load.

B. Hollow Block Construction :

1. Hollow blocks may be prepared from clay or terra-cotta.
2. The blocks can be manufactured in any desired shape and size, but their usual size is 300 mm × 200 mm. Thickness of hollow block walls varies from 50 mm to 150 mm.
3. The blocks have grooves at their surface which help in joining different blocks rigidly. The surface of the blocks is, sometimes, kept glazed in variety of colors.

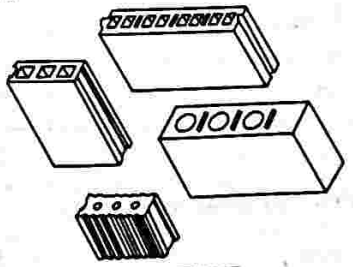


Fig. 3.25.1.

4. These partitions are light in weight, non-shrinkable and efficient in preventing fire and sound.
5. Hollow blocks have following advantages :

i. It consumes less mortar.
ii. Strength of structure increases.
iii. Lesser number of blocks required.

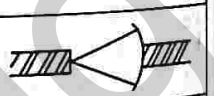
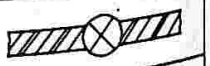
Que 3.26. Give the conventional symbols for :

1. **Various types of doors.**
2. **Almirah.**
3. **Windows.**
4. **Sanitary items.**
5. **Electric items.**

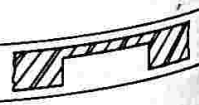
AKTU 2016-17, Marks 10

Answer

1. Conventional Symbols for Various Types of Doors :

S.No.	Element	Symbol
i.	Single leaf, single swing door	
ii.	Single leaf, double swing door	
iii.	Double leaf, single swing door	
iv.	Double leaf, double swing door	
v.	Revolving door	
vi.	Sliding door	
vii.	Rolling shutter	

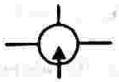
2. Conventional Symbols for Almirah :

Almirah	

3. Conventional Symbols for Windows :

Window	

4. Conventional Symbols for Sanitary Items :

S.No.	Element	Symbol
i.	Indian type water closet (WC)	
ii.	Western style (WC)	
iii.	Rectangular bath	
iv.	Plain kitchen sink	
v.	Kitchen sink with single drainage board	
vi.	Kitchen sink with double drainage board	
vii.	Wash basin	
viii.	Drain cock	
ix.	Mixing valve hand control	
x.	Water meter	 WM

5. Conventional Symbols for Electric Items :

S. No.	Element	Symbol
i.	One way switch, single pole	
ii.	One way switch, double pole	
iii.	One way switch, three pole	

iv.	Two way switch	
v.	Intermediate switch	
vi.	Push button or bell push	
vii.	Socket outlet, 2 Pin 5 A	
viii.	Lamp or outlet for lamp	
ix.	Lamp mounted on wall	
x.	Lamp mounted on ceiling	

VERY IMPORTANT QUESTIONS

Following questions are very important. These questions may be asked in your SESSIONALS as well as UNIVERSITY EXAMINATION.

Q. 1. Describe the classification of buildings as per National Building Code.

Ans: Refer Q. 3.1, Unit-3.

Q. 2. Discuss in detail the various principles for planning the building.

Ans: Refer Q. 3.3, Unit-3.

Q. 3. Explain the ill effects of dampness. What are the techniques and methods of damp prevention ?

Ans: Refer Q. 3.6 and Q. 3.7, Unit-3.

Q. 4. Write a short note on cavity wall with its advantages.

Ans: Refer Q. 3.9, Unit-3.

Q. 5. State briefly the requirements of a good staircase. Also write the type of various steps with their neat sketches. How are the treads and risers proportioned ?

Ans: Refer Q. 3.13, Unit-3.

Q. 6. Explain the different types of floors and flooring materials.

Ans: Refer Q. 3.16, Unit-3.

Q. 7. Discuss in detail about floorings and its requirements.

Ans: Refer Q. 3.20, Unit-3.

Q. 8. Explain the types of bonds used in brick masonry.

Ans: Refer Q. 3.23, Unit-3.

Q. 9. Discuss in detail different types of stone masonry work.

Ans: Refer Q. 3.24, Unit-3.

Q. 10. Write a short note on hollow block construction with its advantages.

Ans: Refer Q. 3.25, Unit-3.

☺☺☺

4 UNIT

Doors And Windows

PART-1

Doors, Windows, Construction Details, Types of Doors and Windows and their Relative Advantages & Disadvantages.

CONCEPT OUTLINE : PART-1

Doors : A door may be defined as an openable barrier secured in a wall opening. It is provided to give an access to the inside of a room of a building.

Windows : A window is also a vented barrier secured in a wall opening to admit light and air to the building and to give a view to the outside.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 4.1. Define the terms door and window ? Discuss the points Considered while locating doors and Windows.

Answer

A. Door :

i. A door may be defined as an openable barrier secured in a wall opening. A door is provided to give an access to the inside of a room of a building.

ii. It serves as a connecting link between the various internal portions of a building.

B. Windows :

i. A window is also a vented barrier secured in a wall opening. The function of the window is to admit light and air to the building and to give a view to the outside.

ii. Windows must also provide insulation against heat loss, and in some case, against sound.

C. Location of Doors and Windows :

The following points should be kept in view while locating doors and windows :

1. The number of doors in a room should be kept minimum.
2. The location of a door should meet functional requirements of a room.
3. If there are two doors in a room, the doors should preferably be located in opposite walls, facing each other.

4. The size and number of windows should be decided on the basis of important factors such as distribution of light, control of ventilation, and privacy of the occupants.
5. The location of a window should also meet the functional requirements of the room such as interior decoration, arrangement of furniture etc.
6. A window should be located in opposite wall, facing a door or another window, so that cross-ventilation is achieved.
7. From the point of view of fresh air, a window should be located on the northern side of a room.
8. The sill of a window should be located about 70 to 80 cm above floor level of the room.

Que 4.2. How the sizes of doors and windows are fixed ?

Answer

A. Sizes of Doors :

1. The size of a door should be such that it would allow the movement of largest object or tallest person likely to use the door. As a rule, the height of a door should not be less than 1.8 m to 2 m.
2. The width of the door should be such that two persons can pass through it walking shoulder to shoulder.
3. The common width-height relations, used in India are :

i. Width = 0.4 to 0.6 height.

ii. Height = (width + 1.2) metres.

4. The following are generally adopted sizes of doors for various types of buildings :

i. Doors of Residential Buildings :

a. External door = (1.0 m × 2 m) to (1.1 m × 2 m)

b. Internal door = (0.9 m × 2 m) to (1 m × 2 m)

c. Doors for bathrooms and water closets = (0.7 m × 2 m) to (0.8 m × 2 m)

d. Garages for cars = 2.25 m (height) × 2.25 m (width) to 2.25 (height) × 2.40 (width).

ii. Public Buildings, such as Schools, Hospitals, Libraries etc :

a. 1.2 m × 2.0 m b. 1.2 m × 2.1 m

c. 1.2 m × 2.25 m.

B. Sizes of Windows :

The following thumb rules are in use :

1. Breadth of window = $\frac{1}{8}$ (width of room + height of room).

2. The total area of window-openings should normally vary from 10 to 20 % of the floor area of the room, depending upon climatic conditions.
3. The area of window-opening should be at least one square metre for every 30 to 40 cubic metre of inside content of the room.
4. In public buildings, the minimum area of windows should be 20 % of floor area.
5. For sufficient natural light, the area of glazed panels should at least be 8 to 10 % of the floor area.

Que 4.3. Discuss the different types of doors in brief. Enlist the various types of doors and explain in detail any four of them.

AKTU 2015-16, Marks 10

OR

Briefly discuss the importance of different types of doors used in the construction work. With the help of neat sketches describe the following types of doors :

1. **Revolving doors.**
2. **Battened, ledged, braced and framed doors.**

AKTU 2012-13, Marks 10

Answer

Types of Doors : The most common types of doors in building constructions may be of following types :

1. Battened and ledged doors.
2. Battened, ledged and braced doors.
3. Battened, ledged and framed doors.
4. Battened, ledged framed and braced doors.
5. Framed and panelled doors.
6. Glazed or sash doors.
7. Sliding doors.
8. Flush doors.
9. Collapsible doors.
10. Revolving doors.
11. Swing doors.
12. Rolling steel doors.
13. Louvered doors.

Some of these doors are explained below :

1. Revolving Doors :

i. This type of door hangs on a central pivot and can rotate, whenever desired, so as to close the opening automatically.

ii. It is useful at places where frequent opening and closing of a door is to be avoided, for example, railway reservation office, fish market, etc.

iii. Single shutter or double shutter revolving doors are also employed in public places such as hostels, hospitals, etc.

iv. They are also used in air conditioned buildings as they keep the door closed for the most period, and do not admit a heavy draught of air when opened.

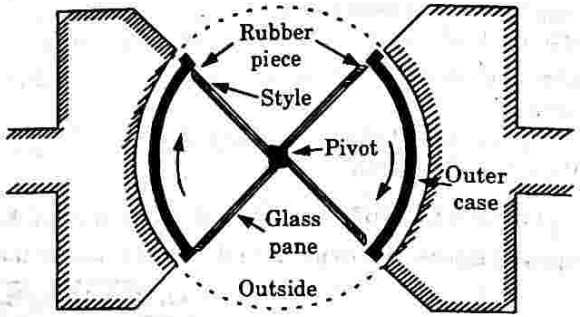


Fig. 4.3.1. Revolving door.

2. Ledged Doors :

i. They are made up of timber boards known as battens which are generally 150 mm wide and 25 mm thick.

ii. They are placed vertically side by side and are fixed in position by horizontal members known as ledges.

iii. Generally T-hinges are used at top and bottom to fix up the shutter in the door frame.

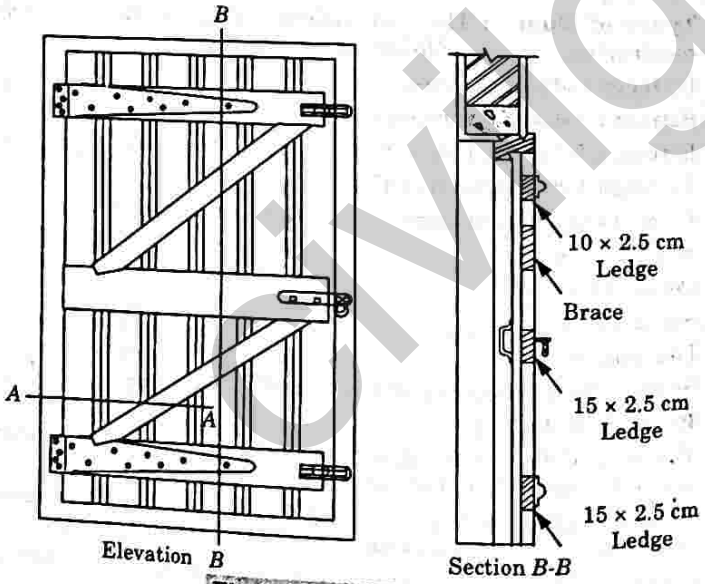


Fig. 4.3.2. Ledged door.

3. Ledged and Braced Doors :

i. They are similar to ledged doors except braces that are fixed in the ledges.

ii. These types of doors are more rigid and they can be used for wide openings.

4. Ledged and Framed Doors : A framework for shutter is made to render the door stronger and improve the appearance.

5. Ledged, Braced and Framed Doors : Similar to the ledged and framed door, only braces are provided in between the two ledges.

6. Battened, Ledged, Braced and Framed Doors :

i. This door is the modification over the door described above, with provision of additional braces, provided diagonally between the ledges, to increase its strength, durability, and appearance.

ii. This door thus consists of battens, two vertical members (styles), three ledges, and two braces.

iii. The battens are generally tongued, grooved and V-jointed. The braces are housed into the ledges, at about 40 mm from the styles.

vi. Fig. 4.3.3 shows the elevation and cross section of this type of door.

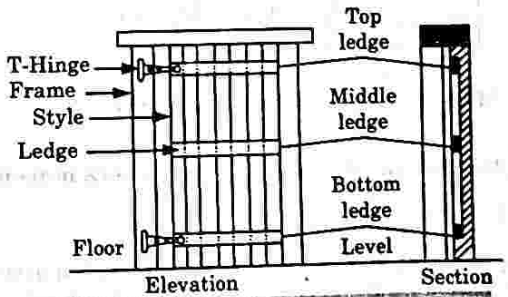


Fig. 4.3.3. Ledged, Braced and Framed Door.

7. Framed and Panelled Doors :

i. These are most commonly used door and it consists of a framework in which panels are fitted.

ii. The style continues from top to bottom.

iii. In such types of doors the tendency to shrink is reduced and appearance is also pleasant.

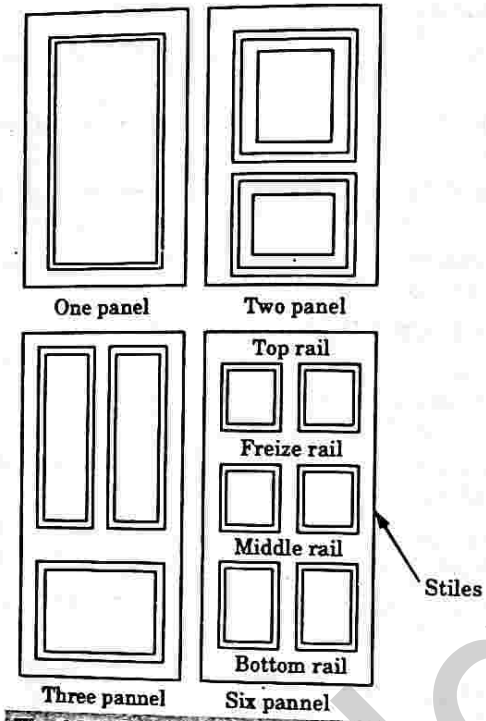


Fig. 4.3.4. Framed and paneled door.

Que 4.4. **Discuss all different types of window movement.**

Answer

1. **Fixed Type :** The framework with the panels or glazing is rigidly fixed with the masonry walls. It cannot have any movement.
2. **Opening Outside :** Shutters open towards external side of the building.
3. **Opening Inside :** Shutter open inside the room.
4. **Double Hung :** One shutter moves up while the other shutter moves down.
5. **Pivoted :** Window shutters rotate about a pivot fixed in the window frame.
6. **Sliding :** Shutters move inside the masonry walls vertically or horizontally.
7. **Top Higned :** The shutter is hinged at the top and is moved outside.
8. **Bottom Higned :** Shutter is hinged at the bottom and is moved inside.

Que 4.5. **What are the different types of windows ? Give brief description of each type.**

OR

With the help of neat sketches, briefly discuss the classification of windows according to the operational point of view.

AKTU 2013-14, Marks 10

Answer

Following are the various types of windows :

1. **Casement Window :**

i. It consists of a square or rectangular window frame of metal or wood, with a casement hinged at one side of the frame to open out.

ii. The side hinged opening part of the window is known as the casement and it consists of glass surrounded and supported by metal or timber strips.

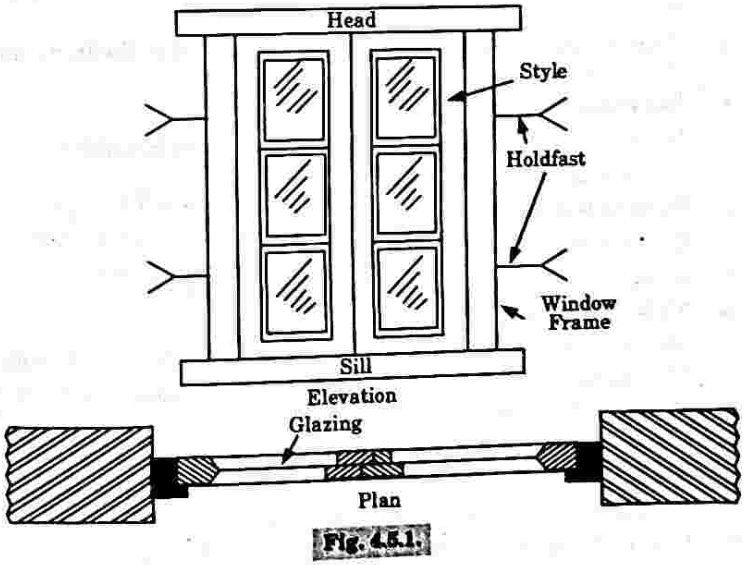


Fig. 4.5.1.

2. **Sash or Glazed Window :**

i. A sash consists of styles, rails transoms and mullions.

ii. The glass panels are cut into smaller size than the size of the panels into which they are to be fitted.

iii. It is essential to allow slight movement of the sash due to temperature changes.

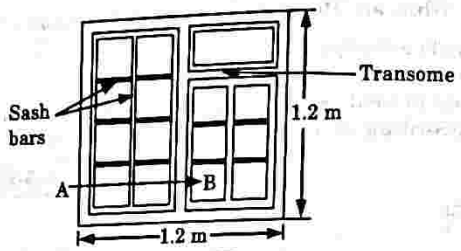


Fig. 4.5.2.

iv. Sash may be rigidly fixed to the frame hinged at the style or it may be sliding horizontally or vertically.

3. **Double – Hung Window :**

i. It consists of a pair of shutters and each of them can slide.

ii. This facilitates cleaning of the window and the ventilation through the window.

iii. Shutters can be slided vertically in the opening left in the frame and the side walls.

4. **Louvered Window :**

i. It is employed when privacy and enough ventilation is required.

ii. It may be fixed or moving type.

5. **Pivoted Window :**

i. In this shutter swings round pivots.

ii. It may be horizontally pivoted or vertically pivoted.

6. **Sliding Window :**

i. Shutters are slided on roller bearings either vertically or horizontally.

ii. The cavities are provided in the walls to accommodate the window shutters, when it is opened as in trains, buses etc.

7. **Circular Window :**

i. It is pivoted window of circular shape.

ii. Commonly used in workshops, factories etc.

8. **Corner Window :** Constructed in corner of a building and admits light and air from two directions.

9. **Gable Window :** Ordinary casement window provided in the gable ends of an inclined roof building.

10. **Bay Window :**

i. It is a window of building which is projected beyond the walls of the room.

ii. It is provided to improve the architectural appearance of the building.

11. **Dormer Window :**

i. It is provided on the inclined roofs of the buildings.

ii. They are constructed within the space of the roof slopes.

12. **Clerestory Window :**

i. It is provided near the main roof.

ii. It admits light and air into the room.

iii. It is pivoted and the shutter is operated by a cord or wire moving round a pulley.

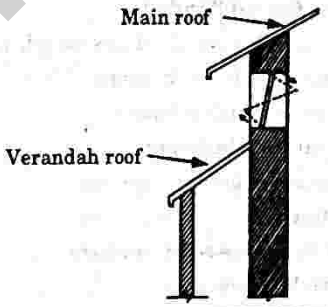


Fig. 4.5.3. Clerestory window.

13. **Lantern Light :**

i. Windows provided on the flat roofs to admit more light into the room.

ii. This type of window is known as lantern.

14. **Sky Light :**

i. It is fixed on the sloping surface of an inclined roof.

ii. A curb frame is provided with the common rafter to support the window.

iii. It is meant to admit light into the room.

15. **Metal Window :**

i. They are fabricated from light rolled steel sections which forms window frame.

ii. The glass pans are fixed into frame.

Que 4.6. What are the advantages of different types of windows ?

Answer

Advantages of Steel Windows :

1. The steel windows are factory made products and hence they possess greater precision as compared to the wooden windows.

2. The steel windows are not subject to contraction or expansion due to weather effects as in the case of wooden windows.
3. The steel windows exhibit elegant appearance.
4. The steel windows are easy to maintain and their cost of maintenance is almost negligible as compared to that of the wooden windows.
5. The steel windows are highly fire-proof and termite-proof.
6. The steel windows grant better facilities for providing different types of openable parts.
7. The steel windows are more durable and stronger as compared to the wooden windows.

Advantages of Double Glazed Window :

i. It provides acoustic insulation and reduces outside noise level.
ii. It provides excellent security for the home.
iii. It reduces heat loss using timber frames.

Advantages of Aluminium Windows :

i. It is more durable and has low maintenance.
ii. It reduces carbon footprint.
iii. They are stronger than the wooden windows.

Advantages of Louvre Window :

i. They are very easy to clean.
ii. The blades can be angled to control the air flow.
iii. They can be opened to nearly the full width of window *i.e.*, it creates maximum flow of air.
iv. They provide protection against excessive daylight.

Advantages of Sliding Window :

i. They provide unobstructed view due to large size.
ii. The operation is easy for this window.
iii. They have low maintenance.

Advantages of Casement Window :

i. They also provide a fully open window.
ii. They provide better security.
iii. They also catch side breezes.

Que 4.7. **What are the different types of glasses used in construction of doors and windows ?**

Answer

The different types of glass used in the construction of doors and windows are as follows :

1. **Plate Glass :**

i. Flat and transparent glass, plain and polished surface shows no distortion. This type of glass is fitted into show windows.
ii. The thickness of glass plate varies from 3 to 6 mm.

2. **Processed Glass :**

i. Three varieties of processed glass are used *i.e.*, ground glass, chipped one process and chipped two process glass.
ii. Some provide privacy in true sense with a uniform diffusion of light and others provide maximum transmission of light.

3. **Prism Glass :** It has prism shaped ribs for deflecting light. Prisms are provided at different angles to suit the various requirements.
4. **Clear Window Glass :** It is transparent thin and flat glass. It has plain and smooth surface with small waviness of surface.
5. **Active Glass :** It reduces heat and large percentage of glare.
6. **Wire Glass :** Sometimes, a mesh of wire is embedded in the glass, in this case flat glass is rolled with wire mesh at the time of manufacture. It is employed for the protection.
7. **Quartz Glass :** It transmits ultraviolet rays and used in hospitals etc.
8. **Bullet-proof Glass :** It is manufactured witl. laminated plate glass which may break under impact but does not turn into pieces.

PART-2

Types of Roof and Roof Treatments.

CONCEPT OUTLINE : PART-2

Roofs : A roof is the uppermost part of a building which is constructed to protect the building from rain, wind, heat, snowfall, etc.

Types of Roof : It can be classified as :

i. Pitched or slopping roof,
ii. Flat roof,
iii. Shelled roof, and
iv. Domed roof.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 4.8. **What are the functional requirements for the design and construction of roofs ?**

Answer

A. Requirements of a Roof : The requirements of a good roof are given below :

1. It should have adequate strength and stability to carry the superimposed dead and live loads.
2. It should effectively protect the building against rain, sun, wind, etc., and it should be durable against the adverse effects of these agencies.
3. It should be water-proof, and should have efficient drainage arrangements.
4. It should provide adequate thermal insulation.
5. It should be fire resistant.
6. It should provide adequate insulation against sound. Most forms of roof construction provide for majority of buildings, an adequate insulation against sound from external sources.

Que 4.9. **What are the different types of roofs ? Explain briefly.**

Answer

A. Classification of Roofs :

The roofs can be classified into following categories :

1. Pitched or slopping roofs.
2. Flat roofs.
3. Shelled roofs.
4. Domed roofs.

1. Pitched or Slopping Roofs :

i. This is the roof which is most commonly used for roofing large-spanned structure like factory buildings, warehouses, workshops etc., in plain areas.

ii. This type of roof is the only roof adopted in hilly areas and areas subjected to extreme winds, rains and snow falls.

iii. They are used not only for industrial buildings but for residential buildings as well.

iv. Pitched roofs are the cheaper than other types.

2. Flat Roof :

i. A roof which is approximately flat is called as flat roof.

ii. It may be constructed in reinforced concrete, flat stone supported on rolled steel joists (RSJ), bricks, concrete or tiled arches etc.

iii. This roof is provided with slight slope in one direction to drain off the rain water easily.

iv. The construction of flat roof is similar to the construction of floor except that the top surface is protected against rain water.

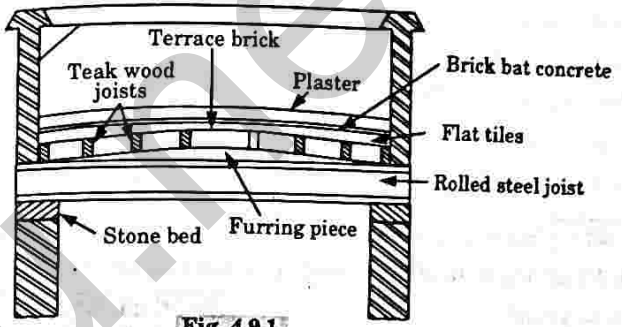


Fig. 4.9.1.

3. Shell Roof :

i. These are very useful for covering large structures, for example assembly halls, recreation centres, libraries, theatres, etc.

ii. Reinforced cement concrete shell roofs are more popular.

iii. Very less quantity of materials are required to build up a shell roof as compared to other.

iv. The design of the shell is made as thin as practical requirement will allow such that the dead load is decreased and the shell acts as a membrane free from large bending stresses.

4. Dome Roof :

i. It is a special type of shell roof, semi spherical or semi elliptical shape.

ii. Domical structures may be divided into two main divisions :

   a. Smooth shell domes.
   b. Ribbed domes.

Que 4.10. **What are the advantages and disadvantages of flat roof ?**

Answer

A. Advantages :

1. It can be used as terrace for playing or for sleeping etc.
2. It construction and maintenance is simpler.
3. It provides better appearance.
4. It possesses good insulating properties.
5. It easier to make it fire resistant.

B. Disadvantages :

1. A flat roof cannot be used for long spans without using columns and beams.
2. Not suitable in areas of heavy rainfall.
3. Initial cost is more.
4. Sometimes cracks develop due to variation in temperature.
5. The speed of construction is slow.
6. Leakage problem.

Que 4.11. What is the role of pitched roof in the construction work ? With the help of their neat sketches classify any five types of pitched roof. **AKTU 2012-13, Marks 10**

OR

Explain the various types of pitched roofs. **AKTU 2015-16, Marks 10**

Answer

A. Role of Pitched Roof :

1. This is the roof which is most commonly used for roofing large-spanned structures like factory buildings, warehouses, workshops etc., in plain areas.
2. This type of roof is the only roof adopted in hilly areas and areas subjected to extreme winds, rains and snow falls.
3. They are used not only for industrial buildings but for residential building as well. Pitched roofs are the cheaper than other types.
4. Its object is to protect the building from rain, heat, wind, snow, etc.

B. Types of Pitched Roof : Following are the various types of pitched roof :

1. Lean of Roof :

i. This types of roof has slope on one side only. It is mostly used to cover the verandah of a building.

ii. In this type of roof one wall is carried sufficiently higher than the other so that necessary slope to the roof is developed.

iii. The roof consists of common rafters, the higher ends of which are supported on a wall plate. This wall plate remains supported on projecting corbel from the wall.

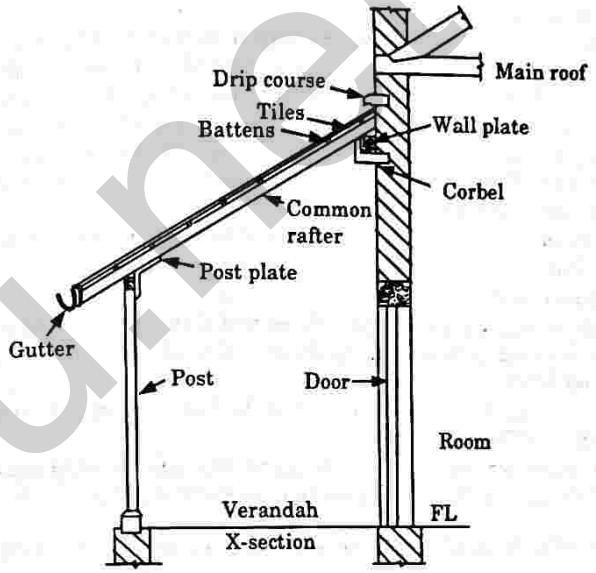


Fig. 4.11.1. Lean to roof.

2. Coupled Roof :

i. This is another roof constructed over rafters only. This roof has slope on both the sides of the ridge.

ii. In this, common rafters slope upwards from the opposite walls and meets on a ridge piece in the middle.

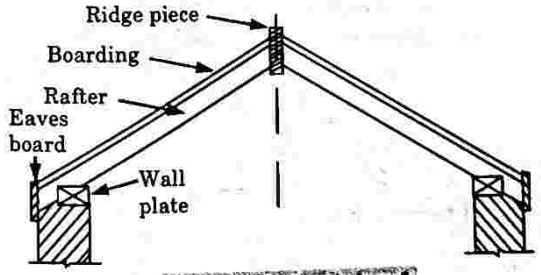


Fig. 4.11.2. Coupled roof.

iii. Lower ends of the rafters are firmly secured by notching or nailing to the wooden wall plates, fixed on the top of the walls.

iv. These rafters are fixed at suitable intervals and battens are nailed on their top. Roofing is lastly fixed on the frame-work of battens.

v. This types of roof can be constructed upto 3.6 m span.

3. Couple-Close Roof :

i. The couple-close roof is just the coupled roof except that the common rafters are connected by a third horizontal member near the lower ends of the rafters. This horizontal member is known as tie beam.

ii. The tie beam takes all the horizontal thrust which was otherwise being transmitted to the side walls in case of coupled roof, and thus tendency of rafter to spread out and also chances of overturning of the walls are completely eliminated.

iv. Tie beam can also act as ceiling joist if ceiling is to be provided. This coupled-closed roof can be used up to span of 5 m.

4. Collar Roof :

i. Collar roof is similar to couple-closed roof with the only difference that the tie beam instead of being fixed at feet of the rafters is fixed at higher level.

ii. The tie beam when fixed higher than the feet of the rafter is known as collar or collar beam.

iii. The collar roof provides more height of the room as ceiling can be fixed to the collar beams and exposed portions of the rafters.

iv. The collar beam should be attached at $\frac{1}{3}$ rd to $\frac{1}{2}$ the vertical height from the wall to the ridge.

v. The lower the collar attached, stronger is the roof. This roof can be used upto span of 5 m.

5. King Post Truss :

i. This truss consists of two principal rafters, one tie-beam, two struts and a king post.

ii. This truss is suitable for roofs of span varying from 5 m to 8 m or 9 m.

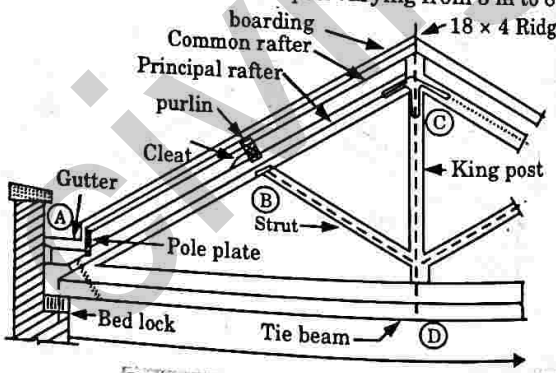


Fig. 4.11.3. Details at joint A.

iii. The trusses are used at centre to centre distance of about 3 m.

iv. The frame-work of the truss is built in such a way that under external load its shape does not change. All the members of this truss are subjected to either direct tension or compression.

v. Magnitude of bending stresses is negligibly small and hence not considered in design. King post truss is shown in Fig. 4.11.3

vi. The central vertical post connecting ridge and the beam is known as king post.

vii. The inclined members connecting base of the king post with principal rafters at their centre points are known as struts.

viii. Struts prevent the principal rafter from bending.

6. Queen Post Truss :

i. Queen post truss differs from king post truss in having two vertical members, known as queen posts.

ii. This truss consists of two queen posts, two principal rafters, struts, tie beam, straining beam, straining sill and purlins etc.

iii. The upper ends of the queen posts are held apart by a horizontal member, known as straining beam.

iv. Straining beam receives thrust from principal rafters and maintains stability of the joint.

v. Inclined struts which rest on splayed shoulders transmit thrust to the queen posts at the bottom and tend them move inwards.

vi. A straining sill is provided on the tie-beam between queen posts to counteract the thrust of struts.

vii. The principal rafters, straining beams, straining sills and struts are subjected to compressive forces whereas queen posts and tie beam to tensile forces.

viii. This truss can be used over spans varying from 9 m to 14 m. Queen post truss, is shown in Fig. 4.11.4.

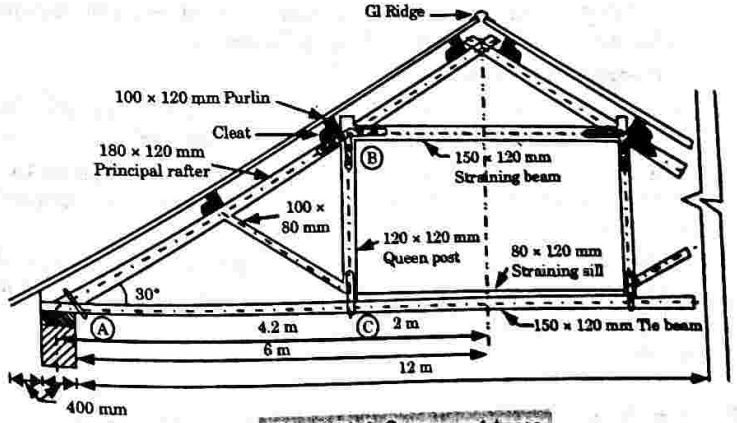


Fig. 4.11.4. Queen post truss.

Que 4.12. **Write a short note on roof treatment.**

AKTU 2016-17, Marks 05

Answer

A. Roof Treatment :

1. The entry of water or dampness into a building is termed as leakage.
2. The process we generally apply to prevent the leakage and to the stop the external output and flow of water inside the building is termed as roof treatment.

B. Treatment of Pitched Roof :

1. In general rainwater is liable to leak through a pitched or sloped roof on account of the following reasons :

i. Due to insufficient roof slope.

ii. Due to insufficient lap in roof covering material *i.e.*, AC or CGI sheets, tiles, slates etc.

iii. Due to inadequate treatment to rain water gutter.

2. The slope of the gutter should not be flatter than 1 : 100 in straight length and it should be made steeper in portion where the gutter is not straight.
3. The gutter should be leak proof and all the joints in the gutter should be made tight.
4. The work of laying roofing should be carefully supervised and it should be ascertained that the sheets or tiles projects beyond the edge of the gutter.
5. Lead flashing should be continued up to the vertical face of the parapet wall and should stop inside the body of the wall.

C. Treatment of Flat Roof :

1. Flat roofs require relatively heavier and costlier water proofing treatment as compared with pitched roof or sloped roofs.
2. The specification of material used for this purpose should be such that it performs the function of water-proofing as well as provides adequate thermal insulation.
3. Stagnation of water on the roof is considered to be the root cause of leakage and dampness in flat roofs. This can be avoided by providing adequate roof slope and rainwater pipes.
4. In case of RCC slab roofing with proper grading above a slope of 1 in 100 is considered desirable.
5. In addition to the slope, the size and the spacing of the rain water pipes or the outlets require due consideration for the proper drainage of the roof.

6. In general practice, one 10 cm diameter pipe is considered suitable for every 30 m^2 of the roof area to be drained.

PART-3

Lintels and Chhajja, Functional Efficiency of Buildings, Ventilations.

CONCEPT OUTLINE : PART-3

Lintel : It is a horizontal structural member spanning any opening to support the load of the structure coming over it.

Chhajja : A chhajja is the projecting or overhanging eaves or cover of a roof, usually supported on large curved brackets.

Ventilators : These are small windows fixed at a greater height than the window, generally about 30 to 50 cm below roof level.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 4.13. **What is lintel ? Classify various types of lintels and discuss their relative use.**

Answer

A. Lintel :

1. Lintel is a horizontal structural member spanning any opening to support the load of the structure coming over it.
2. It is used to span the openings for doors, windows, corridors etc.

B. Types of Lintels : Following are various types of lintels :

1. Wooden Lintels :

i. It is the oldest type of lintels and they are used in hilly areas where timber is cheaply available.

ii. Sound and hard timber like teak is used to span over the opening and masonry is constructed over it.

iii. Only good quality of timber with a coat of suitable preservative should be used as lintels.

iv. The ends of the lintels rest on a mortar base on the walls for a minimum width of 150 mm.

2. **Brick Lintels :**

i. It is used for small openings, not exceeding 1 metre span, and light loads.

ii. They are built up with hard well burnt, copper coloured, free from cracks and with sharp and straight edged bricks.

iii. A centering or temporary support is required to construct a brick lintel.

iv. When brick lintels are constructed to span over large opening mild steel reinforcing bars are used with rich cement mortar. It is known as reinforced brick lintel.

3. **Stone Lintels :**

i. It is used in stone masonry structures of buildings faced with stones.

ii. It may be constructed by single piece or more than one piece.

iii. Due to high cost and its weakness, its use is restricted.

4. **Steel Lintels :**

i. Steel angles are used for spanning small openings and rolled steel joints are used for heavy loading and large spans. Sometimes a combination of two or more is used.

ii. The system may be embedded in cement concrete to protect steel from fire and corrosion.

5. **Reinforced Cement Concrete Lintels :**

i. It is economical and simple in construction.

ii. It consists of a rectangular or square concrete section reinforced with mild steel bars.

iii. Precast RCC lintels are preferred for small spans upto about 2 metres. It increases speed of construction.

iv. When RCC lintels are used, there is no need of providing any relieving arches.

Que 4.14. What are the various functions of lintels and chhajjas ? Explain with neat sketches, various ways of using stone and RB lintels.

AKTU 2012-13, Marks 10

Answer

A. Functions of Lintels :

1. It is beam-like horizontal structural flexural member, used to span over the openings of doors, windows and cup-boards. Lintel behaves just like beam.
2. It provides a bearing for the masonry above the openings and transfers all the loads acting over the opening to the supporting walls.

B. Functions of Chhajjas : A chhajja is the projecting or overhanging eaves or caver of a roof, usually supported on large curved brackets.

Following are the main function of chhajja :

1. It usually protects from external sunlight.
2. It protects from rainwater entering into the building.
3. It also serves as aesthetic decoration with little design on it from architectural point of view.

C. Stone Lintels :

1. Stone lintels are very commonly used in regions where stone is easily available.

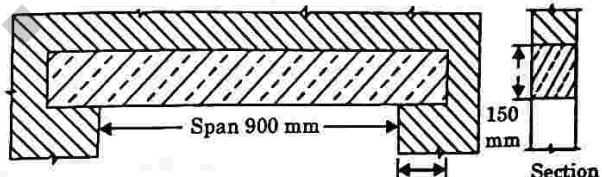


Fig. 4.14.1. Stone lintel.

2. They may be used in form of single-piece or more than one piece. Stone lintels are very weak in tension and thus, cannot be used on large spans.
3. If used over span of 1 m, it should be relieved from most of the load coming over it by providing relieving arch.
4. Depth of stone lintel may be taken on the basis of thumb rule that for every 10 mm span, thickness of lintel should be 1 mm.
5. Stone lintels are required to be dressed before use and hence, prove costly. This lintel is not used except in the stone regions.
6. The lintel can be used on a span of even 3 m but in that case two or three, 3.5 m long stone putties are used on edge side by side and space between putties is filled with cement concrete.

D. Reinforced Brick Work Lintel (RB Lintels) :

1. When brick lintels have to be used over large spans, they are reinforced with steel bars.
2. Bricks are arranged in such a way that 2 cm wide, lengthwise, spaces are left in the brick rows.
3. Steel rods are put in these gaps and spaces are then filled with rich cement mortar or concrete. If gap is about 20 mm wide rich cement is used.
4. If gap is about 40 mm, it should be filled with cement concrete, as shown in Fig. 4.14.2. Depth of the lintel should be minimum 100 mm.

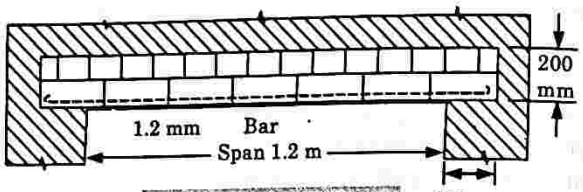


Fig. 4.14.2. (a) RB Lintel.

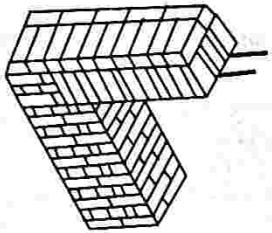


Fig. 4.14.2. (b) RB lintel isometric view.

Que 4.15. **Describe functional efficiency of building.**

AKTU 2016-17, Marks 05

Answer

Functional efficiency refers to :

1. The fact that the size and permanence (attributes or ability of the building to meet the client's goals and objectivcs in terms of the holding period the client decides on keeping the building for, e.g., the client requires the building to last for 20 years to perform his functions economically) of the structures determines the quality of services that can be provided within the physical, technical, philosophical and financial constraints of the client.
2. How serviceable a building is for its existing or proposed use.
3. The building-to-land coverage ratio.
4. The appearance of the building.
5. The adequacy of improvements to land and buildings in promoting the generation of income, for example the rentable floor area to gross area efficiency as a factor of design efficiency.

Que 4.16. **Write a short note on ventilators.**

Answer

1. Ventilators are small windows, fixed at a greater height than the window, generally about 30 to 50 cm below roof level.

2. The ventilator has a frame and a shutter, generally glazed, which is horizontally pivoted.
3. The shutter can be opened or closed by means of two cords, one attached to the top rail and other to the bottom rail of the shutter.
4. The top edge of the shutter opens inside and bottom edge opens outside, so that rain water is excluded.

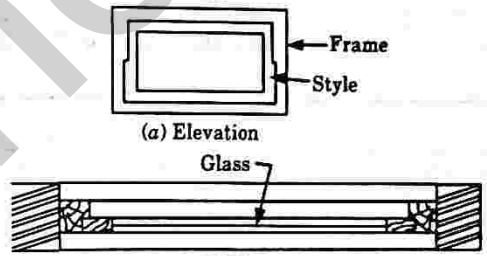


Fig. 4.16.1. Ventilator.

VERY IMPORTANT QUESTIONS

Following questions are very important. These questions may be asked in your SESSIONALS as well as UNIVERSITY EXAMINATION.

Q. 1. Discuss the points which should be considered while locating doors and windows.

Ans. Refer Q. 4.1, Unit-4.

Q. 2. Explain the different types of doors in detail.

Ans. Refer Q. 4.3, Unit-4.

Q. 3. What are the different types of windows ? Write the advantages of steel windows over wooden windows.

Ans. Refer Q. 4.5 and Q. 4.6, Unit-4.

Q. 4. Explain the functional requirements for roof. Also explain the different types of roof.

Ans. Refer Q. 4.8 and Q. 4.9, Unit-4.

Q. 5. Explain in detail king post truss and queen post truss.

Ans. Refer Q. 4.11, Unit-4.

Q. 6. What are the various functions of lintel and chhajjas ? Explain different types of lintel in brief.

Ans. Refer Q. 4.14 and 4.13, Unit-4.

☺☺☺

5 UNIT

Natural Ventilation

PART-1

Natural Ventilation.

CONCEPT OUTLINE : PART-1

Ventilation : It may be defined as supply of fresh outside air into an enclosed space or the removal of inside air from the enclosed space.
Types of Ventilation : Following are two types of ventilation :
i. Natural ventilation.
ii. Artificial ventilation.
Natural Ventilation : It is the one in which ventilation is affected by the elaborated use of doors, windows, ventilators and skylights.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 5.1. **Define the term ventilation. Discuss the factors which affect ventilation.**

Answer

A. Ventilation :

1. Ventilation may be defined as supply of fresh outside air into an enclosed space or the removal of inside air from the enclosed space.
2. In other words, ventilation is the removal of all vitiated air from a building and its replacement with fresh air.
3. Ventilation may be achieved either by natural or by artificial (or mechanical) means.

B. Factors : Following are the factors affect the ventilation :

1. Air Changes :

i. The rate of air change will depend upon the volume of structure, type of activity in the premises, number of persons occupying the premises, etc.

ii. It will also depend on the velocity of incoming fresh air and quantity of heat, moisture and odour present in the room.

iii. The ventilating system as a whole should be such that there is smooth movement of air currents and that there is no stagnation of air at any spot in the room.

2. **Humidity :**

i. The criteria of relative humidity of air also affect the ventilating system of the structure.

ii. For working at temperature of 21°C, a range of 30 to 70 per cent of relative humidity is desirable.

iii. The values of relative humidity is obtained by comparing dry-bulb and wet-bulb temperatures, the low humidity and greater air movement are necessary for removing greater portion of heat from the body.

3. **Quality of Air :**

i. The purity of air plays an important role in the comfort of persons affected by ventilation system.

ii. The air should be free from odours, organic matter, inorganic dust and unhealthy fumes of gases such as carbon monoxide, carbon dioxide, sulphur dioxide, etc.

iii. The ventilating system should be so designed that it gives comfort to the occupants by giving pure air.

4. **Temperature :**

i. It is quite evident that the incoming air for ventilation should be cool in summer and warm in winter before it enters the room.

ii. The usual difference of temperature between inside and outside is kept as about 8°C to 10°C. With regard to the human comfort, the term effective temperature is used.

iii. The popular values of effective temperature in winter and summer are 20°C and 22°C respectively.

5. **Use of Building :** The quantity of fresh air to be supplied to a room depends on the use of building and it is to be decided by taking into consideration various factors such as number of occupants, types of activity, period of working, age or occupant, etc.

Que 5.2. "Maintenance of proper ventilation and temperature in a building is very important from health and hygienic point of view". Justify this with the help of the functional requirements of natural ventilation system. What are the standard norms we use for the natural ventilation ? **AKTU 2012-13, Marks 10**

Answer

A. Proper Ventilation and Temperature in Building :

1. Proper ventilation and temperature in a building is very essential for health, efficiency, and hygienic conditions. Pure air is essential for all.
2. If some room is not properly ventilated, suffocating conditions may develop in the room and no one would like to live in such a room.

3. Lack of ventilation would cause unhygienic conditions and affect health and efficiency. Hence while planning any building is should be ensured that each room is properly ventilated.
4. In such constrained conditions artificial ventilation is adopted to provide good ventilation.
5. In winter, blood pressure of human being is always more than outer atmospheric pressure and to maintain it higher, one has to eat more and thus efficiency of the man is increased.
6. In summer, blood pressure of human beings is less than outer atmospheric pressure. This results in less eating and consequently, efficiency of the man suffers.
7. This is the reason that people in cold western countries work more efficiently than tropical countries.
8. Excess of humidity in the atmosphere also affects health.
9. Disease producing bacteria flourish at a very faster rate in comparatively more humid conditions and thus different diseases spread so often.
10. Like ventilation and humidity, natural light in the building is equally important.
11. Thus, in the design of a new building, utmost effort should be made to ensure proper ventilation, maintain healthy humid conditions, and admit proper natural light from outside.

B. Standard Norms used in Natural Ventilation :

Indian Standard Codes IS 3362 – 1965 lays down the following general rules of natural ventilation :

1. Inlet openings in the buildings should be well-distributed and should be located on the windward side at a low level and outlet openings should be located on the leeward side near the top so that incoming air stream is passed over the occupants. Inlet and outlet openings at high levels only may clear top air at that level without producing air movement at the level of occupancy.
2. Inlet openings should not as far as possible be obstructed by adjoining buildings, trees, sign boards, or other obstructions or by partitions inside in the path of air flow.
3. Greatest flow per unit area of openings is obtained by using inlet and outlet openings of nearly equal areas.
4. Where direction of wind is quite constant and dependable, openings can be readily arranged to take full advantage of the force of the wind.
5. When the wind direction is quite variable, the openings may be arranged so that, as far as possible there is approximately equal area on all sides.
6. Natural ventilation occurs when the air inside building is at a different temperature than the air outside. Thus in a heated building and in an ordinary building during summer nights and during pre-monsoon period

when the inside temperature is higher than outside, cool air will tend to enter through openings at low level and warm air will tend to leave through openings at high level.

7. Windows of living rooms should either open directly to an open space or to an unobstructed facing as open space. In places where building sites are restricted, open space may have to be created in the buildings by providing adequate courtyards.

Que 5.3. **Describe the various types of ventilation.**

AKTU 2016-17, Marks 05

Answer

The systems of ventilation may broadly be divided into the following two categories :

1. Natural Ventilation :

i. In this system of ventilation, the use is made of doors, windows, ventilators and skylights to make the room properly ventilated.

ii. This system is useful for small buildings and it cannot be adopted for big offices, theatres, auditoriums, etc.

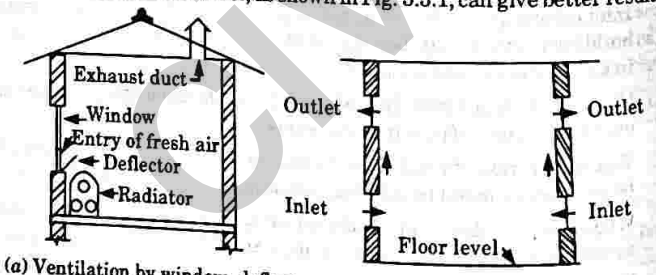
iii. The only advantages of this system are that it is economical in the sense that no special equipment is necessary for making the room adequately ventilated and that it affords living under natural conditions.

iv. The important points to be remembered in connection with natural ventilating system are :

a. The location, size and type of windows play a great role in imparting natural ventilation to the room.

b. The efficiency of roof ventilators depends on their location, wind direction and height of building.

c. It is found that the window ventilation with a combination of radiator, deflector and exhaust, as shown in Fig. 5.3.1, can give better results.



(a) Ventilation by window, deflector, radiator and exhaust (b) Natural ventilation

Fig. 5.3.1.

v. This type of ventilation depends on the direction of wind and it is very difficult to control the entry of air containing smoke, dust, etc.

2. Mechanical or Artificial Ventilation :

i. In this system of ventilation, some mechanical arrangement is adopted to provide enough ventilation to the room. This system has become popular due to recent change in motion regarding ventilation.

ii. At present, the ventilation is required not merely to furnish warm air or cool air. But the ventilation system should provide air of such qualities regarding humidity, temperature, etc. as to make the room comfortable at all times during the year.

iii. The system is costly, but it results in considerable increase in the efficiency of the persons under the command of the system. This system is adopted for big offices, banks, industrial plants, theatres, auditoriums, etc.

iv. Following are the five methods of the artificial ventilation :
   a. Exhaust system.
   b. Supply system.
   c. Combination of exhaust and supply systems.
   d. Plenum process.
   e. Air-conditioning.

Que 5.4. **Write about the functional requirements of a ventilation system. Which are the two effects take place for the rate of natural ventilation or aeration ? Write also the general consideration and rules for natural ventilation.**

AKTU 2013-14, Marks 10

Answer

A. Functional Requirements of Ventilation System : Following are the requirements of a good ventilating system :

1. It should admit required amount of fresh air in the room.
2. It should effectively extract the vitiated air from the room. All the corners of the room should get proper ventilation.
3. The value of desired relative humidity should be maintained.
4. Effective temperature should be maintained with regard to the human comfort.
5. The ventilating air should be free from impurities such as dust, odour etc.

B. Effects : The rate of ventilation depends on two effects :

1. Ventilation due to Wind Effect :

i. In this, the rate of ventilation depends upon the direction and velocity of wind outside and sizes and positions of openings. Such an effect is known as "ventilations due to wind action".

ii. When wind blows at right angles to one face of building, pressure differences are created, positive pressure is produced on windward face and negative pressure is produced on the leeward face.

iii. If the wind direction is at 45° to one of the faces, positive pressure will be produced on two windward faces and negative pressure on the two leeward faces.

2. Ventilation due to Stack Effect :

i. In this, the rate of ventilation is affected by the convection effects arising from temperature or vapour pressure difference (or both) between inside and outside of the room and the difference in the height between the outlet and inlet openings.

ii. When air temperature inside is higher than the outside warmer air rises and passes through openings located in the upper part of the room whereas incoming cool air enters from the lower openings.

3. Ventilation due to Both the Effects :

i. When both wind and stack pressures are acting, it is proper to calculate each pressure acting independently under conditions ideal to it and then apply a percentage.

ii. However, ventilation in residential buildings due to stack pressure both in hot-arid region and in hot-humid region appears to be insignificant and at any rate may be neglected, as when both wind pressure and stack pressure are acting the wind pressure effect may be assumed to be predominant.

C. General Consideration for Natural Ventilation : Following are the general considerations for natural ventilation :

1. Inlet opening should be so located that all the parts of the room are uniformly ventilated. They should be located on wind ward side and at low level.
2. Outlet openings should be located on leeward side near the ceiling in the side walls and if need be in the roof also.
3. More height of the room gives better ventilation due to stack effect.
4. Inlet openings should not be obstructed by trees, partitions, adjoining buildings, or other obstructions. This ensures free entrance of wind into the room.
5. If wind direction is variable, then opening should be provided in all the walls. But all the opening should be provided with suitable means of closing and opening.
6. Long narrow rooms should be ventilated by providing openings in short walls. Ventilation through windows can be improved by using deflectors, radiators and exhaust ducts, etc.
7. In slopping or pitched roofs ventilators should be fixed at the ridge. The effectiveness of roof ventilators depends on their location, wind direction

8. Outlet openings should be just opposite to inlets. This ensures better cross-ventilation. The openings over the doors of back walls create good condition for cross- ventilation.

D. Rules : Refer Q. 5.2, Page 5–3C, Unit-5.

Que 5.5. Enumerate the objects for which ventilation is a must.

Answer

Ventilation is necessary for the following reasons :

1. To create air movement.
2. To prevent an undue accumulation of carbon dioxide and moisture.
3. To prevent depletion of oxygen content in the air.
4. To prevent flammable concentration of gas vapour or dust
5. To prevent undue concentration of body odours, fumes, dust, and other industrial products.
6. To prevent an undue concentration of bacteria-carrying particles.
7. To prevent condensation in the building.
8. To admit fresh air and push out the contaminated air.
9. To prevent suffocating conditions in committee halls, cinema halls and other such buildings.

PART-2

Water Supply and Sanitary Fittings (Plumbing), Electricity, Heating Ventilation and Airconditioning.

CONCEPT OUTLINE : PART-2

Water Supply System : It is a network of engineered hydrologic and hydraulic components which provide water supply in a building.

Air Conditioning : The process of creating, controlling and maintaining indoor atmospheric conditions best suited to the requirements of man or to the needs of industry is known as air conditioning.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 5.6. **Explain in brief water supply system and its fixtures.**

AKTU 2014-15, Marks 03

Answer

A. Water Supply System :

1. Water is collected from the water main through a service connection.
2. The layout of water distribution piping may be basically a horizontal or vertical arrangement of limited height and in which underground mains under pressure supply water to the fixture inlets. Such a system is known as unfeed system.
3. Alternatively, water is first collected in underground tank (known as suction tank) and then it is pumped to elevated storage tanks, usually situated at the top of the building. From these elevated storage tanks, water can flow down and feed the fixtures.

B. Fixtures : Fixtures may be classified as :

1. Valves :

i. These are the devices incorporated in pipelines to control the flow into, through, and from them. Valves are also known as faucets, cocks, bibs, stops, and plugs.

ii. The types of valves generally used in water-supply systems are gate, globe, angle, ball, and check valves.

2. Pipe Supports :

i. When standard pipe is used for water supply in a building, stresses due to ordinary water pressure are well within the capacity of the pipe material.

ii. Generally, it is sufficient to support vertical pipes at their base and at every floor. Maximum support spacing for horizontal pipes depends on pipe diameter and material.

3. Meters :

i. These are generally installed on the service pipe to a building to record the amount of water delivered.

ii. The meters may be installed inside the building, for protection against freezing, or outside, in a vault below the frost line.

Que 5.7. **Write a short note on drains.**

Answer

1. Floor drains should be installed at all areas where the possibility of water spillage occurs.
2. Common areas that are provided with floor drains include restrooms, mechanical rooms, kitchens, shower, and locker rooms.

3. Equipment that requires piped discharge from drains or relief devices, such as boilers, require recessed type drains of adequate size, preferably with a funnel receptor.
4. Large commercial kitchens often require deep, receptor floor sinks to receive indirect wastes from kitchen equipment.
5. In addition to the usual drain at the lowest point, receptacles generally are provided with a drain at the flood level rim to prevent water from overflowing.
6. The overflow should discharge into the waste water system on the fixture side of the trap.

Que 5.8. **Describe the various elements of water supply system with the help of diagram.**

AKTU 2016-17, Marks 10

Answer

The water supply system consists of :

1. Ferrule :

i. It is a right angled sleeve made of brass or gun metal, and is joined to a hole drilled in the water main, to which it is screwed down with a plug.

ii. Its size usually varies between 10 to 50 mm diameter. For all other connections of more than 50 mm diameter, a tee branch connection, of the water main, is used.

2. Goose Neck : It is small sized curved pipe made of a flexible material (usually lead) and is about 75 cm in length forming a flexible connection between the water main and the service pipe.

3. Service Pipe :

i. It is a galvanised iron pipe of size less than 50 mm diameter. It should be laid underground in a trench in which no sewer or drainage pipe is laid.

ii. The service pipe which supplies water through to the building through the municipal main is thus connected to the main through the goose neck and ferrule.

4. Stop Cock :

i. The stop cock is provided before the water enters the water meter in the house.

ii. It is housed in a suitable masonry chamber with a removable cover, and is fixed in the street close to the boundary wall in an accessible position. Sometimes, it is provided just before the water meter inside the house, keeping both of them in one chamber.

5. Water Meter :

i. Water meter measures and records the quantity of water consumed in the house.

ii. The domestic type water meter generally employed for houses is fitted into the service pipe with unions, which enables the meter to be changed where necessary.

iii. The water meter is generally fixed in an iron box fitted in an opening or cavity made in the boundary wall of the house, and is covered with a movable iron cover.

Diagram :

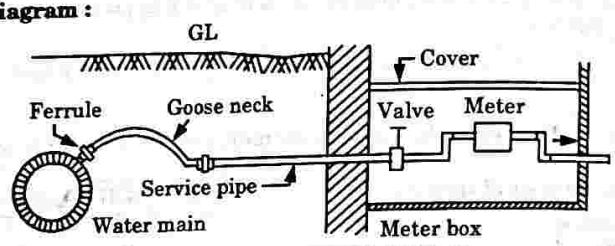


Fig. 5.8.1. Service connection.

Que 5.9. Discuss about various components of electrical supply in a building.

Answer

Following are the components of electricity supply system :

1. **Electrical Supply Intake :** Although the electrical supply intake can be terminated in a meter box situated within a dwelling, most supply companies prefer to use the external meter box to enable the meter to be read without the need to enter the premises.
2. **Meter Boxes :** Generally supply company's meters and termination equipments are housed in a meter box.
3. **Consumer Control Unit :**

i. This provides a uniform, compact and effective means of efficiently controlling and distributing electrical energy within a dwelling.

ii. The control unit contains a main double pole isolating switch controlling the live phase and neutral conductors, called bus bars.

4. **Consumer's Power Supply Control Unit :** This is conveniently abbreviated to consumer unit. It contains a supply isolator switch, live, neutral and earth bars, plus a range of individual circuit over-load safety protection devices.
5. **Over-load Protection :** Protection is provided by a split load residual current device (RCD) dedicated specifically to any circuits that could be used as a supply to equipment outdoors, for example, power sockets on a ground floor ring main.
6. **RCD :** A type of electro-magnetic switch or solenoid which disconnects the electricity supply when a surge of current or earth fault occurs.

7. **Electric Cables :** These are made up of copper or aluminium wire scaled conductors surrounded by an insulating material such as PVC or rubber.
8. **Conduits :** These are steel or plastic tubes which protect the cables. Steel conduits act as an earth conductor whereas plastic conduits will require a separate earth conductor drawn in.
9. **Trunking :** Alternative to conduit and consists of a preformed cable carrier which is surface mounted and is fitted with a movable or 'snap on' cover which can have the dual function of protection and trim or surface finish.
10. **Wiring Systems :** Rewireable systems housed in horizontal conduits can be cast into the structural floor slab or sited within the depth of the floor screed.
11. **Cable Sizing :** The size of a conductor wire can be calculated taking into account the maximum current the conductor will have to carry (which is limited by the heating effect caused by the resistance to the flow of electricity through the conductor) and the voltage drop which will occur when the current is carried.
12. **Socket Outlets :** These may be single or double outlets, switched or unswitched, surface or flush mounted and may be fitted with indicator lights. Recommended fixing heights are.
13. **Power Circuits :** In new domestic electrical installations the ring main system is usually employed instead of the older system of having each socket outlet on its own individual fused circuit with unfused round pin plugs.
14. **Lighting Circuits :** These are usually wired by the loop-in method using an earthed twin cable with a 6 amp fuse or miniature circuit breaker protection.
15. **Electrical Accessories :** For lighting circuits these consist mainly of switches and lamp holders, the latter can be wall mounted, ceiling mounted or pendant in format with one or more bulb or tube holders.

Que 5.10. Explain the term air conditioning. State its objectives.

Answer

A. Air Conditioning :

1. The process of creating, controlling, and maintaining indoor atmospheric conditions best suited to the requirements of man or to the needs of industry is known as air conditioning.
2. This process consists of conditioning air with respect to humidity, temperature, odour, bacteria content, dust content and air movement so that comfortable conditions are maintained inside the room.

B. Objects of Air-Conditioning : Following are the objects of air conditioning :

1. To provide comfort to the occupants.
2. To improve the efficiency of commercial establishments like offices, shops, stores, banks.
3. To provide comfortable conditions in restaurants, cinema houses, auditoriums, etc.
4. To provide comfortable conditions during travelling by air, railway, road, etc. In this case compact air-conditioning devices are used.
5. To improve the quality of products in manufacturing processes such as cotton cloth, artificial silk etc.

PART-3

Mechanical Lifts and Escalators, Fire Fighting, Acoustics.

CONCEPT OUTLINE : PART-3

Mechanical Lift or Elevator : An elevator is a mechanism that moves along guides in a shaft or hoistway in a substantially vertical direction and that can transport passengers and goods between two or more floors of a building.

Escalators : It is also a vertical transportation mechanism in the form of moving staircase *i.e.*, a conveyor which carries people between floors of a building.

Fire Protection : It is defined as the protection of the occupants of the building, contents and structure of the building and adjacent building from the risk of fire.

Acoustics : It is the science of sound which deals with origin, propagation and auditory sensation of sound and also with design and construction of buildings to set optimum conditions for producing and listening speech, music, etc.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 5.11. **Write a short note on mechanical lift and escalators.**

Answer

A. Mechanical Lifts or Elevator :

1. An elevator is a hoisting and lowering mechanism equipped with a car or platform that moves along guides in a shaft, or hoistway, in a substantially vertical direction and that transports passengers or goods, or both, between two or more floors of a building.

2. Passenger elevators are designed primarily to carry persons. Hospital elevators are also passenger elevators but employ special cars, suitable in size and shape for transportation of patients in stretchers or standard hospital beds and of attendants accompanying them.
3. Freight elevators carry freight, which may be accompanied only by an operator and persons necessary for loading and unloading it.
4. Elevators are desirable in all multistory buildings for movement of passengers and freight. They may be required by local building codes for any buildings over two stories high or for transportation of disabled persons.
5. Elevators, however, are not usually accepted as a means of egress, because no cohesive strategy has been established to assure proper operation of elevators in an emergency.
6. Nevertheless, elevators are vital for fire fighting in a high-rise building.

B. Escalators :

1. Escalators, or powered stairs, are used when it is necessary to move large numbers of people from floor to floor.
2. They provide continuous movement of persons and can thus remedy traffic conditions that are not readily addressed by elevators.
3. Escalators should be viewed as preferred transportation systems whenever heavy traffic volumes are expected between relatively few floors.
4. Escalators are used to connect airport terminals, parking garages, sports facilities, shopping malls, and numerous mixed-use facilities.
5. Escalators are generally used in straight sections, spiral escalators are also available.

Que 5.12. **Give all the design considerations, which affect the elevator or lift system. Also write the design parameters and the location of elevators.** **AKTU 2013-14, Marks 10**

Answer

A. Structural Considerations for Elevators :

1. Elevators and related equipment, such as machinery, signal systems, ropes, and guide rails, are generally supplied and installed by the manufacturer.
2. The general contractor has to guarantee the dimensions of the shaft and its freedom from encroachments.
3. The owner's architect or engineer is responsible for the design and construction of components needed for supporting the plant, including buffer supports, machine-room floors, and guiderail bracket supports.

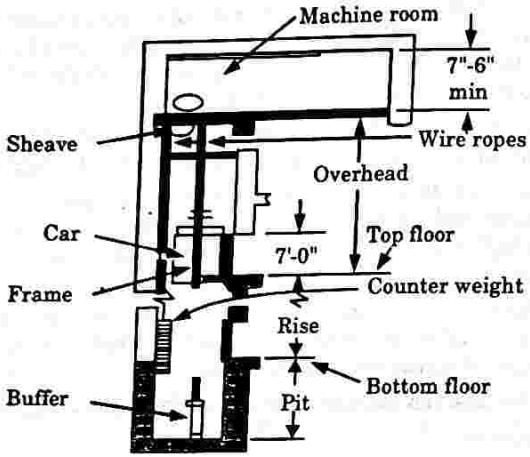


Fig. 5.12.1.

4. Magnitudes of loads are generally supplied by the manufacturer with 100 % allowance for impact.
5. For design of machinery, sheave beams, and floor systems, unit stresses should not exceed 80 % of those allowed for static loads in the design of usual building structural members.
6. Importantly, deflections on machinery and sheave supporting structures may not exceed 1/1666 the span.
7. This stiffness helps to minimize variations in leveling due to load-induced deflection.
8. Where stresses due to loads other than elevator loads, supported on the beams or floor system exceed those due to elevator loads, 100 % of the allowable unit stresses may be used.
9. Unit stresses, calculated without impact, in a steel guide rail or its reinforcement, caused by horizontal forces, should not exceed 15 kN, and deflection should not exceed 1/4 inch.
10. Guide-rail supports should be capable of resisting horizontal forces with a deflection of not more than 1/8 inch.

B. Design Parameters : For design of lifts, parameters to be considered are :

1. Population or number of people who require lift service.
2. Handling capacity or maximum flow rate require by the people.
3. Interval or quality of service required.

C. Location : Elevators should be located at the circulation core of the building and be grouped into banks when this is necessary and desirable.

Que 5.13. Write a short note on fire protection.

Answer

1. It is defined as the protection of the occupants of the building, contents and structure of the building and adjacent buildings from the risks of fire and spread of fire.
2. The objective is achieved by using fire resistive materials in the construction.
3. By suitable planning of the building internally and in relation to adjacent building internally and by providing suitable means of quick escape for the occupants.
4. These measures are essential to minimize the spread of fire and limit the total damage to a minimum.

Que 5.14. Give the general fire safety requirements for the building.

Answer

1. It should be the objective of every engineer and architect while planning and designing the building that the structure offer sufficient resistance against fire so as to afford protection to the occupants, use of fire-resisting materials and construction techniques and providing quick and safe means of escape in the building.
2. All the structural elements such as floors, walls, columns, beams etc., should be made of fire resisting materials.
3. The construction of structural elements such as walls, floors, columns, lintels, arches etc., should be made in such a way that they should continue to function at least for the time, which may be sufficient for occupants to escape safely in times of fire.
4. The building should be so planned or oriented that the elements of construction or building components can withstand fire for a given time depending upon the size and use of building, to isolate various compartments so as to minimize the spread of fire. Suitable separation is necessary to prevent fire, gases, and smoke from spreading rapidly through corridors, staircases left shafts etc.
5. Adequate means of escape are provided for occupants to leave the building quickly and safely in terms of outbreak of fire.
6. In multi-storied office buildings suitable equipment for detecting, extinguishing and warning of fire should be installed in the niches.

Que 5.15. What do you mean by acoustics ? What is its principle ? Also discuss about the various characteristics of audible sound.

AKTU 2012-13, Marks 10

Answer

A. Acoustics :

1. Acoustics is the science of sound, which deals with origin, propagation and auditory sensation of sound, and also with design and construction of different building units to set optimum conditions for producing and listening speech, music, etc.
2. The knowledge of this science is necessary for the proper functional design of theatres, cinema halls, auditoriums, conference halls, hospitals, etc., so that unwanted sound is excluded or insulated.

B. Principle :

1. Sound is generated in the air when a surface is vibrated. The movements of the ear drum are translated by the brain into sound sensation.
2. When the sound waves are periodic, regular and long continued, they produce a pleasing effect, such a sound is known as musical sound.
3. On the contrary, when the sound wave is non-periodic, irregular and of very short duration, it produces displeasing effect, such sound is known as noise.
4. A noise is an abrupt sound of complex character with an irregular period and amplitude originating from a source of non-periodic motion.

C. Characteristics of Audible Sound : Following are three characteristics of sound :

1. Intensity and Loudness :

i. Intensity of sound is defined as the amount of flow of wave energy crossing per unit time through unit area taken perpendicular to the direction of propagation.

ii. Mathematically the energy of a wave and hence the intensity at a point is proportional to the square of the amplitude of vibration of the point, *i.e.*, $I \alpha A^2$.

iii. Loudness of a sound corresponds to the degree of sensation depending on the intensity of sound and the sensitivity of ear drums, and does not increase proportionally with intensity but more nearly to its logarithm, *i.e.*, $L \alpha \log I$.

iv. It is known as Weber and Fechner's law which states that the magnitude of any sensation is proportional to the logarithm of the physical stimulus that produces it.

v. Thus, intensity of sound is purely a physical quantity which can be accurately measured, and which is independent of ear of listener.

vi. Loudness, on the other hand, is the degree of sensation which is not wholly physical but partly subjective and does depend upon the ear and the listener.

2. Frequency or Pitch :

i. Frequency or pitch is defined as the number of cycles which a sounding body makes in each unit of times. It is a measure of the quality of a sound.

ii. It is that characteristic by which a shrill sound can be distinguished from a grave one, even though the two sounds may be of the same intensity.

iii. The sensation of pitch depends upon the frequency with which the vibrations succeed one another at the ear, the greater the frequency, the higher the pitch and the lesser the frequency the lower the pitch.

iv. The frequency scale covers a wide range varying from 20 cycles per second to 1500 cycles per second.

3. Quality :

i. The quality of a sound is that characteristic which enables us to distinguish between notes of the same pitch and loudness played on two different instruments or produced by two different voices.

ii. A study of vibration curves of various musical instruments has shown that the notes emitted by them are seldom pure.

iii. They contain some fundamental tones of frequency n and additional tones (of frequencies $2n$, $4n$, etc.) called overtones.

iv. The quality of a tone is determined by its complex structure and depends upon the presence or absence of a certain number of overtones, on their relative strengths and pitches.

v. It is to be noted that it is the memory of this tonal quality which enables us to recognize a large number of different sounds.

vi. Among these are the voices of friends and acquaintances, the various sound employed in speech and familiar musical instruments and the cries of animals.

Que 5.16. What are the common acoustical defects and their remedies ?

Answer

Following are the common acoustical defects and their remedies :

1. Reverberation :

i. The effect is that the sound once created prolongs for a longer duration resulting in confusion with the sound created next.

ii. The remedy of this defect is to correct the time of reverberation by suitably installing the absorbent materials.

2. Formation of Echoes :

i. When the reflecting surfaces are situated at a distance greater than 17 metres or so and when the shape of the auditorium is unsuitable, the formation of echoes takes place.

ii. This defect can be removed by selecting proper shape of the auditorium and by providing rough and porous interior surfaces to disperse the energy of echoes.

3. Sound Foci :

i. In case of concave reflecting interior surfaces, certain spots are formed where reflected sound waves meet and create a sound of large intensity. These spots are known as the sound foci.

ii. They can be eliminated by avoiding curvilinear interiors or by providing highly absorbent materials on the focusing areas.

4. Dead Spots :

i. Because of high concentration of reflected sound at the sound foci, there is deficiency of reflected sound at some other points. These points are known as dead spots and the sound level at dead spots is generally inadequate for satisfactory hearing.

ii. This defect can be remedied by the installation of suitable diffusers so as to have even distribution of sound in the hall.

5. Loudness :

i. This defect is due to lack of the reflection surfaces near the source of sound and excessive absorption of sound in the hall.

ii. The remedies to correct this defect consist in arranging hard reflecting surfaces near the source of sound and in adjusting the absorption of the hall so as to give an optimum time of reverberation.

Que 5.17. What are the factors to be considered in the acoustic design of a theatre or lecture hall ?

Answer

In general, following are the factors to be considered in the acoustic design of a theatre or lecture hall :

1. Site selection and planning.
2. Determination of capacity and dimensions.
3. Shape, depending on the use and capacity.
4. Reverberation time.
5. Treatment of the interior surfaces.
6. Seating arrangement, provision of balconies, etc.
7. Design of acoustical system of sound reinforcement by loudspeakers, etc.
8. Beautification by architectural effects.

PART-4

Plastering Different Types, Pointing, Distempering.

CONCEPT OUTLINE : PART-4

Plastering : It is the process of covering rough surface of walls, columns, ceiling and other building components with thin coat of plastic mortars to form a smooth durable surface.

Types of Plastering : Following are two types of plastering :

i. Mud plastering.
ii. Stucco plastering.

Distempering : It is the process of applying distemper to the plastered or pointed surface.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 5.18. What do you mean by plastering ? Discuss its objectives and requirements of a good plaster.

Answer

A. Plastering :

1. Plastering is the process of covering rough surfaces of walls, columns, ceilings and other building components with thin coat of plastic mortars to form a smooth durable surface.
2. The coating of plastic material (*i.e.*, mortar) is termed as plaster.
3. Plastering on external exposed surfaces is known as rendering.

B. Objects of Plastering : Plastering is done to achieve the following objects :

1. To protect the external surfaces against penetration of rain water and other atmospheric agencies.
2. To give smooth surface in which dust and dirt can not lodge, etc.
3. To give decorative effect.
4. To protect surfaces against vermin's.
5. To conceal inferior materials or defective workmanship.

C. Requirements of Good Plaster : The plaster material should be full fill the following requirements :

1. It should adhere to the background, and should remain adhered during all variations in seasons and other atmospheric conditions.
2. It should be hard and durable.
3. It should possess good workability.
4. It should be possible to apply it during all weather conditions.
5. It should be cheap.
6. It should effectively check penetration of moisture.

Que 5.19. Explain the different types of plastering.

Answer

A. **Types of Plastering :** Following are the two types of plastering :

1. **Mud Plastering :**

i. This type of plastering is commonly seen in kuchha construction in villages and in other structures of temporary character.

ii. This is the cheapest form of plastering. Mud to be used for plastering should be made from earth free from grass roots, gravel, stone, grit etc.

iii. All the clods in the earth should be broken and reduced to a fine powder. The earth is then mixed with, plenty of water in a pit, adding, chopped straw, hay or hemp at the rate of 33 kg/cubic metre of earth.

iv. This mixture of earth and straw, well flooded with water, is kept for at least 6 days. During this period, the mixture is worked up at intervals with foot or phawras so as to convert it into a homogeneous mass.

v. The surface to be plastered is prepared exactly in the same manner as that for lime or cement plaster.

vi. Mud plaster is generally applied in two coats, the first coat being 18 mm thick while the thickness of the second coat is kept 6 mm.

vii. The plaster is dashed against the wall and worked with a straight edge and float.

viii. The second coat is applied only when the first coat has set (not dry).

2. **Stucco Plastering :**

i. Stucco is the name given to a decorative type of plaster which gives an excellent finish.

ii. The surface plastered with stucco compares very much with marble finish both in smoothness and elegance.

iii. Stucco plaster can be used for interior as well as exterior surfaces.

iv. It is usually laid in three coats making the total thickness of the plaster to about 25 mm.

v. The first coat is called the scratch coat, the second a finer coat, also known as the brown coat, and the third is called the white coat or finishing coat.

Que 5.20. What do you know about the pointing ? With the help of their neat sketches classify the various types of pointing. Also write about their properties. **AKTU 2012-13, Marks 10**

Answer

A. **Pointing :**

1. The term pointing is used to denote the finishing of mortar joints of either stone masonry or brick masonry.
2. The joints are raked out to a depth of about 20 mm and then, these spaces are filled up by suitable mortar in the desired shape.

B. **Types of Pointing :** Following are the usual types of pointing :

1. **Beaded Pointing :**

i. This type of pointing is shown in Fig. 5.20.1 and it is formed by steel or iron rod with a concave edge.

ii. The beaded pointing is good in appearance.

iii. It is difficult to maintain as it can be easily damaged.

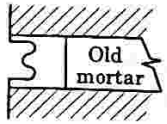


Fig. 5.20.1. Beaded pointing.

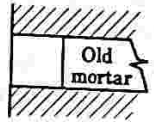


Fig. 5.20.2. Flush pointing.

2. **Flush Pointing :**

i. This type of pointing is shown in Fig. 5.20.2 and it is formed by removing the excess mortar from the joint and it is made flush with the face.

ii. This type of joint does not give good appearance. But it is durable as it does not provide any space for accumulation of dust, water, etc., and hence, it is extensively used.

3. **Recessed Pointing :**

i. The face of this pointing is kept vertical and it is pressed inside the wall surface by a suitable tool to a depth of about 5 mm or more as shown in Fig. 5.20.3.

ii. This pointing gives very good appearance.

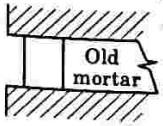


Fig. 5.20.3. Recessed pointing.

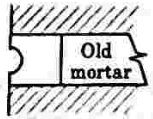


Fig. 5.20.4. Rubbed pointing.

4. Rubbed or Keyed or Grooved Pointing :

i. In this type of pointing, a groove is formed at the centre of height by a pointer as shown in Fig. 5.20.4.

ii. This type of pointing gives better appearance and is generally adopted.

5. Struck Pointing :

i. In this type of pointing, the face of pointing is kept inclined as shown in Fig. 5.20.5.

ii. The upper edge of joint is about 10 mm inside the face of masonry. This joint disposes water easily.

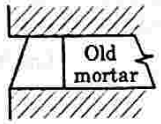


Fig. 5.20.5. Struck pointing.

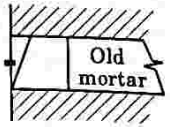


Fig. 5.20.6. Tuck pointing.

iii. If the lower edge of joint is kept inside the face of masonry, it is known as the overhand struck pointing. But it will not form a satisfactory joint as water will be collected in the joint.

6. Tuck Pointing :

i. In this type of pointing a groove is formed at the center of joint.

ii. The width and depth of groove are respectively 5 mm and 3 mm.

iii. The groove is then filled in or tucked in by white cement putty with a projection of 3 mm as shown in Fig .5.20.6.

iv. If projection is done in the mortar, it is called the bastard pointing or half-tuck pointing.

7. Vee-Pointing : In this type of pointing, a Vee-shaped groove is formed in the mortar joint as shown in Fig. 5.20.7.

8. Weathered Pointing : In this type of pointing, a projection in the form of a Vee-shape is formed as shown in Fig. 5.20.8.

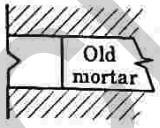


Fig. 5.20.7. Vee-pointing.

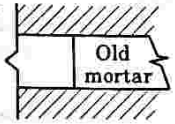


Fig. 5.20.8. Weathered pointing.

Que 5.21. What is distempering and how it is done ? Also write the difference between pointing and distempering.

Answer

A. Distempering :

1. The process of applying distemper is called distempering.

2. Distemper is made with base as white chalk and thinner as water. Some colouring pigments and glue are added.

3. They are available in powder and paste forms and are substantially cheaper than paints.

B. Process of Distempering : Distempers are applied in the following manner :

1. Preparation of Surface :

i. The surface is thoroughly rubbed and cleaned.

ii. In case of a new plastered surface, the surface is kept exposed to weather for drying before the application of distemper.

iii. If an existing (old) distempered surface is to be redone, surface is cleaned with profuse watering.

iv. The efflorescence and patches, if any, should be wiped out by a clean cloth cracks, etc., if any should be filled with putty.

2. Priming Coat : A priming coat as recommended by the manufacturer is applied on the prepared surface.

3. Final Coat : Two or three coats of distemper are applied. Each coat should be applied only after the previous coat has dried.

C. Difference :

S. No.	Pointing	Distempering
1.	It is used to denote the finishing of mortar joints of either stone masonry or brick masonry.	It is used to create a smooth surface to the plastered surfaces.
2.	It may be applied or carried out either in lime mortar or in cement mortar.	It can be applied on brick work, cement plastered surface, lime plastered surface, insulating boards, etc.

PART-5

Colour Washing, Painting etc., Principles and Methods of Building Maintenance.

CONCEPT OUTLINE : PART-5

Colour Washing : It is prepared by adding colouring pigment to the screen white wash.

Painting : The process of applying paints on building components is known as painting. It protects a surface from weathering effects and also prevents corrosion of metals.

Building Maintenance : It performs general repairs to buildings and preventive maintenance of systems and equipment.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

Que 5.22. **What do you mean by colour washing with its characteristics and uses ?**

Answer

A. Colour Washing :

1. Fresh lime slaked with water is mixed thoroughly with water in a tub and then screened through a fine, clean cloth. Thereafter glue, dissolved in water, is added to it.
2. The surface is cleaned and the white wash is applied with jute brushes. A white wash when mixed with colouring pigment such as yellow earth is called colour wash.

B. Characteristics :

1. Lime is toxic for germs, for which white wash is good from hygiene considerations.
2. A bright surface is provided at a very low cost.

C. Uses : They are generally recommended for low and medium class houses; ceilings are white washed and walls are generally colour washed.

Que 5.23. **Define painting. What are the objectives of painting?**

Answer

A. Painting :

The paints are coatings of fluid materials and they are applied over the surfaces of timber and metals. The process of applying paints on the surfaces is called painting.

B. Objective of Painting : Paint perform the following functions :

1. It protects wood from decaying effect.

2. It prevents corrosion in metals.
3. It protects the surface from harmful effects of atmospheric agencies.
4. It is used to give good appearance to the surface. The decorative effects may be created by painting and the surface becomes hygienically good, clean, colour full and attractive.
5. It renders surface hygienically safe and clean.

Que 5.24. **What is the principle of building maintenance ? Explain different types of building maintenance.**

Answer

A. Principle of Building Maintenance :

1. "That which is taken from the ground tends to return to the ground". This statement of fact explains why some form of maintenance is required. In addition, it sums up the problems of deterioration and the care needed for its prevention.
2. All elements of buildings deteriorate at a greater or lesser rate generally depends on :

i. Material and methods of construction,

ii. Environmental conditions, and

iii. The use of the buildings.

B. Types of Maintenance :

1. **Planned Maintenance :** The maintenance organized and carried out with forethought, control and the use of records to a predetermined plan.
2. **Unplanned Maintenance :** The maintenance carried out to no predetermined plan.
3. **Preventive Maintenance :** The maintenance carried at predetermined intervals or corresponding to prescribed criteria and intended to reduce the probability of failure or the performance degradation of an item.
4. **Corrective Maintenance :** The maintenance carried out after a failure has occurred and intended to restore an item to a state in which it can perform its required function.
5. **Emergency Maintenance :** The maintenance which is necessary to put in hand immediately to avoid serious consequences. This is sometimes referred to as day-to-day maintenance, resulting from such incidents as gas leaks and gale damage.
6. **Condition-based Maintenance :** The preventive maintenance initiated as a result of knowledge of the condition of an item from routine or continuous monitoring.
7. **Scheduled Maintenance :** The preventive maintenance carried out to a predetermined interval of time, number of operations, mileage, etc.

VERY IMPORTANT QUESTIONS

Following questions are very important. These questions may be asked in your SESSIONALS as well as UNIVERSITY EXAMINATION.

Q. 1. Define the term ventilation. Discuss the factors which affect ventilation. Which point should be kept in mind while planning ventilation in public building ?

Ans: Refer Q. 5.1 and Q. 5.2, Unit-5.

Q. 2. Explain functional requirements of a ventilation system. Which are two effects take place for the rate of natural ventilation ? Describe the various types of ventilation.

Ans: Refer Q. 5.4 and Q. 5.3, Unit-5.

Q. 3. Explain in brief water supply system and its elements.

Ans: Refer Q. 5.6, Unit-5.

Q. 4. Explain the term mechanical lift or elevators. Give all the factors which affect the elevator system.

Ans: Refer Q. 5.11 and Q. 5.12, Unit-5.

Q. 5. What do you mean by acoustics ? What is its principle and what are the various acoustic defects ? Also discuss about the various characteristics of audible sound.

Ans: Refer Q. 5.15 and Q. 5.16, Unit-5.

Q. 6. What are the requirements of a good plaster ? Explain the different types of plastering.

Ans: Refer Q. 5.18 and Q. 5.19, Unit-5.

Q. 7. What is pointing ? Describe the various types of pointing.

Ans: Refer Q. 5.20, Unit-5.

Q. 8. What is distempering and how it is done ? Also write the difference between pointing and distempering.

Ans: Refer Q. 5.21, Unit-5.

Q. 9. Define painting. What are the objectives of painting ?

Ans: Refer Q. 5.23, Unit-5.

☺☺☺

1 UNIT

Introduction (2 Marks Questions)

Memory Based Questions

1.1. Explain stones as building material.

Ans: Stones are derived from the rocks, a portion of the earth's crust having no definite shape and structure. These are found from rocks either in igneous, sedimentary or metamorphic form.

1.2. What are the important characteristics of stones ?

Ans: The important characteristics of stones are as follows :

i. Structure.
ii. Texture.
iii. Fracture.
iv. Specific gravity.
v. Toughness.
vi. Adsorption, etc.

1.3. Enumerate the different tests applied on stones.

Ans: The tests applied on stones are :

i. Compressive strength test.
ii. Transverse strength test.
iii. Tensile strength test.
iv. Shear strength test.
v. Toughness test, etc.

1.4. Name the different methods used for the preservation of stonework.

Ans: The different methods which are used for the preservation of stonework are :

i. Linseed oil.
ii. Solution of alum and soap.
iii. Paraffin.
iv. Paint.
v. Coal tar, etc.

1.5. What are the different manufacturing processes used in bricks ?

Ans: The manufacturing processes of bricks are :
i. Preparation of clay.
ii. Moulding.
iii. Drying.
iv. Burning.

1.6. Classify the bricks.

Ans:

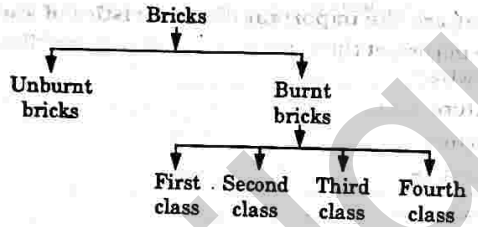


Fig. 1.6.1.

1.7. Discuss the properties which are required for an ideal bricks.

Ans: An ideal brick possesses the following properties :
i. Regularity of form.
ii. Uniformity of size, colour and texture.
iii. Soundness.
iv. Hardness.
v. Strength, etc.

1.8. Discuss the classification of lime.

Ans: Lime can be classified into two types :
i. Hydraulic lime.

ii. Non-hydraulic lime.

1.9. What are the important components of cement ?

Ans: The important components of cement are as follows :
i. Lime.
ii. Silica.
iii. Alumina.
iv. Iron oxide.
v. Magnesia.
vi. Sulphur dioxide.
viii. Alkalis.

1.10. Classify the cement.

Ans: The classification of cement are as follows :
i. White cement.
ii. Low heat cement.
iii. Coloured cement.
iv. Rapid hardening cement.
v. Puzzolana cement.
vi. High alumina cement, etc.

1.11. Discuss the chemical constituents of OPC.

Ans: The chemical constituents of OPC are :
i. Tricalcium silicate.
ii. Dicalcium silicate.
iii. Tricalcium aluminate.
iv. Tetracalcium aluminate.

1.12. Enumerate the physical properties of OPC.

Ans: The various physical properties of OPC are as follows :
i. Fineness.
ii. Setting time.
iii. Soundness test.
iv. Crushing strength, etc.

1.13. What are the different manufacturing processes used for cement ?

Ans: These are the two processes which are used for the manufacturing of cement :

i. Dry process.

ii. Wet process.

1.14. Illustrate the major ingredients of concrete.

Ans: The major ingredients of concrete are given below :

i. Binding material.

ii. Fine aggregate.

iii. Coarse aggregate.

iv. Water.

1.15. Define curing.

Ans: Curing of freshly placed concrete is very important for optimum strength and durability. The process of keeping concrete damp for this purpose is known as curing.

1.16. Name the different methods used for curing of concrete.

Ans: These are the following methods used for curing purpose :

i. Water curing.

ii. Steam curing.

iii. Electrical curing.

iv. Chemical curing.

v. Curing by infrared radiation.

1.17. Enumerate the different tests used for the measurement of concrete's workability.

Ans: The different types of tests are used for the measurement of concrete's workability are as follows :

i. Slump test.

ii. Compaction factor test.

iii. Vee-bee consistometer test.

iv. Flow table test, etc.

1.18. What are the different factors affecting the strength of concrete ?

Ans: The strength of concrete is affected by the following factors :

i. Type and age of cement,

ii. Cement aggregate ratio,

iii. Type and size of aggregates,

iv. Effect of water cement ratio, etc.

1.19. What is puzzolana ? **AKTU 2016-17, Marks 02**

Ans: It is finely ground siliceous material which by itself does not possess any cementing property but in presence of water it reacts with calcium hydroxide *i.e.*, lime at normal conditions and form compound of low solubility having cementation properties.

1.20. What are the different forms of puzzolana ?

Ans: Puzzolana occurs in two forms :

i. Natural puzzolana.

ii. Artificial puzzolana.

1.21. Define timber.

Ans: Timber is a natural product. It has been available to man from thousands of years.

1.22. Classify timber according to engineering applications.

Ans: Timber is classified as :

i. Soft wood (conifers).

ii. Hard wood (deciduous).

1.23. Enumerate the engineering properties of timber.

Ans: The engineering properties of timber are given below :

i. Specific gravity,

ii. Moisture content,

iii. Thermal expansion,

iv. Heat insulation.

1.24. What are the major defects in timber ?

Ans: The major defects in timber are as follows :

i. Defects due to abnormal growth.

ii. Defects due to rupture of tissues.

iii. Defects after falling of tree.

1.25. Explain bitumen.

Ans: Bitumen is the product obtained by fractional distillation of crude petroleum as an end product. Bitumen becomes soft at moderate temperatures.

1.26. Define asphalt.

Ans: Asphalt is defined as a mixture of bitumen with a substantial proportion of inert mineral matter. Bitumen is the binding material in asphalt.

1.27. Classify the types of asphalt.

Ans: The types of asphalt are as follows :
i. Natural asphalt. ii. Residual asphalt.

1.28. Explain the term lime bursting.

AKTU 2015-16, Marks 02

Ans: A common defect of bricks 'lime bursting', a weakening or breaking of bricks, which is caused by the hydration of quick lime particles derived from limestone in brick making clays.

1.29. What do you mean by seasoning of timber ?

AKTU 2015-16, Marks 02

Ans: It reduces the moisture content of wood before its use. When the drying is done in a kiln, the product is known as kiln dried or lumber, where as air drying is the more traditional method.

1.30 Explain the term HVAC. **AKTU 2015-16, Marks 02**

Ans: In the term, 'H' represents 'Heating', 'V' represents 'Ventilation' and 'AC' represents 'Air conditioning'. It is important in designing from medium to large industries and office buildings.

1.31. What do you understand by workability of concrete ?

AKTU 2015-16, Marks 02

Ans: It is defined as the property of concrete which determines the amount of useful internal work necessary to produce full compaction.

1.32. What do you understand by king closer and queen closer ?

AKTU 2015-16, Marks 02

Ans: **Queen Closer :** It is the portion of a brick obtained by cutting a brick lengthwise into two portions. Thus, a queen closer is a brick which is half as wide as the full brick.

King Closer : It is the portion of a brick which is so cut that width of one of its end is half that of a full brick, while the width at the other end is equal to the full width. It is thus obtained by cutting off the triangular piece between the centre of one end and the centre of the other (long) side.

Application Based Questions

1.33. How blending is carried out in brick's manufacturing process ?

Ans: If any ingredient is to be added to it, it is spread out at its top. Blending indicates harmonious mixing. It is carried out by taking small portion of clay every time and by tuning it up and down in vertical direction.

1.34. Explain any two uses of cement.

Ans: The uses of cement are as follows :
i. Used for filling cracks in concrete structures.
ii. Used for masonry work, plastering and pointing.

1.35. How will you identify the different kinds of timber ?

Ans: The timber can be identified in the following manners :
i. Odour and taste.
ii. Colour.
iii. Grain size, etc.

1.36. Write the uses of asphalt in construction.

Ans: The uses of asphalt in construction are as follows :
i. In damp proof courses.
ii. Flooring material.
iii. Roof covering, flashing, etc.

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2 UNIT Plastics Manufacturing Process (2 Marks Questions)

Memory Based Questions

2.1. What is plastic ?

Ans: Plastic may be defined as a natural or synthetic organic material which has the property of being plastic at some stage of their manufacture when they can be moulded to required size and shape.

2.2. Enumerate the different constituents of plastic.

Ans: The constituents of plastic are :
i. Resin. ii. Plasticizer. iii. Filler.
iv. Pigment. v. Lubricant. vi. Catalyst, etc.

2.3. Give the classification of plastics.

AKTU 2015-16, Marks 02

Ans: Plastic may be of two types :
i. Thermosetting plastics. ii. Thermoplastic plastics.

2.4. Define paints and varnishes. **AKTU 2016-17, Marks 02**

Ans: **Paints :** Paints are liquid compositions of pigments and binders which when applied to the surface in thin coats dry to form a solid film to impart the surface a decorative finish, apart from giving protection to the base material from weathering, corrosion and other chemical and biological attacks.
Varnishes : Varnish is the solution of resins or resinous substances like amber, copal, shellac, gum resin etc., in solvents like oil, turpentine, alcohol etc.

2.5. Enumerate the basic constituents of the paint.

Ans: The basic constituents of paint are as follows :
i. Bases. ii. Vehicles. iii. Pigment.
iv. Drier. v. Thinner.

2.6. Give the classification of paints.

Ans: The classification of paints are given as follows :
i. Oil paint. ii. Enamel paint. iii. Emulsion paint.
iv. Cement paint. v. Bituminous paint.
vi. Synthetic rubber paint, etc.

2.7. Discuss the characteristics of an ideal paint.

Ans: An ideal paint should possess the following characteristics :
i. Paint should form hard and durable surface.
ii. It should give attractive appearance.
iii. It should be cheap and readily available.
iv. It should be such that it can be applied easily to the surfaces.

2.8. Define distempering. **AKTU 2016-17, Marks 02**

Ans: Distempering is a process of giving distemper covering to the plastered or pointed surface.

2.9. Explain the term distemper.

Ans: Distemper is made with base as white chalk and thinner as water. Some colouring pigments and glues are added. They are available in powder and paste form.

2.10. What is varnish ?

Ans: Varnish is the solution of resins or resinous substances like amber, copal, shellac, gum resin etc., in solvents like oil, turpentine, alcohol etc.

2.11. Enumerate the methods used for varnishing.

Ans: The methods used for varnishing are as follows :
i. Knotting. ii. Stopping. iii. Varnish coat.
iv. Preparation of surface.

2.12. Classify varnishes.

Ans: Varnishes may be of following types :
i. Oil varnish. ii. Spar varnish. iii. Flat varnish.
iv. Spirit varnish. v. Asphalt varnish. vi. Water varnish.

2.13. Explain the characteristics of a good varnish.

Ans: A good varnish should possess the following characteristics :
i. It should dry quickly.
ii. The protective film obtained on drying should be hard, tough, durable and resistant to wear.

2.14. What are the ingredients of varnish ?

Ans: A varnish has the following essential ingredients :
i. Resins or resinous substance. ii. Solvents. iii. Driers.

2.15. What are the different types of ferrous metals used in construction work ?

Ans. A ferrous material is the one in which iron is a main constituent. The types of ferrous metals are :

i. Cast iron. ii. Wrought iron. iii. Steel.

2.16. Define glass. What are the constituents of glass ?

AKTU 2016-17, Marks 02

Ans. Glass is an amorphous substance having homogeneous texture, solidified from the liquid state without crystallization. It is a hard, brittle, transparent or translucent material.

Constituents of Glass : The constituents of glass are as follows :

i. Silica. ii. Sodium.
iii. Potassium carbonate. iv. Lime or lead oxide.
v. Manganese.

2.17. Explain any four important properties of cast iron.

Ans. The cast iron should have the following properties :

i. It is brittle and does not absorb shocks.
ii. Its specific gravity is 7.5.
iii. It does not rust easily.
iv. It can't be magnetized.

2.18. Discuss the properties of aluminium.

Ans. The properties of aluminium are :

i. It is very light in weight. ii. It melts at 66°C.
iii. It is a good conductor of electricity, etc.

2.19. What are the important properties of glass ?

Ans. The glass should have the following properties :

i. It is strong and brittle.
ii. It can take excellent polish.
iii. It is not affected by atmosphere.

2.20. Enumerate the constituents of glass.

Ans. The constituents of glass are as follows :

i. Silica. ii. Sodium.
iii. Potassium carbonate. iv. Lime or lead oxide.
v. Manganese.

2.21. Classify the different glasses used in construction work.

Ans. These are the following glasses used in construction work :

i. Soda lime glass. ii. Potash lime glass.
iii. Potash lead glass. iv. Common glass.
v. Special glasses.

2.22. What are heat insulating materials ?

Ans. The material which prevents the outflow of indoor heat is normally called adiabator. On the other hand, the material which prevents the inflow of outdoor heat is called heat insulator. These two are collectively called heat insulating materials.

2.23. Name any three heat insulating materials used in construction work.

Ans. The heat insulating materials are :

i. Inorganic fibrous heat insulating materials.
ii. Inorganic granular heat insulating materials.
iii. Inorganic porous heat insulating materials.

2.24. Define sound absorption coefficient.

Ans. The ratio of absorbed sound energy (E) to incident sound energy (E_0) is called sound absorption coefficient (α).

2.25. Write any two objectives of varnish.

Ans. The objectives of varnish are as follows :

i. Render brilliancy to the painted surface.
ii. Brighten the appearance of the grains in wood.

2.26. What is knotting ?

Ans. This is the process of covering the knots in the woodwork, using any of the following methods :

i. Size knotting. ii. Patent knotting.

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3 UNIT

Components of Building (2 Marks Questions)

Memory Based Questions

3.1 What is the introduction of building plan ?

AKTU 2016-17, Marks 02

Ans: Building plan includes the details of all the building elements like foundations, doors, windows, lintels, arches, roofs, floors etc. The building plans should also include the details about the sanitary and electrical fittings.

3.2. Classify all the buildings.

Ans: The buildings are classified on the basis of occupancy as follows :

i. Residential. ii. Educational. iii. Institutional.
iv. Assembly. v. Business. vi. Industrial.

3.3. Enumerate the structural components of a building.

Ans: The structural components of a building are :

i. Foundation. ii. Plinth. iii. Walls and piers.
iv. Doors and windows. v. Floors. vi. Roofs, etc.

3.4. What is plinth ?

Ans: Plinth is the portion of structure between the surface of the surrounding ground and surface of the floor, immediately above the ground.

3.5. Define stairs.

Ans: A stair is a structure consists of number of steps loading from one floor to another.

3.6. Discuss roofs.

Ans: A roof is uppermost part of the building whose main function is to enclose the space and to protect the same from the effects of weather elements such as rain, sun, wind, heat, etc.

3.7. Define damp proofing.

AKTU 2016-17, Marks 02

Ans: The treatment which is given to render building damp proof is known as damp proofing. The damp proofing of a building is done by interposing a layer of damp proof material between source of dampness and building.

3.8. Define DPC.

AKTU 2016-17, Marks 02

Ans: In order to prevent the entry of damp into a building, the courses, known as the damp proofing courses, are provided at various levels of entry of damp into a building.

3.9. Enumerate the causes of dampness in buildings.

Ans: The causes of dampness in buildings are to :

i. Action of rain.
ii. Rising of moisture from the ground.
iii. Exposed tops of walls.
iv. Condensation, etc.

3.10. Discuss the effects of dampness.

Ans: The effects of dampness in the buildings are as follows :

i. It promotes and accelerated the growth of termites.
ii. It results in softening and crumbling of the plaster.
iii. The materials used as floor coverings are seriously damaged.

3.11. What are the requirements of an ideal material used for damp proofing ?

Ans: An ideal damp proof material should possess the following properties :

i. The material should be perfectly impervious.
ii. The material should be reasonably cheap.
iii. It should be dimensionally stable, etc.

3.12. What are the different materials used for damp proofing ?

Ans: The following materials are used for damp proofing :

i. Hot bitumen. ii. Mastic asphalt. iii. Bituminous.
iv. Metal sheets, etc.

3.13. Define guniting.

Ans: The technique of guniting consists in forming an impervious layer of rich cement mortar (1 : 3) or fine aggregate mix for water proofing over the exposed concrete surface or over the pipes, cisterns, etc., for resisting the water pressure.

3.14. Classify the stairs.

Ans: The different types of stairs are :

i. Straight stairs. ii. Circular stairs.
iii. Curved or spiral stairs or a combination of both.
iv. Dog-legged stairs.

3.15. Explain ramps.

Ans: When space permits, a sloping surface, or ramp, can be used to connect different levels or floors. As a means of saving space in some garages, every floor serves as a ramp.

3.16. What do you mean by floorings ?

Ans: In order to sub-divide the portion between the plinth level or basement level and roof level, solid constructions are carried out. These constructions are known as floors and exposed top surface of floors are termed as floorings.

3.17. Classify the composite floors.

Ans: The composite floors may be of following types :
i. Double flag stone floors. ii. Filler joists floors.
iii. Jack arch floors. iv. RCC floors.
v. Hollow block and rib floors.

3.18. What do you understand by masonry construction ?

AKTU 2015-16, Marks 02

Ans: It may be defined as the construction of building units bonded together with mortar. The building units may be stones, bricks or precast blocks of concrete.

3.19. What is stone masonry ? **AKTU 2016-17, Marks 02**

Ans: A construction made by using stone units and mortar is known as stone masonry.

3.20. What is brick masonry ?

Ans: Masonry is a unified mass obtained by systematic arrangement of laying bricks and bonding together with mortar.

3.21. Classify the different types of masonry work.

Ans: The following types of masonry work are used in construction :
i. Stone masonry. ii. Brick masonry.
iii. Reinforced masonry. iv. Composite masonry.
v. Hollow block concrete masonry.

3.22. On what factors, selection of stones for stone masonry depends ?

Ans: There are so many factors on which the selection of stones depends. Some of them are as follows :

i. Availability. ii. Ease of working. iii. Appearance.
iv. Economy. v. Durability, etc.

3.23. Discuss the different types of stone masonry.

Ans: The different types of stone masonry are as follows :
i. Rubble masonry. ii. Ashlar masonry.

3.24. Classify the bonds.

Ans: The different types of bonds are as follows :
i. Stretcher bond. ii. Header bond. iii. Flemish bond.
iv. English bond. v. Facing bond, etc.

3.25. What is zig-zag bond ?

Ans: In this type of bond, alternate courses are placed in different directions to get maximum strength in the wall.

3.26. Enlist the importance of hollow block construction.

AKTU 2015-16, Marks 02

Ans: Following are the importance of it :
i. It reduces the weight of the structure.
ii. It provides the overall economy.

Application Based Questions

3.27. What are the functional requirements of the roof ?

Ans: The functional requirements of roof are as follows :
i. Strength and stability. ii. Weather resistance.
iii. Heat insulation. iv. Sound insulation, etc.

3.28. Discuss the uses of stone masonry.

Ans: The uses of stone masonry are as follows :
i. Building foundations, dams, etc.
ii. Arches, domes, lintels, etc.
iii. Roofs, paving jobs.

3.29. Explain the functions of stairs.

Ans: The functions of the stairs are given below :
i. It provides means of communication between the various floors for everyday use.
ii. To escape from upper floors in the case of fire.

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4 UNIT

Doors and Windows (2 Marks Questions)

Memory Based Questions

4.1. What is door ?

Ans. A door may be defined as an openable barrier secured in a wall opening. A door is provided to give an access to the inside of a room of a building.

4.2. What are the different materials used for door construction ?

Ans. The materials used for door construction are :
i. Timber. ii. Plywood. iii. Glass. iv. Metals etc.

4.3. Classify the door based on different types of movement.

Ans. The different types of door are as follows :
i. Swinging doors, ii. Revolving doors, iii. Sliding doors,
iv. Folding doors, v. Collapsible doors.

4.4. What is window ?

Ans. A window is a vented barrier secured in a wall opening to admit light and air to the building and to give view to the outside.

4.5. Enumerate the various types of window.

Ans. The various types of windows used in buildings are :
i. Casement window. ii. Sash or glazed window.
iii. Pivoted window, iv. Sliding window.

4.6. Define ventilators.

Ans. Ventilators are small windows, fixed at a greater height than the window, generally about 30 to 50 cm below roof level. The ventilator has a frame and a shutter, generally glazed, which is horizontally pivoted.

4.7. Classify the different types of fixtures and fastenings.

Ans. The following types of fixtures and fastenings are required for doors, windows and ventilators :

i. Hinges, ii. Bolts, iii. Handles, and iv. Locks.

4.8. Explain the advantages of steel windows.

Ans. Steel windows have following advantages over timber windows :
i. They exhibit elegant appearance and stream lined-finishing.
ii. They are rat proof and termite proof.
iii. They are highly fire resistant.

4.9. What is a dormer windows ?

Ans. A dormer window is a vertical window provided on the sloping roof. Such a window provides ventilation and lighting to the enclosed space below the roof, and at the same time, very much improvement in the appearance of the building.

4.10. Illustrate lantern windows.

Ans. Such windows are provided over the flat roofs, to provide more light and air to the inner apartments/rooms of a building. These windows project above the roof level.

4.11. What is clerestory windows ?

Ans. Clerestory windows are provided in a room which has greater ceiling height than the surrounding rooms, or when a lean-to-roof of low height is there adjacent to the room.

4.12. Discuss louvered windows.

Ans. These windows are provided for the sole aim of ventilation, and they do not permit any outside vision. The shutter consists of top and bottom rails, and two styles which are grooved to receive the louvers.

4.13. What are sash or glazed windows ?

Ans. A sash window is a type of casement window in which the panels are fully glazed. The frame of each shutter consists of two vertical styles, top rail and a bottom rail.

4.14. Explain the advantages of a flat roof.

Ans. The advantages of a flat roof are as follows :
i. Provide better appearance.
ii. Possess good insulating properties.
iii. Easier to make it fire resistant.

4.15. Discuss the disadvantages of flat roof.

Ans. The disadvantages of flat roof are given below :
i. Initial cost is more. ii. Leakage problem.
iii. Not suitable in areas of heavy rainfall, etc.

4.16. Classify the roofs.

Ans: The roof are classified as :
i. Pitched or sloping roof. ii. Flat roof.

4.17. What is lintel ?

Ans: Lintel is a horizontal structural member spanning any opening to support the load of the structure coming over it. It is used to span the openings for doors, windows, corridors, etc.

4.18. Classify the lintels.

Ans: The lintels are of following types :
i. Wooden lintels. ii. Brick lintels.
iii. Stone lintels. iv. Steel lintels.
v. RCC lintels.

4.19. Explain the term 10WS12. **AKTU 2015-16, Marks 02**

Ans: A designation 10WS12 denotes a window opening with single shutter, having width equal to 10 modules (*i.e.*, 10 × 100 = 1000 mm) and height equal to 12 modules (*i.e.*, = 12 × 100 = 1200 mm).

Application Based Questions

4.20. Draw a neat sketch showing the position of gable and dormer window. **AKTU 2015-16, Marks 02**

Ans:

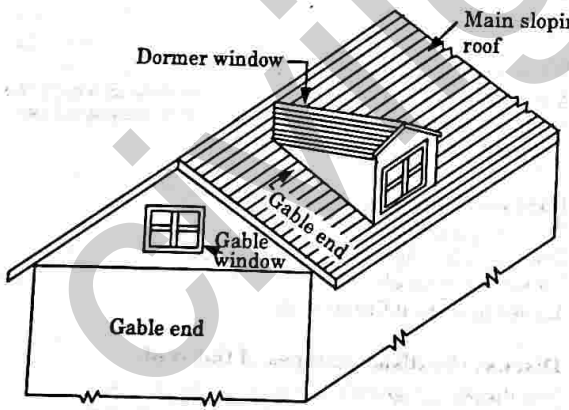

Fig. 4.20.1. Gable and Dormer window.

4.21. Draw the diagram of casement window with their notations.

Ans:

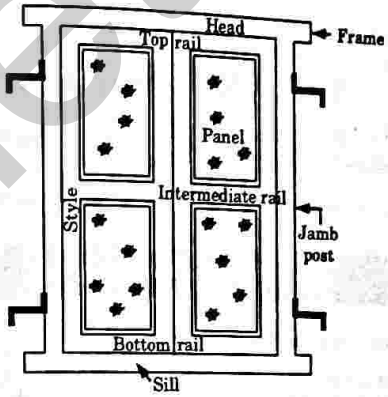

Fig. 1.21.1. Casement window.

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5 UNIT

Natural Ventilation (2 Marks Questions)

Memory Based Questions

5.1. Define is ventilation. **AKTU 2016-17, Marks 02**

Ans: Ventilation may be defined as supply of fresh outside air into an enclosed space or the removal of inside air from the enclosed space.

5.2. What are the basic requirements of ventilation system ?

Ans: The basic requirements of ventilation system are :
i. Air changes or air movement, ii. Humidity,
iii. Quality of air, and iv. Temperature.

5.3. Enumerate the various types of ventilation systems.

Ans: It may be divided into two categories :
i. Natural ventilation, and ii. Mechanical ventilation.

5.4. Define natural ventilation.

Ans: Natural ventilation is the one in which ventilation is affected by the elaborated use of doors, windows, ventilators and skylights.

5.5. What is mechanical ventilation ?

Ans: Mechanical ventilation is the one in which some mechanical arrangements are made to increase the rate of air flow.

5.6. Give the various effects, on which rate of ventilation depends.

Ans: The rate of ventilation depends on two effects :
i. Wind effect. ii. Stack effect.

5.7. What are the different types of mechanical ventilation ?

Ans: These are the following systems of mechanical ventilation :
i. Extraction system. ii. Plenum system.
iii. Extraction-plenum system. iv. Air conditioning.

5.8. What is a service connection ?

Ans: A service connection is primarily a connection from the distribution system to the consumer. A consumer may be a single house, an apartment house, a planned block development or a water district buying water 'wholesale'.

5.9. Discuss water meter.

Ans: Water meter is also installed in suitable chamber with cover. It measures the quantity of water used by the consumer.

5.10. Write the characteristics of a water meter.

Ans: A water meter should possess the following characteristics :
i. It should accurately measure and register both small and large flows.
ii. It should be easy to maintain and repair.

5.11. Classify the domestic water supply valves.

Ans: Two types of valves are commonly used :
i. Globe valve, and ii. Gate valve

5.12. Define globe valve.

Ans: Globe valve is used in pipe lines for convenience in manually closing the pipes to control the flow of water. It should be installed with water pressure under the valve seat.

5.13. What is gate valve ?

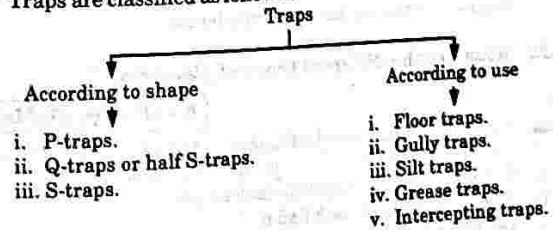
Ans: Gate valve is used in pipe lines for convenience in manually closing the pipes. The gate valve has an advantage over the globe valve *i.e.*, it offers less resistance to flow.

5.14. Discuss traps.

Ans: A trap is a depressed or bent fitting which, when provided in a drainage system, always remains full of water thus maintaining water seal. It prevents the passage of foul air or gas through it.

5.15. Classify traps.

Ans: Traps are classified as follows :



5.16. Explain gully trap.

Ans. Gully trap are special types of traps which disconnect sullage drain (collected from baths, kitchen etc.) from the main drainage system. It is either made of stone-ware or of cast iron.

5.17. What are the commonly used sanitary fittings used in buildings ?

Ans. The following fittings are commonly used in buildings, for efficient collection and removal of wastewater to the house drain :

i. Wash basins. ii. Sinks. iii. Bath tubs.
iv. Water closets. v. Urinals. vi. Flushing cisterns.

5.18. Classify different water closets.

Ans. Water closets are of three types :

i. Indian type. ii. European type. iii. Anglo-Indian type.

5.19. What are the different materials used in the composition of distemper ?

Ans. A distemper is composed of the following :

i. A base, like chalk. ii. A carrier (water).
iii. A binder, such as glue or casein. iv. Colouring pigments.

5.20. Write down the different steps in the process of distempering.

Ans. Distempering is carried out in the following steps :

i. Preparation of surface. ii. Priming coat.
iii. Coats of distemper.

5.21. Discuss colour washing.

Ans. Colour washing is prepared by adding colouring pigment to the screen white wash. Generally used pigments are yellow earth red ocher and blue vitriol. These are crushed to powder, before mixing.

5.22. Define plastering and rendering.

Ans. Plastering is the process of covering rough surfaces of walls, columns, ceilings and other building components with thin coat of plastic mortars to form a smooth durable surface. The coating of plastic material (*i.e.*, mortar) is termed as plaster. Plastering on external exposed surfaces is known as rendering.

5.23. What are the different types of plastering ?

AKTU 2016-17, Marks 02

Ans. Plastered surface may be finished in the following varieties :

i. Smooth cast finish. ii. Sand faced finish.
iii. Rough cast finish or spatter dash finish.
iv. Pebble dash or dry dash finish.
v. Depeter finish. vi. Scrapped finish.

vii. Textured finish.

5.24. What are the different objects of plastering ?

Ans. Plastering is done to achieve the following objects :

i. To give decorative effect.
ii. To protect surfaces against vermin's.
iii. To give smooth surface in which dust and dirt can't lodge, etc.

5.25. Discuss the requirements of good plaster.

Ans. The plaster material should full fill the following requirements :

i. It should be hard and durable.
ii. It should possess good workability.
iii. It should be possible to apply it during all weather conditions.
iv. It should be cheap.

5.26. Enumerate the defects in plastering.

Ans. The following defects may arise in plaster work :

i. Blistering of plastered surface. ii. Cracking.
iii. Crazing. iv. Efflorescence, etc.

5.27. What is pointing ?

Ans. The term pointing is applied to the finishing of mortar joints in masonry. In exposed masonry, joints are considered to be the weakest and most vulnerable spots from which rain water or dampness can enter.

5.28. What are the different types of pointing ?

Ans. Pointing may be of following types :

i. Flush pointing. ii. Recessed pointing.
iii. Rubbed, keyed or grooved pointing. iv. Beaded pointing.
v. Struck pointing. vi. Tuck pointing.
vii. V-pointing. viii. Weathered pointing.

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B.Tech.

(SEM. III) ODD SEMESTER THEORY EXAMINATION, 2012-13

BUILDING MATERIAL AND CONSTRUCTION

Time : 3 Hours **Total Marks : 100**

Note : Attempt **all** the questions. **All** questions carry equal marks.

1. Attempt any **four** parts : **(4 × 5 = 20)**

a. As a civil engineer which clay products you will use as the construction material in the construction site ?

Ans: Refer Q. 1.18, Page 1–22C, Unit-1.

b. List the name of the various preservatives used to preserve the stone. Also write their characteristics.

Ans: Refer Q. 1.11, Page 1–15C, Unit-1.

c. As a site engineer in which manner you will face the efflorescence problem in brick and the lime bursting problem in tiles ? Also give the solution to avoid these problems.

Ans: Refer Q. 1.17, Page 1–21C, Unit-1.

d. Give any three types of puzzolanic materials used at the site with the help of their properties.

Ans: Refer Q. 1.34, Page 1–44C, Unit-1.

e. Explain the different components of an exogenous tree. Also show its cross-section.

Ans: Refer Q. 1.36, Page 1–47C, Unit-1.

f. Classify the different types of fine grades of road tar as per the Indian Standard Code IS : 215 – 1961.

Ans: Refer Q. 1.44, Page 1–56C, Unit-1.

2. Attempt any **four** parts : **(4 × 5 = 20)**

a. What are the mechanical and physical properties of plastics ?

Ans: Refer Q. 2.3, Page 2–4C, Unit-2.

b. Show the role of various ingredients of all the paints with the help of their different properties.

Ans: Refer Q. 2.5, Page 2–6C, Unit-2.

c. Give the details of any two factors which greatly influenced the physical properties like ductility, elasticity and tensile strength of the reinforcing steel.

Ans: Refer Q. 2.14, Page 2–15C, Unit-2.

d. 'Aluminium' is widely used for the construction work. Give its utility with the help of their properties.

Ans: Refer Q. 2.15, Page 2–15C, Unit-2.

e. Write in brief the various properties and their relative uses of different categories of glass.

Ans: Refer Q. 2.19, Page 2–22C, Unit-2.

f. What are the various advantages of using the thermal insulating material in building construction works ?

Ans: Refer Q. 2.22, Page 2–25C, Unit-2.

3. Attempt any **two** parts : **(2 × 10 = 20)**

a. Suppose you are going to construct your own residential building, then which construction principles you will follow for its construction ?

Ans: Refer Q. 3.3, Page 3–5C, Unit-3.

b. Give the name of various chemicals generally used for the anti-termite treatment. What are the basic steps you follow during the pre and post construction anti-termite treatment ?

Ans: Refer Q. 3.10, Page 3–15C, Unit-3.

c. On the basis of the provision of support on the beams, classify in brief, the upper floors with the help of their neat sketches.

Ans: Refer Q. 3.19, Page 3–29C, Unit-3.

4. Attempt any **two** parts : **(2 × 10 = 20)**

a. Briefly discuss the importance of different types of doors used in the construction work. With the help of neat sketches describe the following types of doors :

1. Revolving doors.

2 Battened, ledged, braced and framed doors

Ans: Refer Q. 4.3, Page 4–4C, Unit-4.

b. What is the role of pitched roof in the construction work ? With the help of their neat sketches classify any five types of pitched roof.

Ans: Refer Q. 4.11, Page 4–15C, Unit-4.

c. What are the various functions of lintels and chhajjas ? Explain with neat sketches, various ways of using stone and RB lintels.

Ans: Refer Q. 4.14, Page 4–21C, Unit-4.

5. Attempt any **two** parts : **(2 × 10 = 20)**

a. "Maintenance of proper ventilation and temperature in a building is very important from health and hygienic point of view". Justify this with the help of the functional requirements of natural ventilation system. What are the standard norms we use for the natural ventilation ?

Ans: Refer Q. 5.2, Page 5–3C, Unit-2.

b. What do you know about the pointing ? With the help of their neat sketches classify the various types of pointing. Also write about their properties.

Ans: Refer Q. 5.20, Page 5–22C, Unit-5.

c. What do you mean by the acoustics ? What is its principle and what are the various acoustic defects ? Also discuss about the various characteristics of audible sound.

Ans: Refer Q. 5.15, Page 5–16C, Unit-5.

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B.Tech.

(SEM. III) ODD SEMESTER THEORY EXAMINATION, 2013-14

BUILDING MATERIAL AND CONSTRUCTION

Time : 3 Hours **Total Marks : 100**

Note : Attempt **all** the questions. **All** questions carry equal marks.

1. Attempt any **four** parts : **(4 × 5 = 20)**

a. What are the factors influencing the choice of a building material ?

Ans: Refer Q. 1.3, Page 1–5C, Unit-1.

b. Enumerate the chief characteristics of clay as material used for manufacture of bricks.

Ans: Refer Q. 1.15, Page 1–19C, Unit-1.

c. Write the efflorescence in bricks and how will you classify the presence of efflorescence in bricks ?

Ans: Refer Q. 1.17, Page 1–21C, Unit-1.

d. Briefly describe the tensile strength test and the water absorption test of stones.

Ans: Refer Q. 1.9, Page 1–12C, Unit-1.

e. What are dry and wet rots ? How are they caused and prevented ?

Ans: Refer Q. 1.37, Page 1–49C, Unit-1.

f. What is plywood and where is it used with advantage ? State its uses in modern buildings.

Ans: Refer Q. 1.41, Page 1–53C, Unit-1.

2. Attempt any **four** parts : **(4 × 5 = 20)**

a. What are the effects of different types of impurities in iron on its physical and mechanical properties ?

Ans: Refer Q. 2.17, Page 2–19C, Unit-2.

b. Describe the properties and uses of any two non-ferrous metals. Describe also their alloys and uses.

Ans: Refer Q. 2.15, Page 2–15C, Unit-2.

c. What are the constituents of glass ? Give the functions of each of them.

Ans: Refer Q. 2.18, Page 2–21C, Unit-2.

d. How are plastics classified ? State the role of plastic as a building material.

Ans: Refer Q. 2.2, Page 2–3C, Unit-2.

e. What is distempering and how is it done ?

Ans: Refer Q. 5.21, Page 5–23C, Unit-5.

f. Briefly describe the properties and uses of sound insulating material.

Ans: Refer Q. 2.24, Page 2–26C, Unit-2.

3. Attempt any two parts : (2 × 10 = 20)

a. State briefly the requirements of a good stair case. Also write the type of various steps with their neat sketches. How are the treads and risers proportioned ?

Ans: Refer Q. 3.13, Page 3–20C, Unit-3.

b. What are the advantages of a cavity wall ? Explain general features of a cavity wall with the help of neat sketches.

Ans: Refer Q. 3.9, Page 3–13C, Unit-3.

c. Write the sources of dampness in a building. What are the techniques and methods of damp prevention ?

Ans: Refer Q. 3.7, Page 3–11C, Unit-3.

4. Attempt any two parts : (2 × 10 = 20)

a. With the help of neat sketches, briefly discuss the classification of windows according to the operational point of view.

Ans: Refer Q. 4.5, Page 4–8C, Unit-4.

b. What are the functional requirements for the design and construction of roofs ? Briefly discuss with the neat sketches :

i. King post truss.

ii. Queen post truss.

Ans: **Functional Requirement :** Refer Q. 4.8, Page 4–13C, Unit-4.
King and Queen Post Trust : Refer Q. 4.11, Page 4–15C, Unit-4.

c. Classify various types of lintels and discuss their relative use.

Ans: Refer Q. 4.13, Page 4–20C, Unit-4.

5. Attempt any two parts : (2 × 10 = 20)

a. What are the properties of distempers ? Briefly discuss the process of distempering. Also write the differences between pointing and distempering.

Ans: **Properties of Distempers :** Refer Q. 2.10, Page 2–11C, Unit-2.
Distempering : Refer Q. 5.21, Page 5–23C, Unit-5.

b. Write about the functional requirements of a ventilation system. Which are the two effects take place for the rate of natural ventilation or aeration ? Write also the general consideration and rules for natural ventilation.

Ans: Refer Q. 5.4, Page 5–6C, Unit-5.

c. Give all the design considerations, which affect the elevator or lift system. Also write the design parameters and the location of elevators.

Ans: Refer Q. 5.12, Page 5–14C, Unit-5.

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B. Tech.
(SEM. III) ODD SEMESTER THEORY EXAMINATION, 2014-15
BUILDING MATERIAL AND CONSTRUCTION

Time : 3 Hours **Total Marks : 100**

Notes : 1. Attempt **all** questions.
2. **All** questions carry equal marks.

1. Attempt any four parts : **(4 × 5 = 20)**

a. Explain different characteristics of stones and their method of testing.

Ans. **Characteristics :** Refer Q. 1.8, Page 1–11C, Unit-1.
Testing : Refer Q. 1.9, Page 1–12C, Unit-1.

b. What are the constituent materials and properties of cement concrete ? Also discuss the methods of curing of cement concrete.

Ans. **Constituent of Cement :** Refer Q. 1.28, Page 1–35C, Unit-1.
Properties : Refer Q. 1.27, Page 1–35C, Unit-1.
Method of Curing : Refer Q. 1.33, Page 1–42C, Unit-1.

c. What do you mean by seasoning of timber ? What are the advantages and fundamental engineering properties of timber ?

Ans. Refer Q. 1.38, Page 1–51C, Unit-1.

d. Discuss the manufacturing process of clay bricks and their uses.

Ans. Refer Q. 1.13, Page 1–18C, Unit-1.

e. Write down the process of manufacturing of cement and their uses.

Ans. Refer Q. 1.24, Page 1–29C, Unit-1.

f. Discuss the problem of lime bursting and efflorescence in bricks.

Ans. Refer Q. 1.17, Page 1–21C, Unit-1.

2. Attempt any four parts : **(4 × 5 = 20)**

a. Discuss the properties, ingredients and use of glass used in building construction.

Ans. **Ingredients of Glass :** Refer Q. 2.18, Page 2–21C, Unit-2.
Properties and Uses of Glass : Refer Q. 2.19, Page 2–22C, Unit-2.

b. Explain constituents, desirable properties and types of paints.

Ans. **Properties and Types of Paints :** Refer Q. 2.4, Page 2–5C, Unit-2.
Constituents of Paints : Refer Q. 2.5, Page 2–6C, Unit-2.

c. Write note on the following :

i. Thermosetting and thermoplastic, and

Ans. Refer Q. 2.2, Page 2–3C, Unit-2.

ii. Common terms used in brick masonry.

Ans. Refer Q. 3.22, Page 3–36C, Unit-3.

d. Explain the properties and characteristic of reinforcing steel.

Ans. Refer Q. 2.12, Page 2–13C, Unit-2.

e. Discuss the properties and uses of the following :

a. Aluminium, and

Ans. Refer Q. 2.15, Page 2–15C, Unit-2.

b. Cast iron.

Ans. Refer Q. 2.16, Page 2–17C, Unit-2.

f. Write short note on the following :

A. Types of sound insulating material, and

Ans. Refer Q. 2.23, Page 2–25C, Unit-2.

B. Types of thermal insulating material.

Ans: Refer Q. 2.21, Page 2–24C, Unit-2.

3. Attempt any two parts : (2 × 10 = 20)

a. Discuss in detail the following :

A. Staircase construction (neat sketch), and

Ans: Refer Q. 3.15, Page 3–24C, Unit-3.

B. Cavity wall and hollow block.

Ans: Refer Q. 3.25, Page 3–40C, Unit-3.

b. Explain the classification of stone masonry and bonds used in brick masonry.

Ans: **Classification of Stone Masonry :** Refer Q. 3.24, Page 3–38C, Unit-3.

Type of Bonds : Q. 3.23, Page 3–37C, Unit-3.

c. What are the different types of ground floor ? Describe them briefly.

Ans: Refer Q. 3.18, Page 3–27C, Unit-3.

4. Attempt any two parts : (2 × 10 = 20)

a. Discuss different types of roofs. Write a short note on queen post truss with neat sketch.

Ans: **Types of Roofs :** Refer Q. 4.9, Page 4–13C, Unit-4.

Queen Post Truss : Refer Q. 4.11, Page 4–15C, Unit-4.

b. What is the function of lintels and its classification ?

Ans: **Types of Lintels :** Refer Q. 4.13, Page 4–20C, Unit-4.

Function of Lintels : Refer Q. 4.14, Page 4–21C, Unit-4.

c. Explain the different type of doors and windows.

Ans: **Types of Doors :** Refer Q. 4.3, Page 4–4C, Unit-4.

Types of Windows : Refer Q. 4.5, Page 4–8C, Unit-4.

5. Attempt any two parts : (2 × 10 = 20)

a. Define the term ventilation. Discuss the factors which affect ventilation. Which point should be kept in mind while planning ventilation in public building ?

Ans: **Ventilation and Factors :** Refer Q. 5.1, Page 5–2C, Unit-5.

Points : Refer Q. 5.4, Page 5–6C, Unit-5.

b. Explain the following :

i. Mechanical lifts and escalators.

Ans: Refer Q. 5.11, Page 5–13C, Unit-5.

ii. Acoustics.

Ans: Refer Q. 5.15, Page 5–16C, Unit-5.

iii. Water supply system and fixtures.

Ans: Refer Q. 5.6, Page 5–9C, Unit-5.

c. Explain the following :

i. Plastering and pointing.

Ans: **Plastering :** Refer Q. 5.18, Page 5–21C, Unit-5.

Pointing : Refer Q. 5.20, Page 5–22C, Unit-5.

ii. Drains.

Ans: Refer Q. 5.7, Page 5–9C, Unit-5.

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B.Tech.
(SEM. III) ODD SEMESTER THEORY EXAMINATION, 2015-16
BUILDING MATERIALS AND CONSTRUCTION

Time : 3 Hours **Total Marks : 100**

Section-A

1. Attempt **all** parts. All parts carry equal marks. Write answer of each part in short : **(10 × 2 = 20)**

a. Explain the term lime bursting.

Ans: Refer Q. 1.28, 2 Marks Questions, Page SQ–6C, Unit-1.

b. What do you mean by seasoning of timber ?

Ans: Refer Q. 1.29, 2 Marks Questions, Page SQ–6C, Unit-1.

c. Explain the term HVAC.

Ans: Refer Q. 1.30, 2 Marks Questions, Page SQ–6C, Unit-1.

d. Give the classification of plastics.

Ans: Refer Q. 2.3, 2 Marks Questions, Page SQ–8C, Unit-2.

e. Draw a sketch showing the position of gable and dormer window.

Ans: Refer Q. 4.20, 2 Marks Questions, Page SQ–18C, Unit-4.

f. Explain the term 10WS12.

Ans: Refer Q. 4.19, 2 Marks Questions, Page SQ–18C, Unit-4.

g. Enlist the importance of hollow block construction.

Ans: Refer Q. 3.26, 2 Marks Questions, Page SQ–15C, Unit-3.

h. What do you understand by workability of concrete ?

Ans: Refer Q. 1.31, 2 Marks Questions, Page SQ–6C, Unit-1.

i. What do you understand by king closer and queen closer ?

Ans: Refer Q. 1.32, 2 Marks Questions, Page SQ–6C, Unit-1.

j. What do you understand by masonry construction ?

Ans: Refer Q. 3.18, 2 Marks Questions, Page SQ–14C, Unit-3.

Section - B

Attempt any **five** questions from this section. **(5 × 10 = 50)**

2. **Enlist the various types of doors and explain in detail any four of them.**

Ans: Refer Q. 4.3, Page 4–4C, Unit-4.

3. **Explain the three commercial form of iron products.**

Ans: Refer Q. 2.16, Page 2–17C, Unit-2.

4. **Explain how post-construction anti-termite treatment is carried out in a building ?**

Ans: Refer Q. 3.10, Page 3–15C, Unit-3.

5. **Explain the various types of pitched roofs.**

Ans: Refer Q. 4.11, Page 4–15C, Unit-4.

6. **Explain the various methods of damp proofing.**

Ans: Refer Q. 3.7, Page 3–11C, Unit-3.

7. **What is puzzolana ? Explain the various puzzolanic materials.**

Ans: Refer Q. 1.34, Page 1–44C, Unit-1.

8. **Give the classification of building as per NBC with suitable examples.**

Ans: Refer Q. 3.1, Page 3–2C, Unit-3.

9. **What are varnishes ? Discuss its common constituents.**

Ans: Refer Q. 2.7, Page 2–8C, Unit-2.

Section-C

Attempt any **two** questions from this section. **(2 × 15 = 30)**

10. What is cement ? Explain the various tests needed to be performed to ensure the suitability of cement.

Ans: Refer Q. 1.26, Page 1–32C, Unit-1.

11. Discuss in detail the various principles for planning the building.

Ans: Refer Q. 3.3, Page 3–5C, Unit-3.

12. Explain in detail with suitable sketches the setting out work that is needed to be carried out for a building.

Ans: Refer Q. 3.4, Page 3–7C, Unit-3.

B.Tech.
(SEM. III) ODD SEMESTER THEORY EXAMINATION, 2016-17
BUILDING MATERIAL AND CONSTRUCTION

Time : 3 Hours **Total Marks : 100**

Section-A

1. Answer **all** questions. **(10 × 2 = 20)**

a. Define DPC.

Ans: Refer Q. 3.8, 2 Marks Questions, Page SQ–13C, Unit-3.

b. What is puzzolana ?

Ans: Refer Q. 1.19, 2 Marks Questions, Page SQ–5C, Unit-1.

c. Define glass. What are the constituents of glass ?

Ans: Refer Q. 2.16, 2 Marks Questions, Page SQ–10C, Unit-2.

d. Define paints and varnishes.

Ans: Refer Q. 2.4, 2 Marks Questions, Page SQ–8C, Unit-2.

e. Define damp proofing.

Ans: Refer Q. 3.7, 2 Marks Questions, Page SQ–13C, Unit-3.

f. What is stone masonry ?

Ans: Refer Q. 3.19, 2 Marks Questions, Page SQ–14C, Unit-3.

g. What is the introduction of building plan ?

Ans: Refer Q. 3.1, 2 Marks Questions, Page SQ–12C, Unit-3.

h. Define ventilation.

Ans: Refer Q. 5.1, 2 Marks Questions, Page SQ–20C, Unit-5.

i. Define distempering.

Ans: Refer Q. 2.8, 2 Marks Questions, Page SQ–9C, Unit-2.

j. What are the different types of plastering ?

Ans: Refer Q. 5.23, 2 Marks Questions, Page SQ–22C, Unit-5.

Section-B

2. Attempt any **three** questions. **(3 × 10 = 30)**

a. Describe the process of production of concrete.

Ans: Refer Q. 1.29, Page 1–37C, Unit-1.

b. Discuss in detail essential constituents of paints. Give examples.

Ans: Refer Q. 2.5, Page 2–6C, Unit-2.

c. Discuss in details about flooring and its requirements.

Ans: Refer Q. 3.20, Page 3–32C, Unit-3.

d. Give the conventional symbols for :

1. Various types of doors.

2. Almirah.

3. Windows.

4. Sanitary items.

5. Electric items.

Ans: Refer Q. 3.26, Page 3–41C, Unit-3.

e. Describe the various elements of water supply system with the help of diagram.

Ans: Refer Q. 5.8, Page 5–10C, Unit-5.

Section-C

3. Attempt any **five** questions. **(5 × 10 = 50)**

a. i. Explain the classification of stones.

Ans: Refer Q. 1.7, Page 1–9C, Unit-1.

ii. Explain the different types and identification of timber.

Ans: Refer Q. 1.35, Page 1–45C, Unit-1.

b. i. Describe the various tests on cement.

Ans: Refer Q. 1.26, Page 1–32C, Unit-1.

ii. Discuss about desirable characteristics of reinforcing steel.

Ans: Refer Q. 2.12, Page 2–13C, Unit-2.

c. i. Explain different types of glasses and its uses.

Ans: Refer Q. 2.19, Page 2–22C, Unit-2.

ii. Distinguish between varnishes and distempers.

Ans: Refer Q. 2.11, Page 2–11C, Unit-2.

d. i. Explain different types of floors and flooring materials.

Ans: Refer Q. 3.16, Page 3–26C, Unit-3.

ii. Give a detail description about brick, sand, stone and masonry construction.

Ans: Refer Q. 3.21, Page 3–35C, Unit-3.

e. i. Write short notes on cavity wall and hollow block construction.

Ans: Refer Q. 3.25, Page 3–40C, Unit-3.

ii. Describe the types of windows and its advantages.

Ans: **Types of Windows :** Refer Q. 4.5, Page 4–8C, Unit-4.
Advantages of Windows : Refer Q. 4.6, Page 4–10C, Unit-4.

f. i. Explain treatment of roof.

Ans: Refer Q. 4.12, Page 4–19C, Unit-4.

ii. Describe functional efficiency of building.

Ans: Refer Q. 4.15, Page 4–23C, Unit-4.

g. i. Describe the various types of ventilation.

Ans: Refer Q. 5.3, Page 5–5C, Unit-3.

ii. Explain the different types of plastering and pointing.

Ans: **Plastering :** Refer Q. 5.19, Page 5–21C, Unit-5.

Pointing : Refer Q. 5.20, Page 5–22C, Unit-5.

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B.Tech.

(SEM. III) ODD SEMESTER THEORY EXAMINATION, 2017-18

BUILDING MATERIAL & CONSTRUCTION

Time : 3 Hours **Max. Marks : 70**

Note : Attempt **all** sections. Assume any missing data.

SECTION – A

1. Attempt **all** questions in brief. **(2 × 7 = 14)**

a. What is Fat lime ?

Ans: **Fat Lime :**

1. This type of lime is known as the white lime, rich lime, pure lime, or high calcium lime.
2. It is popularly known as the fat lime as it slakes vigorously and its volume is increased to about 2 to 2.5 times.
3. It is 95 % CaO. The impurities are less than 5 %.
4. This lime is used for plastering and white washing of walls, preparing lime mortar with sand.

b. Discuss about Lime bursting.

Ans: Refer Q. 1.28, 2 Marks Questions, Page, SQ–6C, Unit-1.

c. Define Enamel Paints.

Ans: **Enamel Paints :**

1. It contains white lead, oil, petroleum spirit and resinous material.
2. The surface provided by it resists acids, alkalis and water very well.

d. Differentiate between English Bond and Flemish Bond.

Ans: **Comparison between English Bond and Flemish Bond :**

1. English bond is stronger than Flemish bond for walls more than 1½ brick.
2. Appearance of masonry in Flemish bond is more attractive.
3. Broken brick-bats are utilized in Flemish bond although they require a little more of mortar.
4. Flemish bond is a bit difficult than English bond. Flemish bond requires more skilled mason.

e. What is the function of Lintels.

Ans: Lintel supports the weight of the wall above the opening of door, windows and ventilator.

f. What do you mean be the word door ?

Ans: Refer Q. 4.1, 2 Marks Questions, Page SQ–16C, Unit-4.

g. Explain the term 10 WT 13.

Ans: A designation 10WT13 denotes a window opening with single shutter, having width equal to 10 modules (*i.e.*, 10 × 100 = 1000 mm) and height equal to 13 modules (*i.e.*, = 13 × 100 = 1300 mm).

SECTION-B

2. Attempt any **three** parts of the following : **(7 × 3 = 21)**

a. Discuss Bogue's compound of cement. Also write the chemical composition of cement.

Ans: The following Bogue's compounds are formed during clinkering process.

1. Tricalcium Silicate :

i. It is supposed to be the best cementing material and is well burnt cement.
ii. It is about 25-50 % (normally about 40 %) of cement.
iii. It renders the clinker easier to grind, increases resistance to freezing and thawing, hydrates rapidly generating high heat and develops an early hardness and strength.
iv. However, raising of C_3S content beyond the specified limits increases the heat of hydration and solubility of cement in water.
v. The heat of hydration is 500 J/g.

2. Dicalcium Silicate :

i. It is about 25-40 % (normally about 32 %) of cement.
ii. It hydrates and hardens slowly and takes long time to add to the strength (after a year or more).
iii. It imparts resistance to chemical attack.
iv. Raising of C_2S content renders clinker harder to grind, reduces early strength, decreases resistance to freezing and thawing at early ages and decreases heat of hydration.
v. The hydrolysis of C_2S proceeds slowly. The heat of hydration is 260 J/g.

3. Tricalcium Aluminate :

i. It is about 5-11 % (normally about 10.5 %) of cement.
ii. It rapidly reacts with water and is responsible for flash set of finely grounded clinker.
iii. The rapidity of action is regulated by the addition of 2-3 % of gypsum at the time of grinding cement.
iv. Tricalcium aluminate is responsible for the initial set, high heat of hydration and has greater tendency to volume changes causing cracking.
v. Raising the C_3A content reduces the setting time, weakens resistance to sulphate attack and lowers the ultimate strength, heat of hydration and contraction during air hardening.

vi. The heat of hydration is 865 J/g.

4. Tetracalcium Alumino Ferrite :

i. It is about 8-14 % (normally about 9 %) of cement.
ii. It is responsible for flash set but generates less heat.
iii. It has poorest cementing value.
iv. Raising the C_4AF content reduces the strength slightly.
v. The heat of hydration is 420 J/g.

Composition of Cement : Refer Q. 1.23, Page 1–28C, Unit-1.

b. What are the constituent, desirable properties and types of Paints ?

Ans: **Constituent of Paints :** Refer Q. 2.5, Page 2–6C, Unit-2.
Properties and types : Refer Q. 2.4, Page 2–5C, Unit-2.

c. Discuss the various techniques and methods of Damp Prevention.

Ans: Refer Q. 3.7, Page 3–11C, Unit-3.

d. Discuss about Pitched Roof with neat sketch.

Ans: Refer Q. 4.9, Page 4–13 and Q. 4-11, Page 4–15; Unit-4.

e. Discuss about the traps used in sanitary plumbing.

Ans: **Trap :**

1. The trap is a device which always remains full of water. It is a device which puts a barrier in the sewer line in the form of water seal and does not allow municipal sewer gases to escape into the house.
2. The depth of barrier, in the form of water is called the water seal. The effectiveness of the trap depends upon the depth of water seal. The greater the depth of water seal, the more effective is the trap.
3. Depth of the water seal varies from 2.5 cm to 7.5 cm.
4. The traps can be classified according to shape or according to use :

i. According to shape traps may be *P*-type, *Q*-type and *S*-type as shown in Fig. 1(*a*), (*b*) and (*c*).
ii. According to use they may be Floor or Nahani trap, Gully trap and Intercepting trap.

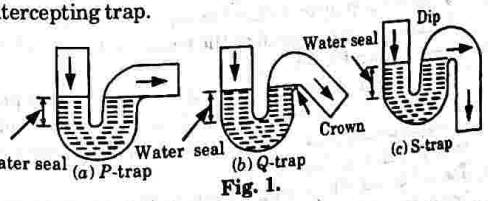

Fig. 1.

1. Floor Trap :

i. It is made of cast iron and provided at the point of entry of waste water in the house. It will thus be placed in bath-rooms, kitchens, sinks etc.

ii. A floor trap forms the starting point of waste water flow.
iii. A cover with grating is provided at its top so as to prevent the entry of solid matter into the underground drain. The cover can be removed for the cleaning of the trap. Fig. 2.

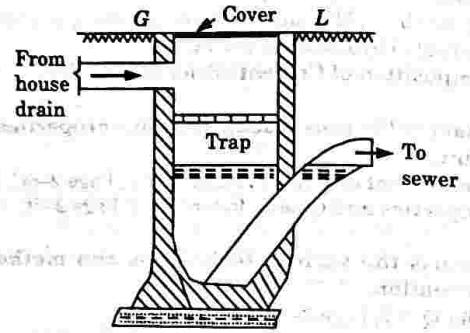

Fig. 2. Nahani trap.

2. Gully Trap :

i. This trap is usually made of stoneware and a cast iron grating is provided at its top. The gully trap is fitted inside a masonry chamber. A water seal of about 75 mm is provided in this trap.
ii. Gully trap forms the beginning point of horizontal flow of sewage, it is normally installed near the external face of the wall and it is kept slightly higher or even in line with the pavement or ground.
iii. This trap takes sewage, either to sewer or to inspection chamber or man-hole. Fig. 3.

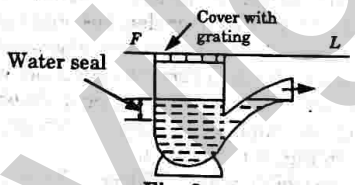

Fig. 3.

iv. The top of the gully trap chamber is provided with a cover usually of CI which may be removed at the time of cleaning the trap.

3. Intercepting Trap :

i. This trap has comparatively deeper water seal. It is provided at the last inspection chamber or manhole of the house drainage system.
ii. Sewage coming from the house enters public sewer after passing through intercepting trap.
iii. The main idea of providing the intercepting sewer trap is to prevent the entry of sewer gases from public sewer line into the house drains.
iv. This trap consists of an inspection arm for the purpose of cleaning or inspection. It is kept closed by a lid or plug.

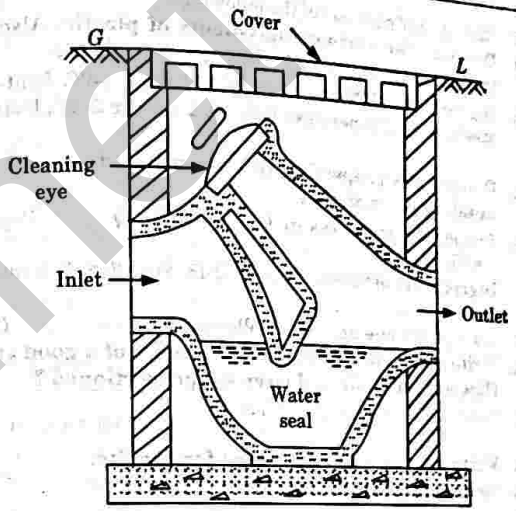

Fig. 4.

SECTION-C

3. Attempt any one part of the following : (7 × 1 = 7)

a. What are different characteristics of stones and their methods of testing ? Write the name of various types of stones which are used in building work ?

Ans: **Characteristics :** Refer Q. 1.8, Page 1–11C, Unit-1.
Method of testing : Refer Q. 1.9, Page 1–12C, Unit-1.
Types of Stones : Refer Q. 1.10, Page 1–14C, Unit-1.

b. What do you mean by efflorescence of Brick and how will you classify the efflorescence in Brick ?

Ans: **Efflorescence :** Refer Q. 1.17, Page 1–21C, Unit-1.
Classification : Presence of efflorescence in bricks is classified as follows :

1. **Nil :** When the deposit of efflorescence is imperceptible.
2. **Slight :** When the deposit of efflorescence does not cover more than 10 percent of the exposed area of the brick.
3. **Moderate :** When the deposit of efflorescence is more than 10 per cent but less than 50 % of the exposed area of the brick.
4. **Heavy :** When the deposit of efflorescence is more than 50 per cent but the deposits do not powder or flake away the brick surface.
5. **Serious :** When the deposits are heavy and powder or flake away the brick surface.

4. Attempt any **one** part of the following : (7 × 1 = 7)

a. Describe the various ingredients of plastic. Also discuss the different mechanical properties of plastic.

Ans: **Ingredients of Plastic :** Refer Q. 2.1, Page 2–2C, Unit-2.
Mechanical Properties : Refer Q. 2.3, Page 2–4C, Unit-2.

b. Discuss the properties, ingredients and uses of glass in building construction.

Ans: **Properties and Uses of Glass :** Refer Q. 2.19, Page 2–22C, Unit-2.
Ingredients of Glass : Refer Q. 2.18, Page 2–21C, Unit-2.

5. Attempt any **one** part of the following : (7 × 1 = 7)

a. Write about the various requirements of a good staircase. How are the trade and riser are proportioned ?

Ans: Refer Q. 3.13, Page 3–20C, Unit-3.

b. Write a note on soil treatment for termite.

Ans: Refer Q. 3.10, Page 3–15C, Unit-3

6. Attempt any **one** part of the following : (7 × 1 = 7)

a. Discuss various technical terms used in Doors.

Ans: Following are the technical terms which are used in doors :

1. Frame :

i. Openings of doors and windows left in masonry work are fitted with timber or steel frames so that shutters may be attached to them.

ii. A door frame consists of two vertical members called jambs and a horizontal member at the top connecting both the jambs. This top horizontal member is called head.

iii. Sometimes, a horizontal member at floor level is also put to bind the jambs at the bottom. This member in that case is known as sill.

2. Hold Fasts :

i. It is generally, made from mild steel strap about 6 mm thick and 30 to 40 mm wide. It is 20 to 30 cm in length.

ii. One end of the holdfast is connected to the frame but free end is split by sawing the strap along its middle width for some length and then both the parts of the sawed length are bent in opposite directions.

iii. This is done to secure the frame tightly and firmly into the masonry.

iv. For a door frame, six hold fasts are required. Three numbers are provided on each side of the door frame.

3. Horns :

i. Projected parts of head or sill, beyond the outer face of the frame is known as horn.

ii. Length of the horn is nearly 15 cm.

iii. Horns when embedded in masonry help in tightly securing the frame into the masonry.

4. Style or Stile : Outside vertical members of frame-work of a shutter are known as styles or stiles.

5. Top Rail : The top-most horizontal member of a shutter frame-work is known as top rail.

6. Lock Rail : It is the middle horizontal member of a shutter of frame-work wherein locking arrangement is provided.

7. Bottom Rail : This is the lower-most horizontal piece of a shutter frame-work.

8. Frieze Rail : It is the horizontal member of the shutter frame work provided near the top rail but slightly below it. This rail is not always provided.

9. Panel : It is the area enclosed between vertical styles and horizontal rails (top, bottom, lock and frieze).

10. Louver : It is an inclined piece of timber fixed within a frame. Louvers are provided in window where vision is required to be prevented without affecting the ventilation system.

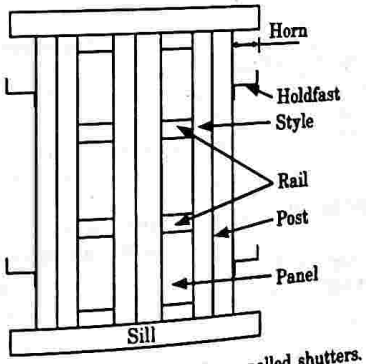

Fig. 5. Doors frame and its panelled shutters.

b. What is the classification of lintels ?

Ans: Refer Q. 4.13, Page 4–20C, Umit-4.

7. Attempt any **one** part of the following : **(7 × 1 = 7)**

a. Define the term ventilation. Discuss the factors which affect ventilation ? Which point should be kept in mind while planning ventilation in public building ?

Ans: **Ventilation and Factors :** Refer Q. 5.1, Page 5–2C, Unit-5.
Requirement : Refer Q. 5.2, Page 5–3C, Unit-5.

b. What is the difference between a lift and escalator ? What are the functional requirement of a lift in building ?

Ans: Refer Q. 5.11, Page 5–13C, Unit-5.

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B. Tech.
(SEM. III) ODD SEMESTER THEORY EXAMINATION, 2018-19
BUILDING MATERIALS & CONSTRUCTION

Time : 3 Hours **Max. Marks : 70**

Note : Attempt all sections. If require any missing data; then choose suitably.

SECTION-A

1. Attempt **all** questions in brief : **(2 × 7 = 14)**

a. What is meant by term PVCN ?

Ans: The concentration of pigment in paint is denoted by pigment volume concentration number (PVCN). It is define as the ratio of the volume of pigment to the volume of total non-volatile material present in a coating.

$$PVCN = \frac{V}{V_1 + V_2}$$

where, V_1 = Volume of pigment in the paint.

V_2 = Volume of non-volatile vehicle.

b. What is terra-cotta ?

Ans: Terra-cotta refers to a high grade of weathered or aged clay which, when mixed with sand or with pulverized fired clay, can be molded and fired at high temperatures to a hardness and compactness not obtainable with brick. Simply put, terra-cotta is an enriched molded clay brick or block.

c. For exterior works, the turpentine should be taken in minimum quantity. Why ?

Ans: Turpentine oil is affected by weather; hence minimum quantity of thinner (turpentine oil) should be used for painting external surfaces.

d. Differentiate between lift and escalator.

Ans.

	Lift (Elevator)	Escalator
Movement	Goes verticle.	Moving stairs.
Function	A type of vertical transport equipment that efficiently moves people or goods between floors (levels, decks) of a building, vessel or other structure.	A conveyor transport device for carrying people between floors of a building.
Speed	Speeds of up to 2,000 feet per minute (10 m/sec)	A single-width escalator traveling at about 1.5 feet (0.5 m) per second can move about 2,000 people per hour.

e. What are the factors which affects the choice of flooring material ?

Ans. Following are the factors affecting the choice of flooring material :

1. Appearance.
2. Cleaning.
3. Comfort.
4. Cost.
5. Damp resistance.
6. Slipperness.
7. Durability.
8. Fire resistance.
9. Hardness.
10. Maintenance.

f. Define string.

Ans. It is the continuous horizontal course of masonry, projecting from the face of the wall for shedding rain water of the face. It is generally provided at every floor and sill level.

g. What are the fibrous plaster boards ?

Ans. This board is manufactured specifically for interior ceilings of residential, commercial and institutional buildings. It consists of gypsum plaster reinforced with fibre glass strands.

SECTION-B

2. Attempt any **three** of the following : **(7 × 3 = 21)**

a. Name the various types stones which are used for building works and give brief the specifications for a good building stones.

Ans. **Types of Stone :** Refer Q. 1.10, Page 1–14C, Unit-1.
Specification : Refer Q. 1.8, Page 1–11C, Unit-1.

b. What is cement paints ? What are the advantages of cement paints and what are precautions to be taken to avoid defects of the cement paints ?

Ans. **Cement Paint :** Cement paints are covered under powder paints which are used for exterior cemented walls, all types of masonry surfaces like bungalows, multistoried buildings, bridges, dams, houses, buildings of general public, etc. and can also be used for interior as well as exterior masonry cemented surfaces.

Advantages : Following are the advantages of cement paint :

1. Economical.
2. Better performance for outdoor protection and decoration.
3. Available in various colours and can match up with any shade.
4. Has matt finish, an inexpensive way to cover large areas such as cellars and garages.
5. No chance of drying it up since it is available in powder form which is mixed into water before application.

Precautions :

1. Precautions to Avoid Algae Defects :

i. If algae occur outdoor then remove plants or shrub from surrounding areas.

ii. If there is any leakage from the concealed plumbing lines then find the source of it, as it increases moisture on the surface and algae/mould can occur.

2. Precautions to Avoid Bleeding Defects :

i. Thoroughly clean the areas to be painted before and after sanding.

ii. Apply two medium coats of primer, in accordance with manufacturer's recommendation.

3. Precautions to Avoid Blistering Defects :

i. Make sure that the surface to be painted is clean and dry.

ii. Allow the paint to dry completely before exposing the surface to moisture.

c. Briefly describe the construction of terrazzo flooring.

Ans. **Construction of Terrazzo Flooring :**

1. Terrazzo flooring consists of :

i. Concrete bed.

ii. Mortar bed, 1 cm of cement mortar (cement sand mixture 1:3).

iii. Metal strips.
iv. Marble cheeps 3 to 6 mm.

2. Terrazzo is concrete containing marble chipping as an aggregate.
3. Terrazzo mixture is made up of cement and marble chips in different proportions.
4. First of all, a concrete bed is formed as a base course which is covered by tarred paper.
5. Over this, a layer of rich mortar is spread.
6. This mortar bedding is struck off about 1 to 1.5 cm below the finished floor level.
7. After that metal dividing strips of 20 gauges in thickness are inserted into the mortar base and the terrazzo covering.
8. After the mortar base has hardened the terrazzo mixture is placed at the top level of the dividing strips.
9. After the terrazzo mixture has hardened the surface is ground by hand or by a machine. After cutting we use waxing for glazing floor.

d. What are the difference between damp proofing and water proofing? Describe the various methods of damp proofing.

Ans. Difference :

S. No.	Damp Proofing	Water Proofing
1.	Damp proofing is defined as a treatment of a surface or structure to resist the passage of water in the absence of hydrostatic pressure.	Water proofing is defined as a treatment of a surface or structure to resist the passage of water under hydrostatic pressure.
2.	Damp proofing is intended to keep out soil moisture.	Water proofing keeps out both moisture and liquid water.
3.	Any concrete or masonry foundation walls that retain earth and enclose interior spaces and floors below grade shall be damp proofed from the top of the footing to the finished grade.	Water proofing is only required by the IRC in areas where a high water table or other severe soil-water conditions are known to exist.
4.	Unmodified asphalt used in damp proofing.	Polymer-enhanced asphalt membrane or all-polymer composition is used in water proofing.

Methods : Refer Q. 3.7, Page 3–11C, Unit-3.

e. How will you prevent the cracks and leaks in the building? Also explain the process of repairing the cracks and leaks.

Ans.

A. Prevent the Cracks :

1. By creating slip joints under the support of RCC slab on walls, cracks by elastic deformation can be prevented.
2. Construct various joints such as expansion joints, construction joints, slip joints and control joints to prevent cracks from thermal movement.
3. Slab should be provided with thermal insulation.
4. Concrete should be of good quality. Use richer mix of cement concrete 1:1.5:3 to prevent cracks.
5. In mixing of cement concrete or cement mortar, Use minimum quantity of water, as per water cement ratio.
6. Use largest possible aggregate and the materials should be of good grading and quality.
7. Proper monitoring is required at the time of construction.

Cracks Repair in Building by Grouting Method :

i. We used Portland cement grouting method to repair cracks in our selected site.
ii. Injection of slurry or a liquid solution into a soil or rock formation is termed as grouting.
iii. The injected material is referred to as the grout.
iv. The ordinary Portland cement used in grouting should be as per IS: 269 and sand and water should be as per IRS Concrete Bridge Code. With the approval of the Divisional Engineer, admixtures can be added to impart non-shrinkable properties and to improve flow ability of grout.
v. The water cement ratio (by weight) for the grout should be 0.4 to 0.5, when crack width exceeds 0.5 mm, the lower ratio should be used.
vi. Pressure grouting equipment is used to inject grout in the cracks.
vii. After grouting, curing should be done for 14 days.
viii. Although it is time consuming method yet it is more used because it gives better result. The result of grouting method restores and increases the strength of cracked component.

B. Prevent the Leakage in Building :

1. Cleaning of terraces, drains before monsoon and when chocked.
2. Replacement of leaky/damaged washers in fittings.
3. Replacement of leaky/damaged pipe line, gate valves etc.
4. Replacement of leaky/damaged gasket in flanges.
5. Replacement of leaky/damaged joint in CI drain pipes.
6. Replacement of leaky/damaged MS trays under Air Handling Units.

Repairing the Leakage in Building :

Step 1 : Using a masonry chisel, enlarge the crack to a minimum $\frac{3}{4}$ inch width and then remove all loose material.

Step 2 : Squarely cut or undercut the edges of the crack. It is important not to create "v" shaped edges as the Hydraulic Water-Stop expands as it hardens.

Step 3 : Mix Hydraulic Water-Stop by adding about 4 to $4\frac{1}{2}$ parts Water-Stop cement to 1 part clean water.

Step 4 : Use a margin trowel to thoroughly mix the material to a heavy putty consistency, making sure that the mix is uniform and lump free. If the mix is too wet, add additional Water-Stop cement and mix thoroughly; if the mix is too dry, add small amounts of water sparingly.

Step 5 : Once a putty consistency is achieved, take a handful of Water-Stop in your gloved hand and begin to work the material into a ball.

Step 6 : Press the Water-Stop cement into the crack using heavy pressure and hold in place for several seconds.

Step 7 : After the material has become "thumbprint" hard, use a margin trowel to trim the patch to match the contour of the surrounding surface.

Step 8 : The Water-Stop repair can be painted after 7 days with a water-based latex paint.

SECTION-C

3. Attempt any **one** of the following : **(7 × 1 = 7)**

a. What is pug mill ? How does it help in the manufacturing the bricks ? Describe the different processes of moulding of bricks.

Ans: Pug Mill : It is a machine in which clay or other materials are mixed into a plastic state or a similar machine for the trituration of ore. Industrial applications are found in pottery, bricks, cement and some parts of the concrete and asphalt mixing processes.

Working : Blended earth along with required water is fed into the pug mill from the top. The knives cut through the clay and break all the clods or lump-clays when the shaft rotates. The thoroughly pugged clay is then taken out from opening provided

in the side near the bottom. The yield from a pug mill is about 15 or bricks.

Moulding : Refer Q. 1.13, Page 1–18C, Unit-1.

b. Why is seasoning of timber necessary ? Why should timbers be preserved ? State various methods of preservation of timbers.

Ans: Seasoning : Refer Q. 1.38, Page 1–51C, Unit-1.

Necessity of Preservation : Following are the necessity of preservation of timber :

i. Preservation of timber is carried out to increase the life of timber.
ii. It makes the timber more durable.
iii. It also helps the timber to get rid of insects and fungi etc.

Method of Preservation : Following are the various methods of preservation of timber :

i. Application of some preservatives on the surface of the timber.
ii. Injection of the preservatives into the body of the timber.
iii. Construction of protective coverings or shields around timber used in construction.

4. Attempt any **one** of the following : **(7 × 1 = 7)**

a. What are plastics and how are they classified ? List the commonly used thermoplastic plastics and briefly describe polyvinyl chloride.

Ans: Plastic : Refer Q. 2.1, Page 2–2C, Unit-2.

Classification : Refer Q. 2.2, Page 2–3C, Unit-2.

Thermoplastic : Following are the commonly used thermoplastics :

i. Polyethylene.
ii. Polypropylene.
iii. Polyvinyl chloride.
iv. Polystyrene.
v. Nylon.
vi. Acrylics.
vii. Acrylonitrile butadiene styrene.

Polyvinyl Chloride (PVC) : It is a versatile thermoplastic material obtained from ethylene and salt by vinyl chloride polymerization.

Applications of PVC :

i. PVC has been used as construction product.

ii. PVC used as a health care products :

Example : Artificial skin, blood transfusion sets, blood vessels for artificial kidneys.

iii. Instrument panels, seat coverings, head lining, protective strips, floor coverings and anti stone damage protection are things done by using PVC.

b. Explain the difference between wrought iron, steel and cast iron. What are the distinguishing features of mild steel ? Why is it easy to make cast iron castings ?

Ans. Difference :

	Wrought Iron	Cast Iron	Steel
Malleability Ductility	Tough, malleable ductile and moderately elastic	Brittle and cannot be welded or rolled into sheets	Tough, malleable and ductile
Reaction to sudden shock	Cannot stand heavy shocks	Does not absorb shocks	Absorbs shocks
Welding	Easily welded	Cannot be welded	Can be welded
Composition	Purest contains upto 0.25 % C	Crude form containing 2-4% C	Midway
Melting point	1500 °C	1200 °C	1300-1400 °C
Hardness	Cannot be hardened or tempered	Hard, hardened by heating and sudden cooling	Can be hardened and tempered
Strength	Compressive strength is 0.2 t/cm^2, ultimate tensile strength is 3.15 t/cm^2	Compressive strength is 6.3-7.1 t/cm^2, ultimate tensile strength is 1.26-1.57 t/cm^2	Compressive strength is 4.75-25.2 t/cm^2, ultimate tensile strength is 5.51-11.02 t/cm^2

Features of Mild Steel : Following are the features of mild steel :

1. Ductile and malleable.
2. More tough and more elastic than cast iron and wrought iron.
3. More prone to rusting than wrought iron.
4. Corrodes quickly.

5. Easily forged, welded and riveted.
6. Withstands shocks and impacts well.
7. Not much affected by saline water.
8. Equally strong in tension, compression and in shear.
9. Difficult to harden or temper.
10. Specific gravity is 7.8.

Cast Iron Casting : Cart iron casting easily due to following reason :

1. Cast iron contains over 2 percent by weight of carbon, and as a result has a lower melting temperature and requires less refining.
2. Cast iron castings can be produced with less costly and less specialized equipment.
3. Cast iron shrinks less when solidifying.
4. Cast iron can be cast into more complex shapes easily.

5. Attempt any **one** of the following : **(7 × 1 = 7)**

a. What are the different types of brick masonry ? List out the types of bonds in brick work. Write the difference between modular bricks and traditional bricks.

Ans. Brick Masonry : The construction carried out using bricks and mortar is known as brick masonry.

Types : Following are the different types of brick masonry :

1. **Mud-brick Masonry :** It is used in works in temporary nature.
2. **Cement-brick Masonry :** It is used for very important and heavily loaded structure.
3. **Lime-brick Masonry :** It is used for work of ordinary use.

Types of Bond : Refer Q. 3.23, Page 3–37C, Unit-3.

Difference :

Modular Bricks	Traditional Bricks
Size is fixed by Bureau of Indian standard institution (BIS). Actual size of modular brick is 19 cm × 9 cm × 9 cm. With mortar thickness, size is becomes 20 cm × 10 cm × 10 cm.	It is not standardized in size. Bricks are prepared in various sizes. The length varies from 20 to 25 cm, width varies from 10 to 23 cm. Commonly adopted sized is 23 cm × 11.4 cm × 7.5 cm.

b. What are the various components of building with their basic requirements ? What are the important factors considered in planning of a residential building ?

Ans. Components : Refer Q. 3.2, Page 3–4C, Unit-3.
Factors : Refer Q. 3.3, Page 3–5C, Unit-3.

6. Attempt any **one** of the following : **(7 × 1 = 7)**

a. What are the functions of ventilator ? How is it different from a window ? Draw details of a ventilator combined with a window.

Ans. Function : Refer Q. 5.4, Page 5–6C, Unit-5.
Difference : Ventilator are small windows fixed at a greater height than the window, generally about 30 to 50 cm below roof limit.
Sketch :

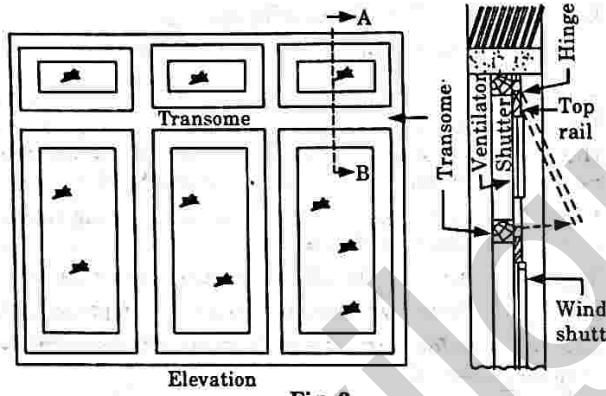

Fig. 2.

b. What are lintels ? Explain the classification of lintels with neat sketches.

Ans. Lintels and its Classification : Refer Q. 4.13, Page 4–20C, Unit-4.
Sketch : Following are the sketches of lintels :

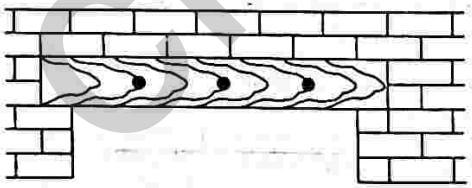

Fig. 3. Timber lintel.

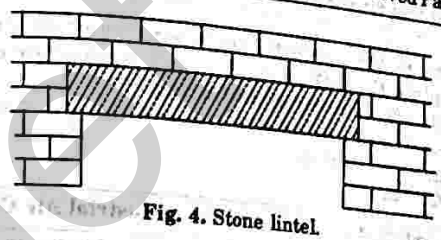

Fig. 4. Stone lintel.

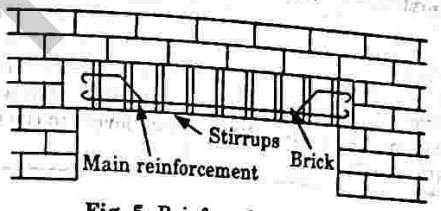

Fig. 5. Reinforced brick lintel.

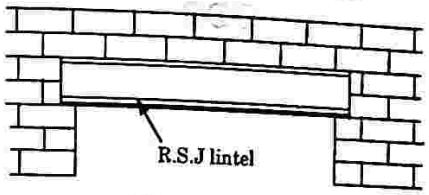

Fig. 6. Steel lintel.

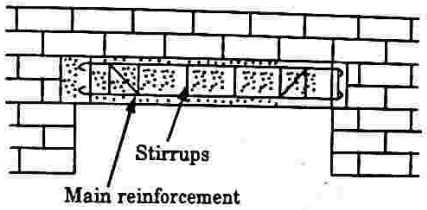

Fig. 7. Reinforced cement concrete lintels.

7. Attempt any **one** of the following : **(7 × 1 = 7)**

a. What are traps ? Explain the various types of traps commonly used.

Ans. Trap and Types of Trap : Refer Q. 2(e), Page SP–20C, Solved Paper 2017-18.

b. Discuss the essential requirements of air conditioning. Explain the difference between comfort air conditioning and industrial air conditioning.

Ans: Requirements of Air Conditioning : Refer Q. 5.12, Page 5–14C, Unit-5.

Difference :

Comfort Air Conditioning	Industrial Air Conditioning
It meant for human comfort. It provides comfortable and healthy conditions for the occupants in residence, theaters, hospitals offices, railway coaches.	It is used for improving the quality of the manufactured materials. It increases the working efficiency of the employees in the factories.

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