

QUESTION BANK – H SCHEME CURRICULUM

Subject: Construction Materials (L-T-P-C: 3-0-0-3)

Unit I: Construction Materials and Properties

PART – A

Section 1: Multiple Choice Questions (21)

1. Which of the following is an eco-friendly construction material?

- A) Ordinary Portland Cement
- B) Fly ash brick
- C) Mild steel
- D) PVC pipe

Answer: B

2. The ratio of the weight of a given volume of material to the weight of an equal volume of water is called:

- A) Density
- B) Porosity
- C) Specific gravity
- D) Permeability

Answer: C

3. Porosity of a building material is defined as the ratio of:

- A) Volume of voids to total volume
- B) Weight of voids to total weight
- C) Volume of solids to total volume
- D) Weight of water absorbed to dry weight

Answer: A

4. Water absorption test is primarily conducted to assess a material's:

- A) Compressive strength
- B) Durability and porosity
- C) Fire resistance
- D) Thermal expansion

Answer: B

5. Permeability of a building material refers to its ability to:

- A) Resist fire
- B) Allow water/fluids to pass through
- C) Expand under heat
- D) Resist chemical attack

Answer: B

6. Weathering resistance of a material is its ability to withstand:

- A) Fire and heat
- B) Atmospheric agents like rain, sun and wind
- C) Chemical corrosion only
- D) Mechanical load

Answer: B

7. The property of a material to resist damage from high temperature and flames is called:

- A) Thermal conductivity
- B) Fire resistance
- C) Thermal expansion
- D) Specific heat

Answer: B

8. Thermal conductivity of a material indicates its ability to:

- A) Store heat
- B) Conduct/transfer heat
- C) Resist fire
- D) Expand on heating

Answer: B

9. Thermal expansion of a building material refers to change in its:

- A) Colour with temperature
- B) Dimensions with temperature change
- C) Weight with temperature
- D) Density with pressure

Answer: B

10. Durability of a construction material is best defined as its ability to:

- A) Resist decay and retain properties over its service life
- B) Absorb maximum water
- C) Conduct heat efficiently
- D) Expand under load

Answer: A

11. Which of the following is NOT a factor affecting durability of building materials?

- A) Climatic conditions
- B) Quality of raw materials
- C) Colour of the material
- D) Workmanship during construction

Answer: C

12. Aggregates obtained from crushing of natural rocks are classified as:

- A) Artificial aggregates
- B) Natural aggregates
- C) Recycled aggregates
- D) Lightweight aggregates

Answer: B

13. Aggregates produced from industrial by-products such as blast furnace slag are called:

- A) Natural aggregates
- B) Artificial aggregates
- C) Heavy weight aggregates
- D) Fine aggregates

Answer: B

14. Lightweight aggregates are mainly used in construction to:

- A) Increase self-weight of structure
- B) Reduce dead load of structure
- C) Increase permeability
- D) Improve fire hazard

Answer: B

15. Heavyweight aggregates such as barytes are typically used in:

- A) Radiation shielding concrete
- B) Roof insulation
- C) Plastering
- D) Waterproofing

Answer: A

16. Recycling of aggregates mainly helps in:

- A) Increasing construction cost
- B) Conserving natural resources and reducing waste
- C) Reducing compressive strength requirements
- D) Increasing water absorption only

Answer: B

17. As per IS 456:2000, presence of excessive sulphates in water used for concrete leads to:

- A) Improved workability
- B) Sulphate attack causing disintegration of concrete
- C) Faster setting with no harm
- D) Increased compressive strength

Answer: B

18. Excessive chlorides in mixing water primarily promote:

- A) Corrosion of reinforcement steel
- B) Better curing
- C) Reduced shrinkage
- D) Improved fire resistance

Answer: A

19. Water used for construction should be free from organic matter mainly because it:

- A) Improves setting time
- B) Affects setting and strength of concrete
- C) Increases workability permanently
- D) Has no effect on concrete

Answer: B

20. Which property of water is essential before it is used for curing and mixing concrete?

- A) High turbidity
- B) Potability / suitability as per IS 456:2000
- C) High salinity
- D) High acidity

Answer: B

21. An example of a new/advanced building material is:

- A) Burnt clay brick
- B) Autoclaved Aerated Concrete (AAC) block
- C) Lime mortar
- D) River sand

Answer: B

Section 2: Multiple Choice Questions – Analytical Type (9)

22. [Type 0 – Assertion Reason]

Assertion (A): Fly ash bricks are considered more eco-friendly than conventional clay bricks. Reason (R): Fly ash is an industrial by-product, and its use reduces both raw material consumption and waste disposal. Choose the correct option:

- A) Both A and R are true, and R is the correct explanation of A
- B) Both A and R are true, but R is NOT the correct explanation of A
- C) A is true but R is false
- D) A is false but R is true

Answer: A

23. [Type 4 – Large Explanation to Inference]

A site engineer observes that a batch of aggregates has low specific gravity, high water absorption and visible surface cracks after a freeze-thaw cycle. Based on this description, what conclusion should the engineer draw about the aggregate's suitability?

- A) Suitable for high-strength structural concrete
- B) Poor durability; unsuitable for exposure to freezing and thawing
- C) Ideal for radiation shielding
- D) No conclusion can be drawn from this description

Answer: B

24. [Type 5 – Emotion Type]

Despite costing more than conventional clay bricks, AAC blocks are increasingly preferred by homeowners. What is the most likely underlying reason beyond the stated cost?

- A) They are lighter, offer better thermal comfort, and reduce long-term energy costs
- B) They are only preferred for their colour
- C) They have no functional advantage
- D) They are cheaper to manufacture than bricks

Answer: A

25. [Type 6 – Articles / Magazines]

Recent industry publications highlight a growing shift toward 'carbon-negative' construction materials that absorb more CO₂ than they emit during production. Based on this current trend, which conventional material is MOST likely being replaced first?

- A) Ordinary Portland Cement in select applications
- B) Natural river sand
- C) Mild steel reinforcement
- D) Burnt clay bricks only

Answer: A

26. [Type 7 – Controversial Statements]

Statement 1: Natural aggregates are always superior to recycled aggregates. Statement 2: Recycled aggregates are always unsuitable for structural concrete. Which of the following best justifies both statements?

- A) Both statements are entirely true
- B) Both statements are exaggerated; suitability depends on grading, source and application
- C) Statement 1 alone is true
- D) Statement 2 alone is true

Answer: B

27. [Type 9 – Terms and Conditions]

As per IS 456:2000, permissible limits are prescribed for sulphates and chlorides in mixing water. If a water sample exceeds the chloride limit, the MOST appropriate immediate action is to:

- A) Use the water without treatment
- B) Reject the source or treat/dilute before use
- C) Increase cement content only

D) Ignore the limit for non-reinforced work

Answer: B

28. [Type 10 – Financial Aspects]

A contractor compares the cost of natural aggregates versus recycled aggregates for a large paving project. Considering transport cost, availability and environmental levy, which factor would MOST influence overall project cost?

- A) Colour of aggregate
- B) Distance of source and transportation cost
- C) Shape of aggregate only
- D) Time of day of delivery

Answer: B

29. [Type 13 – Health Awareness]

Green/eco-friendly building materials are increasingly promoted in construction. Which of these is a valid health-related justification for their use?

- A) They reduce indoor air pollutants and improve occupant health
- B) They are always more colourful
- C) They eliminate the need for ventilation
- D) They have no relation to occupant health

Answer: A

30. [Type 14 – Problematic (Numerical)]

A material sample weighs 250 g dry and 275 g after water absorption. If the dry weight changes to 300 g in a repeated trial with the same % absorption, what would be the new saturated weight?

- A) 325 g
- B) 330 g
- C) 300 g
- D) 350 g

Answer: B

PART – B

Section 1: Descriptive-Type Questions (4)

1. Explain the classification of aggregates based on source and unit weight. Discuss the characteristics and applications of lightweight and heavyweight aggregates. [Marks: 10]
2. (a) Explain any five properties of construction materials with respect to durability. (b) List and briefly explain five factors affecting the durability of building materials. [Marks: 5+5 = 10]
3. Discuss the requirements of water used in construction works. Explain the effects of sulphates and chlorides present in water on concrete, with reference to IS 456:2000. [Marks: 10]
4. (a) Define eco-friendly and green construction materials, listing any five examples. (b) Define energy-efficient and sustainable building materials, listing any five examples. [Marks: 5+5 = 10]

Section 2: Analytical Question with Subdivisions (1)

1. [Type 9 – Terms and Conditions (with subdivisions)]

As per IS 456:2000, water used for construction must satisfy prescribed permissible limits for organic matter, inorganic matter, sulphates, chlorides and pH value before it can be approved for mixing and curing of concrete. A site engineer receives water from a new borewell source and must decide whether it meets these conditions before approving its use.

- (a) List the key permissible-limit conditions (as per IS 456:2000) that the borewell water must satisfy before approval. (3 marks)
- (b) Explain the consequence on reinforced concrete if the chloride limit is exceeded but the water is used anyway. (3 marks)
- (c) Justify what decision the engineer should take if the sulphate content is found to be marginally above the permissible limit, and suggest one corrective measure. (4 marks)

[Total Marks: 10]

Unit II: Bricks, Masonry blocks, Ceramic products, and Glass

PART – A

Section 1: Multiple Choice Questions (21)

1. Good brick earth should NOT contain excessive:

- A) Alumina
- B) Silica
- C) Lime in small proportion
- D) Pebbles and gravel

Answer: D

Solution: Pebbles, gravel and coarse sand prevent proper moulding and cause bricks to crack; they are undesirable in brick earth.

2. Excess alumina in brick earth causes bricks to:

- A) Warp and crack on drying
- B) Become too porous
- C) Become glassy on burning
- D) Lose all plasticity

Answer: A

Solution: Excess alumina increases plasticity beyond the workable limit, causing the brick to shrink unevenly and crack/warp while drying.

3. As per BIS classification, bricks are graded mainly on the basis of:

- A) Colour
- B) Compressive strength
- C) Size only
- D) Water absorption alone

Answer: B

Solution: IS 1077 classifies common burnt clay bricks into classes/grades based on their minimum average compressive strength (e.g., Class 35, 30, 25, etc., in N/mm²).

4. A first-class brick, as per BIS, should have a minimum compressive strength of about:

- A) 3.5 N/mm²
- B) 10.5 N/mm²
- C) 1 N/mm²
- D) 0.5 N/mm²

Answer: B

Solution: First-class bricks typically require a minimum compressive strength of around 10.5 N/mm² (Class 105/Class 10.5 category) as per BIS grading.

5. Water absorption of a good quality brick should generally not exceed:

- A) 5%
- B) 20%
- C) 50%
- D) 75%

Answer: B

Solution: As per BIS, water absorption of good quality bricks (after 24-hour immersion) should not exceed about 20% by weight.

6. A good brick, when struck with another, should produce:

- A) A dull thud
- B) A clear metallic/ringing sound
- C) No sound
- D) A cracking sound

Answer: B

Solution: A clear ringing sound on striking indicates a well-burnt, dense, sound brick free from internal cracks.

7. Perforated bricks are mainly used to:

- A) Increase weight of masonry
- B) Reduce weight and improve thermal insulation
- C) Increase water absorption
- D) Improve fire hazard

Answer: B

Solution: Perforations reduce the brick's material volume and weight while trapping air pockets that improve thermal insulation.

8. Fly ash bricks are manufactured primarily using:

- A) River sand and cement only
- B) Fly ash, sand/stone dust, lime and gypsum
- C) Pure clay only
- D) Crushed granite only

Answer: B

Solution: Fly ash bricks are typically made from fly ash, sand or stone dust, lime and a small quantity of gypsum, compacted and cured.

9. Compared to conventional clay bricks, fly ash bricks generally offer:

- A) Lower compressive strength and higher water absorption
- B) Higher uniformity, better strength and lower water absorption
- C) No environmental benefit
- D) Higher weight per unit volume

Answer: B

Solution: Fly ash bricks are more uniform in size/shape, generally have higher compressive strength and lower water absorption than clay bricks.

10. Hollow concrete blocks are mainly preferred over solid blocks because they:

- A) Are heavier
- B) Reduce dead load and improve thermal insulation
- C) Have lower compressive strength always
- D) Cannot be used in load-bearing walls

Answer: B

Solution: The hollow cores reduce material usage and self-weight, and trapped air improves thermal insulation, compared to solid blocks.

11. AAC (Autoclaved Aerated Concrete) blocks are cured using:

- A) Sun drying only
- B) High-pressure steam curing in an autoclave
- C) Air curing for one month
- D) Cold water immersion

Answer: B

Solution: AAC blocks are cured under high-pressure saturated steam in an autoclave, which develops their strength and light cellular structure.

12. Earthenware, as a ceramic product, is characterised by:

- A) High porosity and opaque body, fired at relatively low temperature
- B) Zero porosity and translucency
- C) Highest strength among ceramic products
- D) Use only in electrical insulators

Answer: A

Solution: Earthenware is a porous, opaque ceramic body fired at comparatively lower temperatures than stoneware or porcelain.

13. Stoneware differs from earthenware mainly in that stoneware is:

- A) More porous
- B) Vitrified, denser and less porous, fired at higher temperature
- C) Never glazed
- D) Weaker in strength

Answer: B

Solution: Stoneware is fired at higher temperatures than earthenware, producing a vitrified, dense, low-porosity body with greater strength.

14. Porcelain is distinguished from other ceramic products by its:

- A) High porosity
- B) Translucency, high strength and very low water absorption
- C) Low firing temperature
- D) Use only for roofing

Answer: B

Solution: Porcelain is fired at very high temperature, producing a dense, translucent, high-strength, virtually non-porous ceramic body.

15. Terracotta is primarily used in construction for:

- A) Structural load-bearing columns
- B) Decorative facades, cladding and ornamental work
- C) Waterproofing membranes
- D) Electrical insulation only

Answer: B

Solution: Terracotta, being a moulded and fired clay product, is commonly used for decorative architectural cladding, facades and ornamentation.

16. Glazed tiles differ from unglazed ceramic tiles in that they have:

- A) No surface coating
- B) A fused glass-like coating providing impervious, decorative finish
- C) Higher porosity than unglazed tiles
- D) Lower resistance to staining

Answer: B

Solution: Glazing applies a fused glass-like coating on the tile surface, making it impervious to water/stains and giving a decorative finish.

17. Thermal care tiles are specially designed to:

- A) Increase heat absorption into the building
- B) Reduce heat transmission and keep interiors cooler
- C) Increase water absorption
- D) Replace structural roofing entirely

Answer: B

Solution: Thermal care/cool roof tiles are designed with reflective or insulating properties that reduce heat transmission into the building.

18. The main constituents used in manufacturing glass are:

- A) Silica, soda ash and lime
- B) Clay, gypsum and fly ash
- C) Cement, sand and water
- D) Bitumen and tar

Answer: A

Solution: Ordinary glass is manufactured primarily from silica (sand), soda ash (sodium carbonate) and lime (calcium oxide) as fluxing/stabilising agents.

19. Toughened glass is produced by a process of:

- A) Slow annealing only
- B) Controlled rapid heating and cooling to induce surface compression
- C) Simple polishing
- D) Soaking in acid

Answer: B

Solution: Toughened (tempered) glass is produced by heating glass and then rapidly cooling its surface, inducing compressive stresses that increase strength.

20. Laminated glass is mainly used in construction for:

- A) Reducing safety by shattering easily
- B) Improved safety, since fragments adhere to an interlayer on breaking
- C) Reducing sound insulation
- D) Structural columns

Answer: B

Solution: Laminated glass consists of glass layers bonded with an interlayer (e.g., PVB); on breaking, fragments stick to the interlayer, improving safety.

21. Roof tiles are primarily selected based on their:

- A) Water resistance, durability and thermal performance
- B) Only their colour
- C) Electrical conductivity
- D) Compressive strength alone, ignoring water resistance

Answer: A

Solution: Roof tiles must resist water penetration, withstand weathering over long service life, and provide good thermal performance for the building.

Section 2: Multiple Choice Questions – Analytical Type (9)

22. [Type 0 – Assertion Reason]

Assertion (A): AAC blocks are increasingly replacing conventional clay bricks in modern construction.
Reason (R): AAC blocks are lighter, offer better thermal insulation and reduce overall structural dead load. Choose the correct option:

- A) Both A and R are true, and R is the correct explanation of A
- B) Both A and R are true, but R is NOT the correct explanation of A
- C) A is true but R is false
- D) A is false but R is true

Answer: A

Solution: The lightweight, thermally insulating cellular structure of AAC blocks directly explains their growing preference over clay bricks — R correctly explains A.

23. [Type 4 – Large Explanation to Inference]

A batch of bricks is found to have high water absorption, dull sound on striking, and visible surface cracks after drying. Based on this description, what should be concluded about the batch?

- A) The bricks are well-burnt and suitable for load-bearing walls
- B) The bricks are under-burnt/poor quality and unsuitable for structural use
- C) The bricks are ideal for exterior cladding
- D) No conclusion is possible from this data

Answer: B

Solution: High water absorption, dull sound and cracking together are classic indicators of under-burnt or poor-quality bricks, unsuitable for structural/load-bearing use.

24. [Type 5 – Emotion Type]

Homeowners are increasingly choosing glazed ceramic tiles over plain cement flooring despite the higher cost. What is the most likely underlying reason beyond cost?

- A) Glazed tiles offer better aesthetics, easy cleaning and stain resistance
- B) Glazed tiles are always heavier
- C) They have no functional advantage over cement flooring
- D) They are cheaper to manufacture

Answer: A

Solution: The impervious, decorative glazed surface improves aesthetics and is easy to clean and resistant to staining — practical and emotional appeal beyond raw cost.

25. [Type 6 – Articles / Magazines]

Recent construction industry articles report growing adoption of 'cool roof' tiles that reflect solar radiation to reduce building cooling loads. Based on this trend, which conventional roofing material is MOST likely to be replaced first in hot climates?

- A) Dark-coloured conventional clay roof tiles with poor reflectivity
- B) Toughened glass
- C) Structural steel beams
- D) Reinforced concrete slabs

Answer: A

Solution: Dark, low-reflectivity conventional tiles absorb the most heat, making them the primary candidates for replacement by reflective cool-roof tiles in hot climates.

26. [Type 7 – Controversial Statements]

Statement 1: Hollow concrete blocks are always structurally weaker than solid blocks. Statement 2: Hollow blocks should never be used in load-bearing walls. Which of the following best justifies both statements?

- A) Both statements are entirely true
- B) Both statements are exaggerated; suitability depends on block grade, wall design and load requirements
- C) Statement 1 alone is true
- D) Statement 2 alone is true

Answer: B

Solution: Both statements use absolute terms; properly designed and graded hollow blocks can be used in load-bearing walls of low-rise structures, so suitability depends on design context, not an absolute rule.

27. [Type 9 – Terms and Conditions]

As per BIS specifications, bricks supplied for a project must meet minimum compressive strength and maximum water absorption limits. If a delivered batch fails the water absorption limit, the MOST appropriate action is to:

- A) Accept the batch without testing further
- B) Reject the batch or subject it to further verification before acceptance
- C) Use it only for plastering, ignoring the specification
- D) Ignore the limit since appearance looks fine

Answer: B

Solution: Failing a mandatory BIS limit means the batch does not meet contractual/quality terms and conditions; it must be rejected or further verified before acceptance for use.

28. [Type 10 – Financial Aspects]

A contractor is deciding between fly ash bricks and conventional clay bricks for a large housing project. Considering raw material cost, transportation and long-term maintenance, which factor would MOST influence the overall project cost?

- A) Colour of the bricks
- B) Combined cost of materials, transport distance and reduced long-term maintenance
- C) Shape of the brick only
- D) The season in which bricks are purchased

Answer: B

Solution: For bulk masonry materials, total cost is driven by material price, transportation distance/logistics, and reduced long-term maintenance (fewer repairs from durability) — not incidental factors.

29. [Type 13 – Health Awareness]

Glazed ceramic tiles are often recommended for kitchen and bathroom walls/floors. Which of these is a valid health-related justification?

- A) Their impervious surface resists moisture, mould and bacterial growth, easing cleaning
- B) They are always more colourful
- C) They eliminate the need for ventilation
- D) They have no relation to hygiene

Answer: A

Solution: The non-porous glazed surface prevents moisture absorption, discouraging mould/bacterial growth and enabling easier cleaning — a genuine hygiene benefit in wet areas.

30. [Type 14 – Problematic (Numerical)]

A brick sample weighs 3.2 kg dry and 3.6 kg after 24-hour water immersion. If a second sample of the same brick type weighs 4.0 kg dry with the same % absorption, what would be its saturated weight?

- A) 4.4 kg
- B) 4.5 kg
- C) 4.2 kg
- D) 4.8 kg

Answer: B

Solution: % water absorption = $(3.6 - 3.2) / 3.2 \times 100 = 12.5\%$. For 4.0 kg dry weight: saturated weight = $4.0 \times 1.125 = 4.5$ kg.

PART – B

Section 1: Descriptive-Type Questions (4)

1. Explain the classification and grading of bricks as per BIS. Discuss the compressive strength criteria used for grading common burnt clay bricks. [Marks: 10]

Solution:

As per IS 1077, common burnt clay building bricks are classified into different classes/grades based on their minimum average compressive strength, expressed in N/mm² (or designated as Class 35, 30, 25, 20, 17.5, 12.5, 10, 7.5, 5, 3.5, etc.). For example, a Class 35 brick must have a minimum average compressive strength of 35 N/mm², while a Class 3.5 brick needs only 3.5 N/mm². Higher classes are used for heavily loaded structural masonry, while lower classes suit non-load-bearing partitions and general filling work. Grading also considers dimensional tolerance, water absorption (generally not exceeding about 20%), and efflorescence rating (nil to serious) apart from compressive strength, ensuring bricks selected match the structural and durability demands of the specific application.

2. (a) Explain any five characteristics of a good quality brick. (b) List and briefly explain any five special types of bricks along with their uses. [Marks: 5+5 = 10]

Solution:

(a) Five characteristics of good bricks: 1) Uniform size, shape and colour with sharp edges. 2) Free from cracks, flaws and nodules of lime. 3) Adequate compressive strength as per BIS class. 4) Water absorption not exceeding about 20% by weight. 5) Emits a clear metallic/ringing sound when struck, indicating a well-burnt, dense body.

(b) Five special types of bricks: 1) Perforated bricks – have holes through the thickness, reducing weight and improving thermal insulation; used in non-load-bearing walls. 2) Hollow bricks – lightweight, with internal cavities, used for partition walls and thermal insulation. 3) Wire-cut bricks – machine-extruded

and cut with wire, giving uniform shape for facing brickwork. 4) Fly ash bricks – made from industrial waste, used as an eco-friendly substitute for clay bricks. 5) Purpose-made/special-shape bricks – moulded for specific applications like copings, cornices and arches.

3. Discuss the properties, characteristics and uses of ceramic products used in construction, namely earthenware, stoneware, porcelain and terracotta. [Marks: 10]

Solution:

Earthenware is a porous, opaque ceramic body fired at relatively low temperature; it has moderate strength and higher water absorption, and is commonly used for unglazed flower pots, drainage pipes and low-cost tiles. Stoneware is fired at a higher temperature than earthenware, producing a dense, vitrified, low-porosity body with good mechanical strength and chemical resistance; it is widely used for sanitary fittings, drainage/sewer pipes and acid-resistant linings. Porcelain is fired at the highest temperature among these, giving a translucent, very dense, virtually non-porous and high-strength body; it is used for sanitary ware, electrical insulators and fine decorative tiles due to its excellent strength and chemical resistance. Terracotta is a moulded and fired clay product, typically reddish-brown, porous and moderately strong; it is mainly used for decorative architectural cladding, facades, ornamental jaalis and roofing elements because of its aesthetic appeal, though it requires protection from excess moisture ingress.

4. (a) Explain the constituents and classification of glass used in construction. (b) Explain the constituents, properties and uses of any two types of masonry blocks (fly ash bricks, solid blocks, hollow blocks, AAC blocks). [Marks: 5+5 = 10]

Solution:

(a) Glass is manufactured mainly from silica (sand), soda ash (sodium carbonate) and lime (calcium oxide), along with minor additives for colour/property modification, melted at high temperature and formed into sheets. It is classified into types such as float glass (flat, distortion-free, produced by floating molten glass on molten tin), toughened/tempered glass (heat-treated for increased strength and safe fragmentation), laminated glass (glass layers bonded with a plastic interlayer for safety), and wired glass (embedded wire mesh for fire resistance and impact containment). Glass is selected in construction based on required size, thickness, strength and safety performance for the specific application (windows, facades, partitions, skylights).

(b) Fly ash bricks: made from fly ash, sand/stone dust, lime and gypsum, compacted and cured; offer uniform size, higher strength and lower water absorption than clay bricks, and are used as an eco-friendly substitute in masonry walls. AAC blocks: made from cement, fly ash/sand, lime and an aerating agent, cured in an autoclave under high-pressure steam; they are lightweight, provide excellent thermal insulation and fire resistance, and are widely used in modern load-bearing and partition walls to reduce dead load and improve energy efficiency.

Section 2: Analytical Question with Subdivisions (1)

1. [Type 9 – Terms and Conditions (with subdivisions)]

As per BIS specifications, bricks supplied to a construction site must satisfy prescribed conditions on minimum compressive strength, maximum water absorption and permissible efflorescence before they

can be approved for use in load-bearing masonry. A site engineer receives a new consignment of bricks from a supplier and must decide whether to approve it.

(a) List the key BIS conditions that the brick consignment must satisfy before approval for load-bearing masonry. (3 marks)

Solution: The bricks must satisfy: minimum average compressive strength corresponding to the specified class (e.g., not less than the declared N/mm² value); water absorption generally not exceeding about 20% by weight after 24-hour immersion; efflorescence rating within the 'nil' to 'slight' range; and dimensional tolerances within permissible limits as per IS 1077.

(b) Explain the consequence on the masonry structure if bricks with excessive water absorption are used anyway. (3 marks)

Solution: Bricks with excessive water absorption are more porous, absorb more moisture from the environment, and are more susceptible to freeze-thaw damage, salt crystallization and efflorescence. This leads to gradual disintegration of brick surfaces, reduced bond strength with mortar, and long-term durability problems in the masonry.

(c) Justify what decision the engineer should take if the compressive strength of the consignment is found to be marginally below the specified class, and suggest one corrective measure. (4 marks)

Solution: The engineer should not approve the consignment for load-bearing structural masonry, since even a marginal strength deficit compromises the structural safety margin assumed in design — the risk outweighs the convenience of accepting a substandard batch. As a corrective measure, the consignment may be rejected and replaced with a batch meeting the specified class, or it may be reclassified and used only in a lower-demand application (e.g., non-load-bearing partition walls) where the reduced strength is acceptable, subject to the structural engineer's approval.

[Total Marks: 10]

Unit III: Cementitious materials

PART – A

Section 1: Multiple Choice Questions (21)

1. The main raw materials used in manufacturing Ordinary Portland Cement (OPC) are:

- A) Limestone and clay
- B) Sand and bitumen
- C) Gypsum and fly ash only
- D) Silica and glass

Answer: A

Solution: OPC is manufactured primarily from limestone (calcareous material) and clay (argillaceous material), burnt and ground with gypsum.

2. Gypsum is added during cement manufacture mainly to:

- A) Increase colour
- B) Retard/control the setting time of cement
- C) Increase water absorption
- D) Reduce compressive strength

Answer: B

Solution: Gypsum controls the rate of hydration of tricalcium aluminate, preventing flash setting and regulating the overall setting time of cement.

3. Portland Pozzolana Cement (PPC) is produced by intergrading OPC clinker with:

- A) Pozzolanic material such as fly ash
- B) Pure gypsum only
- C) River sand
- D) Bitumen

Answer: A

Solution: PPC is manufactured by intergrading OPC clinker with a pozzolanic material (commonly fly ash) and gypsum, improving durability and reducing heat of hydration.

4. The grade of cement (e.g., 33, 43, 53) as per BIS indicates its:

- A) Colour rating

- B) Minimum 28-day compressive strength in N/mm²
- C) Setting time in minutes
- D) Fineness in microns

Answer: B

Solution: Cement grade denotes the minimum compressive strength (in N/mm²) attained by a standard mortar cube after 28 days of curing.

5. Water-cement ratio is defined as the ratio of:

- A) Weight of water to weight of cement in a mix
- B) Volume of aggregate to volume of cement
- C) Weight of sand to weight of water
- D) Weight of cement to weight of coarse aggregate

Answer: A

Solution: Water-cement ratio (w/c) is the ratio of the weight of water used to the weight of cement in a concrete/mortar mix.

6. As the water-cement ratio increases beyond the optimum value, the compressive strength of concrete generally:

- A) Increases indefinitely
- B) Decreases due to increased porosity
- C) Remains unaffected
- D) Becomes zero immediately

Answer: B

Solution: Excess water beyond the optimum requirement creates additional voids/porosity in hardened concrete, reducing its compressive strength.

7. Hydration of cement refers to the:

- A) Physical drying of cement powder
- B) Chemical reaction between cement compounds and water forming hydration products
- C) Grinding process during manufacture
- D) Addition of gypsum during storage

Answer: B

Solution: Hydration is the exothermic chemical reaction of cement compounds with water, producing calcium silicate hydrate and other products that give concrete its strength.

8. Initial setting time of cement refers to the time from:

- A) Manufacture to packing
- B) Adding water to when the paste starts losing plasticity
- C) Final strength gain to failure
- D) Curing start to curing end

Answer: B

Solution: Initial setting time is measured from the instant water is added to cement, until the paste begins to lose its plasticity/workability.

9. The Bogus compounds of cement include C3S, C2S, C3A and:

- A) C4AF
- B) CaCO₃
- C) MgO
- D) SO₃

Answer: A

Solution: The four principal Bogus compounds of Portland cement clinker are Tricalcium Silicate (C3S), Dicalcium Silicate (C2S), Tricalcium Aluminate (C3A), and Tetracalcium Aluminoferrite (C4AF).

10. Tricalcium Silicate (C3S) in cement is primarily responsible for:

- A) Early strength development
- B) Colour of cement only
- C) Retarding setting indefinitely
- D) Reducing heat of hydration to zero

Answer: A

Solution: C3S hydrates rapidly and contributes most to early strength gain (up to about 7–28 days) in Portland cement.

11. Dicalcium Silicate (C2S) in cement mainly contributes to:

- A) Immediate flash setting
- B) Later/long-term strength development
- C) High initial heat of hydration
- D) No contribution to strength

Answer: B

Solution: C2S hydrates more slowly than C3S and contributes mainly to strength gain at later ages (beyond 28 days).

12. Supplementary cementitious materials are added to concrete mainly to:

- A) Increase cost without benefit
- B) Improve durability, reduce heat of hydration and utilise industrial by-products
- C) Reduce workability drastically with no benefit
- D) Replace water entirely

Answer: B

Solution: Supplementary cementitious materials (fly ash, GGBS, silica fume) improve long-term durability, reduce heat of hydration, and beneficially utilise industrial by-products.

13. Fly ash used as a pozzolanic material is primarily a by-product of:

- A) Steel manufacturing
- B) Coal-fired thermal power plants
- C) Cement kilns directly
- D) Timber processing

Answer: B

Solution: Fly ash is a fine particulate by-product collected from the flue gases of coal-fired thermal power plants.

14. Ground Granulated Blast furnace Slag (GGBS) is obtained as a by-product of:

- A) Iron and steel manufacturing (blast furnace process)
- B) Timber sawmills
- C) Glass manufacturing
- D) Brick kilns

Answer: A

Solution: GGBS is produced by rapidly quenching molten blast furnace slag (a by-product of iron manufacture) and grinding it into fine powder.

15. Silica fume, used as a supplementary cementitious material, is characterised by:

- A) Very coarse particle size
- B) Extremely fine particle size and high pozzolanic reactivity
- C) Zero effect on concrete strength
- D) Being obtained from limestone quarries

Answer: B

Solution: Silica fume consists of extremely fine spherical particles (by-product of silicon/ferrosilicon production) with high pozzolanic reactivity, significantly enhancing strength and durability.

16. Natural pozzolans, such as volcanic ash, are used in cement mainly because they:

- A) React with lime to form cementitious compounds in presence of water
- B) Have no chemical reactivity
- C) Are only decorative additives
- D) Increase the cost with no technical benefit

Answer: A

Solution: Natural pozzolans contain reactive silica/alumina that combine with calcium hydroxide (released during cement hydration) in the presence of water to form additional cementitious compounds.

17. Fat lime, a classification of lime, is characterised by:

- A) High calcium content and slaking freely with water
- B) High clay content and poor slaking
- C) Hydraulic setting underwater
- D) No use in construction

Answer: A

Solution: Fat lime (pure/high-calcium lime) has high calcium oxide content, slakes vigorously and freely with water, and hardens by carbonation in air.

18. Hydraulic lime differs from fat lime mainly in that hydraulic lime:

- A) Cannot set at all
- B) Contains clayey impurities and can set even under water
- C) Has zero clay content
- D) Slakes more violently than fat lime

Answer: B

Solution: Hydraulic lime contains silica/alumina (clayey) impurities that impart hydraulic setting properties, allowing it to set and harden even underwater.

19. Slaking of lime refers to the process of:

- A) Burning limestone to produce quicklime
- B) Adding water to quicklime to produce hydrated lime (calcium hydroxide)
- C) Mixing lime with cement only
- D) Drying lime in the sun

Answer: B

Solution: Slaking is the chemical process of adding water to quicklime (CaO), producing hydrated lime (calcium hydroxide) with the evolution of heat.

20. Bituminous materials such as bitumen are primarily obtained from:

- A) Petroleum refining or natural deposits
- B) Limestone quarries
- C) Coal-fired power plants
- D) Timber processing

Answer: A

Solution: Bitumen is obtained mainly as a residue from petroleum refining, or found naturally in deposits such as natural asphalt lakes.

21. Bituminous materials (bitumen, tar, asphalt) are widely used in construction mainly for:

- A) Load-bearing structural columns
- B) Waterproofing and road pavement construction
- C) Electrical insulation of cables only
- D) Structural reinforcement of concrete

Answer: B

Solution: Bituminous materials are valued for their waterproofing and binding properties, making them widely used in road pavements and waterproofing/damp-proofing works.

Section 2: Multiple Choice Questions – Analytical Type (9)

22. [Type 0 – Assertion Reason]

Assertion (A): Portland Pozzolana Cement (PPC) is often preferred over OPC for mass concrete work.
Reason (R): PPC generates lower heat of hydration than OPC, reducing thermal cracking risk in large concrete pours. Choose the correct option:

- A) Both A and R are true, and R is the correct explanation of A
- B) Both A and R are true, but R is NOT the correct explanation of A
- C) A is true but R is false
- D) A is false but R is true

Answer: A

Solution: PPC's lower heat of hydration directly explains why it is preferred for mass concrete works, where thermal cracking due to high heat build-up is a major concern — R correctly explains A.

23. [Type 4 – Large Explanation to Inference]

A concrete mix is reported to have an unusually high water-cement ratio, resulting in a highly workable but weak mix with visible bleeding and segregation. Based on this description, what should be concluded?

- A) The mix will achieve higher long-term strength
- B) Excess porosity and reduced strength/durability will result
- C) The mix is ideal for structural columns
- D) No conclusion is possible

Answer: B

Solution: A high water-cement ratio with bleeding and segregation directly indicates excess free water, leading to greater porosity and reduced strength and durability upon hardening.

24. [Type 5 – Emotion Type]

Despite requiring more careful handling, many modern ready-mix concrete suppliers are shifting toward GGBS-blended cement. What is the most likely underlying reason beyond convenience?

- A) Improved long-term durability and lower carbon footprint
- B) It is always cheaper regardless of application
- C) It has no functional advantage over OPC
- D) It sets instantly with no curing needed

Answer: A

Solution: GGBS-blended cements are adopted mainly for their improved sulphate/chloride resistance, lower heat of hydration and reduced embodied carbon compared to straight OPC.

25. [Type 6 – Articles / Magazines]

Recent construction industry articles highlight a push toward 'low-carbon cement' using higher proportions of supplementary cementitious materials to cut CO₂ emissions. Based on this trend, which conventional material is being reduced in proportion first?

- A) Ordinary Portland Cement (clinker content)
- B) Natural river sand
- C) Reinforcement steel
- D) Bituminous binders

Answer: A

Solution: Clinker production is the primary source of CO₂ emissions in cement manufacture, so low-carbon cement strategies focus on reducing clinker content by replacing it with fly ash, GGBS or other SCMs.

26. [Type 7 – Controversial Statements]

Statement 1: Higher grade cement (e.g., 53 grade) is always better than lower grade cement (33 grade) for all applications. Statement 2: Lower grade cement should never be used in modern construction. Which of the following best justifies both statements?

- A) Both statements are entirely true

B) Both statements are exaggerated; grade selection depends on the specific application, cost and durability requirements

C) Statement 1 alone is true

D) Statement 2 alone is true

Answer: B

Solution: Both statements are absolute; lower grade cement remains suitable for mass concrete, masonry mortar and plastering, where high early strength is unnecessary — so selection depends on application, not grade alone.

27. [Type 9 – Terms and Conditions]

As per BIS specifications, cement must satisfy prescribed limits on fineness, setting time and soundness before it can be approved for structural use. If a cement sample fails the soundness test, the MOST appropriate action is to:

A) Use it anyway, since strength appears adequate

B) Reject the batch, since unsoundness can cause delayed expansion and cracking

C) Use it only for plastering, ignoring the specification

D) Ignore the test since it is optional

Answer: B

Solution: Failing the soundness test indicates free lime/magnesia content that can cause delayed expansion and cracking after hardening; such a batch must be rejected as per the mandatory BIS terms.

28. [Type 10 – Financial Aspects]

A contractor compares straight OPC versus PPC (with fly ash) for a large mass-concrete foundation project. Considering material cost, cement content required and long-term maintenance, which factor would MOST influence overall project cost?

A) Colour of the cement

B) Reduced cement content, lower heat-related cracking, and reduced long-term repair cost with PPC

C) Packaging size of cement bags only

D) Time of year cement is purchased

Answer: B

Solution: For mass concrete, PPC often reduces total cementitious material cost and minimizes costly thermal-cracking repairs later, making it the dominant cost factor over incidental considerations.

29. [Type 13 – Health Awareness]

Cement dust exposure at construction sites is a recognised occupational health concern. Which of the following is a valid health-related precaution?

A) Workers should use dust masks and ensure proper ventilation while handling cement

- B) No precautions are needed since cement is harmless
- C) Cement dust only affects visibility, not health
- D) Precautions are needed only for coloured cement

Answer: A

Solution: Cement dust can cause respiratory irritation and skin issues; using dust masks, protective equipment and adequate ventilation is a standard, valid occupational health precaution.

30. [Type 14 – Problematic (Numerical)]

A concrete mix uses 50 kg of cement and 25 kg of water. If the cement quantity is increased to 80 kg while keeping the same water-cement ratio, what quantity of water is required?

- A) 35 kg
- B) 40 kg
- C) 45 kg
- D) 50 kg

Answer: B

Solution: Water-cement ratio = $25/50 = 0.5$. For 80 kg cement: water required = $0.5 \times 80 = 40$ kg.

PART – B

Section 1: Descriptive-Type Questions (4)

1. Explain the composition of Ordinary Portland Cement (OPC) and describe the formation and role of the four principal Bogus compounds. [Marks: 10]

Solution:

OPC is manufactured by burning a mixture of calcareous material (limestone, providing lime) and argillaceous material (clay, providing silica, alumina and iron oxide) at high temperature (about 1450°C) to form clinker, which is then interground with a small quantity of gypsum. During burning, the raw materials combine chemically to form four principal compounds, known as Bogus compounds: Tricalcium Silicate (C3S) – hydrates rapidly, contributing mainly to early strength (up to 28 days) and generating considerable heat of hydration; Dicalcium Silicate (C2S) – hydrates slowly, contributing to long-term/late strength gain with lower heat of hydration; Tricalcium Aluminate (C3A) – reacts very quickly with water, contributing to flash setting if uncontrolled (hence gypsum is added to regulate it), and is largely responsible for cement's vulnerability to sulphate attack; and Tetracalcium Aluminoferrite (C4AF) – contributes little to strength but influences the colour of cement and provides some resistance during initial hydration. The relative proportions of these compounds determine the setting behaviour, strength development pattern, and durability characteristics of the cement.

2. (a) Explain the grades of cement as per BIS classification. (b) Define water-cement ratio and explain its effect on the strength and durability of concrete. [Marks: 5+5 = 10]

Solution:

(a) As per BIS, OPC is classified into grades such as 33, 43 and 53, where the number denotes the minimum compressive strength (in N/mm²) attained by a standard cement mortar cube after 28 days of curing. Grade 33 is used for general masonry and low-strength applications, Grade 43 for general RCC work, and Grade 53 for high-strength structural concrete and precast elements where faster strength gain is desired.

(b) Water-cement ratio is the ratio of the weight of water to the weight of cement used in a concrete or mortar mix. A lower water-cement ratio (within the workable range) produces denser, less porous concrete with higher compressive strength and better durability, while an excessively high water-cement ratio introduces excess capillary voids after excess water evaporates, reducing strength, increasing permeability, and making the concrete more vulnerable to weathering, chemical attack and reinforcement corrosion. Hence, selecting an optimum water-cement ratio balances adequate workability with the required strength and durability.

3. Discuss the types, sources and uses of supplementary cementitious materials, namely fly ash, Ground Granulated Blast Furnace Slag (GGBS), silica fume and natural pozzolans. [Marks: 10]

Solution:

Fly ash is a fine particulate by-product of coal-fired thermal power plants; it reacts pozzolanically with calcium hydroxide released during cement hydration, improving workability, reducing heat of hydration and enhancing long-term durability; it is classified into Class F (low-calcium, from bituminous coal) and Class C (higher-calcium, from lignite/sub-bituminous coal, with some self-cementing property). GGBS is obtained by rapidly quenching molten blast furnace slag (an iron-manufacturing by-product) and grinding it to a fine powder; it improves resistance to sulphate and chloride attack, reduces heat of hydration, and is widely used in mass concrete and marine structures. Silica fume, a by-product of silicon/ferrosilicon production, consists of extremely fine, highly reactive particles; even small additions significantly increase compressive strength, reduce permeability, and improve resistance to chemical attack, making it valuable in high-performance and high-strength concrete. Natural pozzolans (e.g., volcanic ash, calcined clay) contain reactive silica/alumina that combine with lime in the presence of water to form additional cementitious compounds; they have been used historically and continue to be used regionally where such natural materials are locally available, offering a sustainable alternative to industrial by-products.

4. (a) Explain the classification and uses of lime in construction. (b) Explain the constituents and applications of bituminous materials (bitumen, tar and asphalt) in construction. [Marks: 5+5 = 10]

Solution:

(a) Lime is classified based on composition into Fat lime (high-calcium lime, slakes freely with water, hardens slowly by carbonation in air, used for whitewashing, plastering and lime mortar in dry conditions) and Hydraulic lime (contains clayey impurities imparting hydraulic setting properties, capable of setting even under water, used in foundations, damp locations and masonry exposed to moisture). Lime is used in construction for preparing lime mortar (mixed with sand for masonry and plastering), lime putty (fine lime paste for finishing coats and whitewash), soil stabilization, and as a raw material in cement manufacture.

(b) Bitumen is a dark, viscous hydrocarbon material obtained mainly from petroleum refining (or natural deposits), valued for its strong waterproofing, adhesive and binding properties; tar is a similar dark viscous material obtained by the destructive distillation of coal, wood or other organic matter, generally used less than bitumen today due to health/environmental concerns; asphalt refers to a mixture of

bitumen (or tar) with mineral aggregate, commonly used as a paving material. Applications of these bituminous materials include road pavement construction (asphalt concrete/bituminous macadam), roofing felts and waterproofing membranes, damp-proof courses, and joint sealants, owing to their excellent water resistance and flexibility.

Section 2: Analytical Question with Subdivisions (1)

1. [Type 9 – Terms and Conditions (with subdivisions)]

As per BIS specifications (IS 269/IS 8112/IS 12269), cement supplied to a construction site must satisfy prescribed conditions on fineness, setting time, soundness and compressive strength before it can be approved for use in structural concrete. A site engineer receives a new consignment of cement bags from a supplier and must decide whether to approve it for use in a reinforced concrete project.

(a) List the key BIS conditions that the cement consignment must satisfy before approval for structural RCC work. (3 marks)

Solution: The cement must satisfy: fineness within the specified limit (ensuring adequate surface area for hydration); initial setting time not less than about 30 minutes and final setting time not more than about 600 minutes; soundness (Le Chatelier expansion) within the permissible limit; and minimum 28-day compressive strength meeting the declared grade (33/43/53) as per relevant BIS standard.

(b) Explain the consequence on the structure if cement that fails the soundness test is used anyway. (3 marks)

Solution: Unsound cement contains excess free lime or magnesia that continues to hydrate slowly after the concrete has hardened, causing delayed expansion. This expansion generates internal stresses that lead to cracking, disintegration and long-term loss of strength and durability in the hardened structure.

(c) Justify what decision the engineer should take if the 28-day compressive strength of the consignment is found to be marginally below the declared grade, and suggest one corrective measure. (4 marks)

Solution: The engineer should not approve the consignment for structural RCC work, since even a marginal shortfall in strength compromises the safety margin assumed in structural design calculations — the risk to structural safety outweighs the convenience of using the substandard batch. As a corrective measure, the consignment should be rejected and replaced with cement meeting the declared grade, or, if retained, it may be used only in a non-structural application (e.g., plastering or blinding concrete) with the structural engineer's explicit approval, and never in load-bearing reinforced members.

[Total Marks: 10]

Unit IV: Timber, mortar, Concrete, Protective materials and Coatings

PART – A

Section 1: Multiple Choice Questions (21)

1. Timber is broadly classified based on the type of tree into:

- A) Softwood and hardwood
- B) Wet wood and dry wood
- C) Painted and unpainted wood
- D) Local and imported wood

Answer: A

Solution: Timber is broadly classified as softwood (from coniferous/needle-leaved trees) and hardwood (from broad-leaved trees), based on botanical origin.

2. The primary purpose of seasoning timber is to:

- A) Increase its weight
- B) Reduce moisture content and improve dimensional stability
- C) Change its colour permanently
- D) Increase its susceptibility to decay

Answer: B

Solution: Seasoning reduces the moisture content of freshly cut timber to a level suited to its end use, minimising shrinkage, warping and decay after installation.

3. Kiln seasoning, compared to natural (air) seasoning, mainly offers the advantage of:

- A) Zero cost
- B) Faster and more controlled drying
- C) No risk of defects
- D) No need for equipment

Answer: B

Solution: Kiln seasoning uses controlled temperature, humidity and air circulation in a chamber, drying timber much faster and more uniformly than natural air seasoning.

4. Knots, as a defect in timber, are caused by:

- A) Improper sawing only
- B) Base portions of branches embedded in the trunk

- C) Excess seasoning
- D) Chemical preservation treatment

Answer: B

Solution: Knots are formed where branches originate from the trunk; the embedded branch base appears as a knot when the log is sawn into timber.

5. Shakes, as a defect in timber, refer to:

- A) Cracks/separation along the grain, often due to internal stresses
- B) Insect infestation
- C) Excess resin content
- D) Surface staining only

Answer: A

Solution: Shakes are cracks or splits that develop along the grain of timber, often caused by internal growth stresses, felling shock, or improper seasoning.

6. Creosoting is a method of timber preservation that involves:

- A) Applying creosote oil to protect against decay and insect attack
- B) Painting timber with lime wash only
- C) Soaking timber in plain water
- D) Exposing timber to direct sunlight only

Answer: A

Solution: Creosoting involves impregnating timber with creosote oil (a coal-tar distillate), which is toxic to fungi and insects, providing effective long-term preservation.

7. The main purpose of timber preservation is to:

- A) Increase susceptibility to fungal decay
- B) Protect timber from decay, insects and weathering, extending service life
- C) Reduce timber's structural strength intentionally
- D) Eliminate the need for seasoning

Answer: B

Solution: Preservation treatments protect timber against biological decay (fungi, termites, borers) and weathering, thereby extending its useful service life.

8. Plywood, as a manufactured wood product, is produced by:

- A) Gluing thin wood veneers together with grains oriented alternately
- B) Compressing sawdust with cement only

- C) Melting wood chemically
- D) Using solid timber blocks without processing

Answer: A

Solution: Plywood is manufactured by bonding thin layers (veneers) of wood with adhesive, with grain direction alternated in successive layers to improve strength and stability.

9. Mortar is essentially a mixture of:

- A) Binding material, fine aggregate (sand) and water
- B) Coarse aggregate and water only
- C) Cement and coarse aggregate only, without sand
- D) Steel and binding material

Answer: A

Solution: Mortar consists of a binding material (cement or lime), fine aggregate (sand), and water, mixed to a workable paste for masonry and plastering work.

10. Based on the binding material used, mortar is classified mainly into:

- A) Cement mortar and lime mortar
- B) Wet mortar and dry mortar only
- C) Coloured and plain mortar
- D) Fine and coarse mortar

Answer: A

Solution: Mortar is primarily classified by its binding material into cement mortar (using cement as binder) and lime mortar (using lime as binder), among other combinations.

11. A characteristic of good mortar is that it should:

- A) Have poor workability
- B) Develop adequate strength and adhere well to masonry units
- C) Crack immediately after application
- D) Have excessive shrinkage

Answer: B

Solution: Good mortar should be workable, develop adequate compressive/bond strength, adhere well to bricks/blocks, and exhibit minimal shrinkage cracking.

12. A commonly used cement mortar mix ratio for general brickwork is:

- A) 1:6 (cement:sand)
- B) 1:1 (cement:sand)

- C) 1:20 (cement:sand)
- D) Pure cement with no sand

Answer: A

Solution: A 1:6 cement:sand ratio is a commonly used mix for general brickwork, balancing strength, workability and economy.

13. Grouting refers to the process of:

- A) Injecting a fluid cementitious/chemical mixture into voids or cracks to fill and strengthen them
- B) Painting a wall surface
- C) Cutting timber to size
- D) Seasoning of wood

Answer: A

Solution: Grouting is the injection of a fluid grout (cement-based or chemical) into voids, cracks or joints to fill gaps, improve strength and reduce permeability.

14. Guniting is a process in which mortar or concrete is:

- A) Poured slowly into formwork
- B) Sprayed under pressure onto a surface using a cement gun
- C) Cured underwater only
- D) Mixed by hand without machinery

Answer: B

Solution: Guniting (shotcreting) involves pneumatically spraying a mortar/concrete mixture at high velocity onto a surface, used for repairs, linings and thin structural elements.

15. A nominal mix of M20 grade concrete corresponds approximately to a mix ratio of:

- A) 1:1.5:3 (cement:sand:aggregate)
- B) 1:10:20
- C) 1:0:0
- D) 1:1:1

Answer: A

Solution: M20 grade concrete corresponds to a nominal mix ratio of approximately 1:1.5:3 (cement:fine aggregate:coarse aggregate) by volume.

16. The workability of fresh concrete is commonly measured using the:

- A) Slump test
- B) Compression test

- C) Rebound hammer test
- D) Water absorption test

Answer: A

Solution: The slump test measures the consistency/workability of fresh concrete by observing how much a moulded concrete cone settles (slumps) after removal of the mould.

17. Ready mix concrete (RMC) is mainly advantageous because it offers:

- A) Consistent quality control and reduced site congestion
- B) No need for transportation
- C) Lower strength than site-mixed concrete always
- D) Unlimited setting time

Answer: A

Solution: RMC is batched under controlled plant conditions, ensuring consistent quality, and is delivered ready to place, reducing on-site mixing congestion and labour.

18. The rebound hammer test is a non-destructive test used to estimate:

- A) Surface hardness/approximate compressive strength of hardened concrete
- B) Workability of fresh concrete
- C) Water-cement ratio directly
- D) Setting time of cement

Answer: A

Solution: The rebound hammer test measures the surface hardness of hardened concrete, which correlates approximately with its compressive strength, without damaging the structure.

19. Which of the following is NOT typically a factor affecting the durability of concrete?

- A) Water-cement ratio
- B) Quality of curing
- C) Exposure to aggressive environment
- D) Colour of the formwork used

Answer: D

Solution: Formwork colour has no bearing on concrete durability, unlike water-cement ratio, curing quality and environmental exposure, which directly affect long-term performance.

20. Damp proofing in buildings is primarily provided to:

- A) Increase water absorption into walls
- B) Prevent moisture rising from the ground into walls (rising damp)

- C) Reduce structural strength intentionally
- D) Replace the need for a foundation

Answer: B

Solution: A damp-proof course (DPC) is installed to prevent moisture from rising through walls by capillary action from the ground (rising damp).

21. Termite-proofing treatment in buildings is mainly applied to:

- A) Protect timber and wooden components from termite attack
- B) Increase the aesthetic appeal of paint only
- C) Improve fire resistance only
- D) Increase water absorption of soil

Answer: A

Solution: Termite-proofing (soil poisoning, chemical barriers) protects timber and wood-based building components from termite infestation and structural damage.

Section 2: Multiple Choice Questions – Analytical Type (9)

22. [Type 0 – Assertion Reason]

Assertion (A): Kiln-seasoned timber is generally preferred over air-seasoned timber for high-quality furniture and structural work. Reason (R): Kiln seasoning achieves faster, more uniform and controlled moisture reduction than natural air seasoning. Choose the correct option:

- A) Both A and R are true, and R is the correct explanation of A
- B) Both A and R are true, but R is NOT the correct explanation of A
- C) A is true but R is false
- D) A is false but R is true

Answer: A

Solution: The controlled, faster, uniform drying achieved through kiln seasoning directly explains why it is preferred over natural seasoning for demanding applications — R correctly explains A.

23. [Type 4 – Large Explanation to Inference]

A concrete sample tested on-site shows low slump value, difficulty in compaction, and honeycombing after demoulding. Based on this description, what should be concluded about the mix?

- A) The mix had excellent workability and was properly compacted
- B) The mix had inadequate workability, leading to poor compaction and voids
- C) The mix had excess water content only
- D) No conclusion can be drawn

Answer: B

Solution: Low slump combined with compaction difficulty and honeycombing (voids) together indicate the mix lacked sufficient workability for proper placement and compaction.

24. [Type 5 – Emotion Type]

Despite higher initial cost, many builders now prefer ready-mix concrete (RMC) over site-mixed concrete. What is the most likely underlying reason beyond cost?

- A) Consistent quality, reduced site congestion and faster construction
- B) RMC has no quality advantage over site mixing
- C) RMC is always weaker in strength
- D) RMC eliminates the need for testing

Answer: A

Solution: RMC offers plant-controlled consistent quality, reduces material storage/mixing congestion at site, and speeds up construction — practical benefits that outweigh the higher initial cost.

25. [Type 6 – Articles / Magazines]

Recent construction articles highlight growing use of non-destructive testing (NDT) methods like rebound hammer and ultrasonic pulse velocity tests for assessing existing structures before renovation. Based on this trend, which conventional method is being reduced in reliance?

- A) Core cutting and destructive strength testing for routine assessment
- B) Visual inspection entirely
- C) Structural drawings review
- D) Material procurement records

Answer: A

Solution: NDT methods allow strength/quality assessment without damaging the structure, reducing reliance on destructive core-cutting tests for routine condition assessment.

26. [Type 7 – Controversial Statements]

Statement 1: Lime mortar is always inferior to cement mortar in all applications. Statement 2: Cement mortar should never be used in heritage/conservation masonry work. Which of the following best justifies both statements?

- A) Both statements are entirely true
- B) Both statements are exaggerated; suitability depends on application, compatibility with existing materials, and conservation requirements
- C) Statement 1 alone is true
- D) Statement 2 alone is true

Answer: B

Solution: Both statements are absolute; lime mortar remains preferred for heritage conservation due to compatibility and breathability, while cement mortar suits modern high-strength work — suitability depends on context, not a blanket rule.

27. [Type 9 – Terms and Conditions]

As per IS 456:2000 and site quality control norms, fresh concrete delivered to site must satisfy prescribed slump and strength requirements before placement is approved. If a delivered batch fails the slump test, the MOST appropriate action is to:

- A) Place the concrete anyway since it looks adequate
- B) Reject the batch or adjust the mix before placement, as per quality control terms
- C) Add water on site without approval to fix workability
- D) Ignore the test for minor elements

Answer: B

Solution: Failing the slump/workability specification means the batch does not meet the mandatory quality control terms; it must be rejected or corrected under approved procedures before placement — arbitrary site water addition is not permitted as it changes the water-cement ratio uncontrollably.

28. [Type 10 – Financial Aspects]

A contractor is deciding between site-mixed concrete and ready-mix concrete (RMC) for a mid-sized project. Considering labour cost, wastage, quality control and transportation, which factor would MOST influence the overall project cost?

- A) Colour of the concrete
- B) Combined savings from reduced wastage, labour and rework versus RMC transportation cost
- C) Shape of the formwork only
- D) Time of day concrete is poured

Answer: B

Solution: The overall cost comparison hinges on whether RMC's higher transportation/batching cost is offset by savings from reduced material wastage, labour requirement and fewer quality-related reworks — the dominant real cost factors.

29. [Type 13 – Health Awareness]

Proper termite-proofing and damp-proofing of buildings is often linked to occupant health. Which of these is a valid health-related justification?

- A) Controlling dampness reduces mould growth and associated respiratory health risks
- B) Damp-proofing has no effect on occupant health
- C) Termite-proofing only affects furniture, not health
- D) Dampness has no relation to indoor air quality

Answer: A

Solution: Persistent dampness promotes mould and fungal growth, which can trigger allergies and respiratory issues; effective damp-proofing helps maintain healthier indoor air quality.

30. [Type 14 – Problematic (Numerical)]

A concrete mix uses cement, sand and coarse aggregate in the ratio 1:1.5:3 by volume. If 100 kg of cement is used, what quantity of coarse aggregate (in kg, assuming equal unit weight simplification for this calculation) is required?

- A) 150 kg
- B) 200 kg
- C) 300 kg
- D) 450 kg

Answer: C

Solution: For a 1:1.5:3 ratio, coarse aggregate proportion is 3 times the cement quantity: $3 \times 100 \text{ kg} = 300 \text{ kg}$ (simplified volume-to-weight assumption as stated in the question).

PART – B

Section 1: Descriptive-Type Questions (4)

1. Explain the classification of timber and describe the methods of seasoning of timber, along with common defects found in timber. [Marks: 10]

Solution:

Timber is broadly classified based on botanical origin into softwood (from coniferous, needle-leaved trees, generally lighter and easier to work) and hardwood (from broad-leaved trees, generally denser and stronger). Seasoning is carried out to reduce the moisture content of freshly felled timber to a level suitable for its intended use, improving dimensional stability and reducing decay. Natural (air) seasoning involves stacking timber in the open under cover, allowing it to dry gradually over weeks to months through natural air circulation; it is economical but slow and less controlled. Kiln seasoning involves drying timber in a closed chamber with controlled temperature, humidity and air circulation, achieving faster and more uniform drying, though at higher cost. Common defects in timber include knots (embedded branch bases), shakes (cracks/splits along the grain caused by growth stress or improper seasoning), warping (distortion of shape due to uneven shrinkage), and decay/insect damage from inadequate preservation.

2. (a) Explain the classification and characteristics of good mortar. (b) Explain the processes of grouting and guniting with their applications. [Marks: 5+5 = 10]

Solution:

(a) Mortar is classified based on binding material into cement mortar (cement + sand, used for general masonry/plastering requiring higher strength) and lime mortar (lime + sand, used traditionally for masonry/plastering requiring flexibility and breathability). Characteristics of good mortar include adequate workability for easy application, sufficient bond/adhesive strength with masonry units,

minimal shrinkage to avoid cracking, adequate water retentivity to prevent premature drying, and durability against weathering.

(b) Grouting is the process of injecting a fluid cementitious or chemical mixture into voids, cracks, or joints under pressure to fill gaps, improve strength, and reduce permeability; it is commonly used for foundation stabilization, crack repair and anchoring. Guniting (shotcreting) is the process of pneumatically spraying a mortar or concrete mixture at high velocity onto a surface using a cement gun; it is used for repairing damaged concrete/masonry surfaces, constructing thin shell structures, and lining tunnels/canals where conventional formwork is impractical.

3. Discuss the production, mix ratios, workability and strength assessment of concrete, including the concept of ready mix concrete and non-destructive testing methods. [Marks: 10]

Solution:

Concrete is produced by proportioning and mixing cement, fine aggregate, coarse aggregate and water in specified ratios, either as nominal mixes (e.g., M20 $\approx$ 1:1.5:3 by volume) for ordinary work or as design mixes for specified strength/durability requirements in major structures. Mixing is done manually or using mixers to achieve a homogeneous mass, and workability (the ease with which fresh concrete can be mixed, transported, placed and compacted) is commonly assessed using the slump test. Ready mix concrete (RMC) is concrete batched and mixed at a centralized plant under controlled conditions and delivered to site in transit mixers, offering consistent quality, reduced site congestion, and faster construction, though at higher transportation cost. Strength of hardened concrete is primarily verified by compressive strength tests on cube/cylinder specimens at 7 and 28 days; where destructive testing on the actual structure is undesirable, non-destructive tests such as the rebound hammer test (surface hardness) and ultrasonic pulse velocity test (internal homogeneity/quality) are used to estimate in-situ strength and quality without damage. Durability of concrete depends on factors such as water-cement ratio, quality of curing, cover to reinforcement, and exposure to aggressive environments (chlorides, sulphates), all of which must be controlled to ensure long-term performance.

4. (a) Explain the protective and insulating measures used in buildings: damp proofing, water proofing, termite proofing and pest control. (b) Explain the characteristics of an ideal paint and describe the types of paints, distempers and varnishes used in construction. [Marks: 5+5 = 10]

Solution:

(a) Damp proofing involves installing a damp-proof course (DPC) — typically a layer of impermeable material at plinth level — to prevent rising dampness from the ground into walls. Water proofing involves treatments/membranes applied to roofs, basements and wet areas to prevent water ingress, often using bituminous coatings, cementitious coatings or polymer-based membranes. Termite proofing involves chemical soil treatment/barriers around the foundation and treatment of timber components to protect against termite infestation. Pest control in buildings involves periodic chemical treatment and design measures (sealing gaps, proper drainage) to prevent infestation by insects and rodents that could damage structural or finishing materials.

(b) An ideal paint should have good covering/hiding power, durability, ease of application, resistance to weathering, quick and uniform drying, and should not fade or crack over time. Types of paints include oil-based paints (durable, glossy finish), water-based/emulsion paints (quick-drying, low odour, widely used for interiors), and enamel paints (hard, glossy, water-resistant finish). Distemper is an economical water-based coating used mainly for interior walls and ceilings, offering a matte finish but lower durability and washability than emulsion paint. Varnishes are transparent or translucent protective

coatings, typically applied over wood or metal, that provide a glossy protective film while allowing the natural grain/surface to remain visible.

Section 2: Analytical Question with Subdivisions (1)

1. [Type 9 – Terms and Conditions (with subdivisions)]

As per IS 456:2000 and standard site quality control practice, fresh concrete delivered to a site must satisfy prescribed conditions on slump (workability), and hardened concrete must satisfy prescribed 28-day compressive strength before a structural pour can be approved. A site engineer receives a truckload of ready-mix concrete and must decide whether to approve its placement.

(a) List the key conditions the delivered concrete batch must satisfy before the engineer approves placement. (3 marks)

Solution: The batch must satisfy: slump value within the specified range for the intended placement method (e.g., pumping vs manual placement); concrete temperature and time-since-batching within permissible limits to avoid premature stiffening; correct grade/mix design as ordered; and sampling for cube tests must be arranged to verify the declared 28-day compressive strength.

(b) Explain the consequence on the structure if concrete with a slump significantly outside the specified range is placed anyway. (3 marks)

Solution: Concrete with too low a slump is difficult to compact fully, leading to honeycombing and voids that reduce strength and allow ingress of moisture/chemicals, while concrete with too high a slump (excess water) leads to segregation, bleeding, increased porosity and reduced long-term strength and durability.

(c) Justify what decision the engineer should take if the delivered batch's slump is marginally outside the specified range, and suggest one corrective measure. (4 marks)

Solution: The engineer should not approve the batch for placement as delivered, since even a marginal deviation in slump can compromise compaction quality and long-term durability, and the structural risk outweighs the inconvenience of delay. As a corrective measure, the engineer may reject the truckload and request a fresh batch conforming to specification, or — only if within permissible plant/site protocol and verified by the quality control team — adjust the mix at the plant (not by uncontrolled site water addition) before re-testing and re-approving the batch for placement.

[Total Marks: 10]

Unit V: Metallic, Plastic and Composite materials

PART – A

Section 1: Multiple Choice Questions (21)

1. Structural steel used in construction is primarily an alloy of:

- A) Iron and carbon
- B) Aluminium and copper
- C) Zinc and tin
- D) Lead and silica

Answer: A

Solution: Structural (mild) steel is essentially an iron-carbon alloy with a small percentage of carbon, along with controlled amounts of other elements, giving it strength and ductility.

2. Common structural steel sections used in construction include:

- A) I-beams, channels and angles
- B) Only round bars
- C) Only flat sheets
- D) Only wire mesh

Answer: A

Solution: Standard market forms of structural steel include I-sections (beams), channel sections, and angle sections, chosen based on structural requirements.

3. Galvanised iron (GI) is produced by coating iron/steel with:

- A) Zinc, to protect against corrosion
- B) Aluminium foil
- C) Bitumen
- D) Lime wash

Answer: A

Solution: Galvanising involves coating iron or steel with a layer of zinc, which sacrificially protects the base metal from corrosion.

4. Stainless steel resists corrosion mainly due to the presence of:

- A) Chromium, which forms a passive protective oxide layer
- B) Excess carbon

- C) Zinc coating
- D) Lead content

Answer: A

Solution: Stainless steel contains a significant proportion of chromium, which forms a thin, self-healing passive chromium oxide layer that resists corrosion.

5. Cold-formed light gauge steel sections are mainly used in construction for:

- A) Heavy load-bearing columns only
- B) Lightweight framing systems such as partition walls and roof trusses
- C) Underground foundations only
- D) Waterproofing membranes

Answer: B

Solution: Cold-formed light gauge steel sections are manufactured by roll-forming thin steel sheets and are widely used for lightweight framing such as partitions, roof trusses and drywall systems.

6. Aluminium is often preferred over steel in certain construction applications mainly due to its:

- A) Higher weight and lower corrosion resistance
- B) Lightweight nature and good corrosion resistance
- C) Higher cost with no functional benefit
- D) Inability to be extruded into sections

Answer: B

Solution: Aluminium's low density (lightweight) combined with good natural corrosion resistance makes it preferable for facades, windows and certain structural applications.

7. A composite material, in the context of construction, refers to a material:

- A) Made from a single homogeneous substance
- B) Formed by combining two or more distinct materials to achieve improved properties
- C) That cannot be engineered for specific properties
- D) That is always a metal alloy

Answer: B

Solution: Composite materials combine two or more distinct constituent materials (e.g., fibre and matrix) to achieve properties superior to the individual components alone.

8. Plastics used in construction are generally valued for their:

- A) High weight and poor corrosion resistance
- B) Lightweight nature, corrosion resistance and ease of moulding

- C) Inability to be shaped into pipes or panels
- D) High electrical conductivity

Answer: B

Solution: Plastics are lightweight, resistant to corrosion/chemical attack, and can be easily moulded into pipes, panels and fittings, making them versatile construction materials.

9. PVC (Polyvinyl Chloride) pipes are commonly used in construction mainly for:

- A) Structural columns
- B) Water supply, drainage and sanitary plumbing
- C) Roofing sheets only
- D) Load-bearing beams

Answer: B

Solution: PVC pipes are widely used for water supply, drainage and sanitary plumbing applications due to their corrosion resistance, light weight and ease of jointing.

10. UPVC (Unplasticized PVC) differs from standard PVC mainly in that UPVC is:

- A) More flexible due to added plasticizers
- B) Rigid, without plasticizers, offering greater strength and weather resistance
- C) Used only for flexible tubing
- D) Not suitable for doors and windows

Answer: B

Solution: UPVC does not contain plasticizers, making it more rigid, stronger and more weather-resistant than standard flexible PVC — hence its use in doors, windows and pipes.

11. CPVC (Chlorinated PVC) pipes are specifically preferred over standard PVC for:

- A) Cold water supply only
- B) Hot water supply, due to higher temperature resistance
- C) Structural roofing
- D) Electrical wiring insulation only

Answer: B

Solution: CPVC has higher chlorination content than PVC, giving it greater heat resistance, making it suitable for hot water plumbing applications where PVC would soften.

12. Standards for plastic pipes used in water supply and sanitary applications in India are governed by:

- A) BIS (Bureau of Indian Standards) specifications
- B) No standards exist

- C) International standards only, with no Indian equivalent
- D) Manufacturer's discretion alone

Answer: A

Solution: BIS prescribes specific Indian Standards (e.g., IS 4985 for PVC pipes, IS 15778 for CPVC pipes) governing dimensions, material quality and performance for plumbing pipes.

13. RCC (Reinforced Cement Concrete) roofing is generally characterised by:

- A) Low durability and poor structural strength
- B) High durability, strength and suitability for flat/sloped roofs
- C) Being unsuitable for any building type
- D) Being the lightest roofing option available

Answer: B

Solution: RCC roofing offers high strength, durability and design flexibility (flat or sloped), making it a widely used permanent roofing solution in construction.

14. AC (Asbestos Cement) sheets, though historically used for roofing, are now less favoured mainly due to:

- A) Their extremely high cost
- B) Health hazards associated with asbestos fibres
- C) Excellent insulation properties with no drawback
- D) Superior strength compared to all other roofing options

Answer: B

Solution: Asbestos fibres in AC sheets pose significant health hazards (respiratory diseases) when disturbed or damaged, leading to reduced preference for AC roofing today.

15. GI (Galvanised Iron) sheets used for roofing are valued mainly for their:

- A) Corrosion resistance due to zinc coating and relatively low cost
- B) Extremely high weight
- C) Poor durability
- D) Use only in interior flooring

Answer: A

Solution: GI sheets combine the strength of steel with the corrosion protection of a zinc coating, offering a durable and economical roofing option.

16. Galvalume sheets differ from standard GI sheets mainly in that Galvalume is coated with:

- A) An alloy of aluminium and zinc, offering superior corrosion resistance

- B) Pure copper
- C) Plain paint only
- D) No coating at all

Answer: A

Solution: Galvalume sheets are coated with an aluminium-zinc alloy, which provides better corrosion resistance and heat reflectivity compared to standard zinc-only GI coating.

17. False ceilings are commonly constructed using materials such as:

- A) Gypsum board and mineral fibre boards
- B) Structural steel beams only
- C) Reinforced concrete slabs only
- D) Raw timber logs

Answer: A

Solution: False ceilings are commonly made from lightweight materials such as gypsum boards, mineral fibre boards, and PVC/metal panels, suspended below the main structural ceiling.

18. Insulated glass units used in modern facades primarily help in:

- A) Increasing heat transfer into the building
- B) Reducing heat transfer and improving energy efficiency
- C) Eliminating the need for any window at all
- D) Reducing transparency to zero

Answer: B

Solution: Insulated glass units (double/triple glazing with sealed air/gas gaps) reduce heat transfer through the facade, improving thermal comfort and energy efficiency.

19. Aluminium Composite Panels (ACP) used in facades consist of:

- A) Two thin aluminium sheets bonded to a non-aluminium core
- B) Solid aluminium blocks only
- C) Pure glass sheets
- D) Timber planks coated with aluminium paint

Answer: A

Solution: ACPs consist of two thin aluminium skin sheets bonded to a lightweight core material (often polyethylene or fire-rated mineral core), offering a light, flat, weather-resistant facade material.

20. Fibre cement panels used in facades and cladding are valued for their:

- A) Poor fire resistance and low durability

- B) Good fire resistance, durability and weather resistance
- C) Complete inability to be painted or finished
- D) Extremely high weight compared to concrete

Answer: B

Solution: Fibre cement panels combine cement with reinforcing fibres, offering good fire resistance, durability and weather resistance, while being lighter than conventional concrete panels.

21. Wood Plastic Composite (WPC) materials, used in cladding and other applications, are manufactured by combining:

- A) Wood fibres/flour with plastic resin
- B) Pure steel and glass only
- C) Only natural wood without any additive
- D) Concrete and sand only

Answer: A

Solution: WPC is manufactured by combining wood fibres or wood flour with thermoplastic resin, producing a durable, moisture-resistant material used for cladding, decking and trim.

Section 2: Multiple Choice Questions – Analytical Type (9)

22. [Type 0 – Assertion Reason]

Assertion (A): Stainless steel is preferred over mild steel for exposed architectural elements in coastal buildings. Reason (R): Stainless steel's chromium content forms a passive oxide layer that resists chloride-induced corrosion better than mild steel. Choose the correct option:

- A) Both A and R are true, and R is the correct explanation of A
- B) Both A and R are true, but R is NOT the correct explanation of A
- C) A is true but R is false
- D) A is false but R is true

Answer: A

Solution: The chromium-based passive layer directly explains stainless steel's superior corrosion resistance in chloride-rich coastal environments, which is why it is preferred there — R correctly explains A.

23. [Type 4 – Large Explanation to Inference]

A facade panel sample is described as lightweight, having two thin metal skins bonded to a polymer core, with flatness and easy formability for curved facades. Based on this description, what should be concluded about the material?

- A) It is most likely a solid timber panel

- B) It is most likely an Aluminium Composite Panel (ACP)
- C) It is most likely a plain glass sheet
- D) No conclusion can be drawn from this description

Answer: B

Solution: The combination of two thin metal (aluminium) skins bonded to a lightweight core, with flatness and formability, is a defining characteristic of Aluminium Composite Panels.

24. [Type 5 – Emotion Type]

Despite higher cost, architects increasingly specify insulated glass units (IGUs) for building facades. What is the most likely underlying reason beyond aesthetics?

- A) IGUs significantly reduce heat transfer, improving occupant comfort and lowering energy bills
- B) IGUs have no functional advantage over single glazing
- C) IGUs are always cheaper than single glazing
- D) IGUs eliminate the need for any HVAC system

Answer: A

Solution: The sealed air/gas gap in IGUs reduces heat transfer through the facade, improving thermal comfort and cutting long-term energy costs — a genuine functional and financial benefit beyond appearance.

25. [Type 6 – Articles / Magazines]

Recent industry articles report a decline in the use of Asbestos Cement (AC) sheets due to health regulations, with Galvalume and insulated roofing sheets gaining preference. Based on this trend, which property is driving the shift?

- A) Health safety and improved thermal/corrosion performance of alternatives
- B) Lower initial cost of AC sheets being irrelevant
- C) AC sheets being banned for aesthetic reasons only
- D) No specific property; purely a random market trend

Answer: A

Solution: The shift away from AC sheets is driven primarily by asbestos health hazards, combined with the superior corrosion resistance and thermal performance of Galvalume/insulated alternatives.

26. [Type 7 – Controversial Statements]

Statement 1: Plastic pipes (PVC/UPVC/CPVC) are always superior to metal pipes for all plumbing applications. Statement 2: Metal pipes should never be used in modern plumbing systems. Which of the following best justifies both statements?

- A) Both statements are entirely true

B) Both statements are exaggerated; pipe material selection depends on application (hot/cold water, pressure, exposure) and cost

C) Statement 1 alone is true

D) Statement 2 alone is true

Answer: B

Solution: Both statements are absolute; metal pipes remain preferred in certain high-pressure or fire-rated applications, while plastics suit general water supply/drainage — selection depends on specific requirements, not a blanket rule.

27. [Type 9 – Terms and Conditions]

As per BIS specifications (e.g., IS 4985 for PVC pipes, IS 15778 for CPVC pipes), plastic pipes supplied for a plumbing project must meet prescribed conditions on pressure rating, dimensions and material grade. If a delivered batch of pipes fails the pressure rating test, the MOST appropriate action is to:

A) Install the pipes anyway since they look fine visually

B) Reject the batch, since it does not meet the mandatory BIS terms for the intended pressure application

C) Use them only for non-pressure drainage, ignoring the original specification silently

D) Ignore the test since it is optional for plastics

Answer: B

Solution: Failing the pressure rating test means the pipes do not satisfy the mandatory BIS terms and conditions for the intended pressurised water supply application; the batch must be rejected rather than used against specification.

28. [Type 10 – Financial Aspects]

A contractor compares GI sheets versus Galvalume sheets for a large industrial shed roof. Considering material cost, corrosion-related maintenance and service life, which factor would MOST influence the overall lifecycle cost?

A) Colour of the sheet

B) Long-term corrosion resistance and reduced maintenance/replacement cost of Galvalume versus its higher initial price

C) Sheet thickness alone, ignoring coating type

D) Time of year of installation

Answer: B

Solution: Although Galvalume costs more initially, its superior corrosion resistance reduces maintenance and premature replacement costs over the roof's service life, making lifecycle cost the dominant financial consideration.

29. [Type 13 – Health Awareness]

The shift away from Asbestos Cement (AC) roofing sheets is closely tied to occupant and worker health. Which of these is a valid health-related justification?

- A) Airborne asbestos fibres released from damaged AC sheets can cause serious respiratory diseases
- B) AC sheets have no relation to health at all
- C) AC sheets are banned only for cost reasons
- D) Asbestos fibres only affect visual appearance of roofing

Answer: A

Solution: Asbestos fibres, when released into the air from damaged or cut AC sheets, can be inhaled and cause serious long-term respiratory diseases, which is the primary health justification for phasing them out.

30. [Type 14 – Problematic (Numerical)]

A CPVC pipe is rated to withstand a maximum working pressure of 12 kg/cm² at 27°C, with pressure rating reducing by 20% for every 15°C rise in temperature above 27°C. What is the approximate working pressure rating at 42°C?

- A) 12.0 kg/cm²
- B) 9.6 kg/cm²
- C) 8.0 kg/cm²
- D) 6.0 kg/cm²

Answer: B

Solution: Temperature rise = $42 - 27 = 15^{\circ}\text{C}$, i.e., one 15°C increment. Reduction = 20% of 12 = 2.4 kg/cm². Working pressure at 42°C = $12 - 2.4 = 9.6$ kg/cm².

PART – B

Section 1: Descriptive-Type Questions (4)

1. Explain the various metals used in construction, namely steel, galvanised iron and stainless steel, along with their market forms and structural applications. [Marks: 10]

Solution:

Steel, an iron-carbon alloy, is the most widely used structural metal in construction due to its high strength-to-weight ratio, ductility and ease of fabrication; it is available in market forms such as rounds, flats, angles, channels and I-sections, used for beams, columns, trusses and reinforcement. Galvanised Iron (GI) is steel/iron coated with a layer of zinc through the galvanising process, which sacrificially protects the base metal from corrosion; GI is widely used for roofing sheets, pipes, fencing and ductwork where corrosion resistance is important at moderate cost. Stainless steel contains a significant proportion of chromium (and often nickel), which forms a thin, self-healing passive oxide layer that provides excellent corrosion resistance; it is used for architectural fittings, railings, cladding and fixtures exposed to corrosive or aesthetic-sensitive environments, though at higher cost than plain or galvanised steel. Structural steel is also available as cold-formed light gauge sections, produced by roll-forming thin steel sheets, used for lightweight framing systems such as partition walls, roof trusses and drywall

support structures, offering an economical alternative to hot-rolled heavy sections for non-heavy-load applications.

2. (a) Explain the properties and construction applications of aluminium and composite materials. (b) Explain the characteristics of plastics and describe the applications of PVC, UPVC and CPVC pipes in construction. [Marks: 5+5 = 10]

Solution:

(a) Aluminium is a lightweight, corrosion-resistant, non-magnetic metal that can be easily extruded into complex sections; it is widely used in construction for window/door frames, curtain wall framing, roofing sheets and facade elements, offering durability with reduced structural dead load compared to steel. Composite materials combine two or more distinct constituent materials (e.g., aluminium skins with a polymer core, or fibre-reinforced polymers) to achieve properties — such as lightness, strength, flatness and weather resistance — superior to the individual constituents; they are increasingly used in modern facades, cladding panels and structural reinforcement applications.

(b) Plastics used in construction are valued for their light weight, corrosion/chemical resistance, ease of moulding into complex shapes, and relatively low cost. PVC (Polyvinyl Chloride) pipes are widely used for cold water supply, drainage and sanitary plumbing due to their corrosion resistance and ease of jointing. UPVC (Unplasticized PVC), being rigid and without plasticizers, offers greater strength and weather resistance, making it suitable for doors, windows and pressure pipes. CPVC (Chlorinated PVC) has enhanced heat resistance compared to standard PVC, making it the preferred choice for hot water supply plumbing lines, where standard PVC would soften or deform.

3. Discuss the various types of roofing materials used in construction, including RCC, AC sheets, GI sheets, Galvalume sheets and insulated roofing sheets, along with materials used for false ceilings. [Marks: 10]

Solution:

RCC (Reinforced Cement Concrete) roofing is a durable, strong and design-flexible option suited for flat or sloped roofs in permanent structures, though it involves higher cost and construction time compared to sheet roofing. AC (Asbestos Cement) sheets were historically popular for their low cost and moderate durability, but their use has declined due to the serious health hazards posed by airborne asbestos fibres, particularly when sheets are damaged or cut. GI (Galvanised Iron) sheets, coated with zinc for corrosion protection, offer an economical and durable roofing option widely used for industrial sheds and temporary structures. Galvalume sheets, coated with an aluminium-zinc alloy, provide superior corrosion resistance and better heat reflectivity than standard GI sheets, making them increasingly preferred for both industrial and residential roofing. Insulated roofing sheets incorporate an insulating core (such as PUF or rockwool) sandwiched between metal skins, significantly improving thermal performance and reducing heat gain into the building. False ceilings, typically constructed using gypsum boards, mineral fibre boards, or metal/PVC panels suspended below the main structural ceiling, are used to conceal services, improve acoustics, and enhance the aesthetic and thermal performance of interior spaces.

4. (a) Explain the importance of facade design in architecture. (b) Describe the properties and applications of facade materials: insulated glass, aluminium composite panels, fibre cement, wood plastic composites, and types of cladding. [Marks: 5+5 = 10]

Solution:

(a) Facade design is important in architecture as it forms the primary visual identity of a building while also serving critical functional roles — regulating heat gain/loss, controlling daylight and glare, providing weatherproofing, and contributing to energy efficiency and occupant comfort. A well-designed facade balances aesthetic expression with performance requirements such as thermal insulation, structural safety, fire resistance, and maintainability over the building's lifecycle.

(b) Insulated glass units (IGUs) consist of two or more glass panes separated by a sealed air/gas-filled gap, significantly reducing heat transfer and improving energy efficiency, commonly used in modern glazed facades. Aluminium Composite Panels (ACP) consist of two thin aluminium skins bonded to a lightweight core, offering a flat, lightweight, weather-resistant and easily formable cladding material for building exteriors. Fibre cement panels, made from cement reinforced with fibres, provide good fire resistance, durability and weather resistance at lower weight than conventional concrete panels, used for cladding and rainscreen systems. Wood Plastic Composite (WPC) materials, made by combining wood fibres with thermoplastic resin, offer a durable, moisture- and decay-resistant alternative to natural timber for cladding, decking and trim applications. Cladding types include rainscreen cladding (ventilated cavity behind cladding panels for moisture management), curtain wall systems (non-structural glazed/panel facade hung off the structural frame), and stone/brick veneer cladding, each selected based on aesthetic, budget and performance requirements of the project.

Section 2: Analytical Question with Subdivisions (1)**1. [Type 9 – Terms and Conditions (with subdivisions)]**

As per BIS specifications (IS 4985 for PVC pipes and IS 15778 for CPVC pipes), plastic pipes supplied for a plumbing project must satisfy prescribed conditions on pressure rating, dimensional tolerance and material grade before they can be approved for installation. A site engineer receives a new consignment of pipes intended for a hot-water supply line and must decide whether to approve it.

(a) List the key BIS conditions that the pipe consignment must satisfy before approval for a hot-water supply application. (3 marks)

Solution: The pipes must satisfy: correct material grade suited to hot water service (CPVC rather than standard PVC); pressure rating adequate for the system's operating pressure at the expected service temperature; dimensional tolerances (diameter, wall thickness) within IS 15778 limits; and markings/certification confirming compliance with the relevant BIS standard.

(b) Explain the consequence on the plumbing system if standard PVC pipes (instead of CPVC) are mistakenly used for the hot-water line. (3 marks)

Solution: Standard PVC softens and loses strength at elevated temperatures; if used for hot water, the pipe can deform, weaken, or fail under pressure, leading to leaks, bursts, and potential water damage or scalding hazards for occupants.

(c) Justify what decision the engineer should take if the consignment's pressure rating is found to be marginally below the required value for the hot-water application, and suggest one corrective measure. (4 marks)

Solution: The engineer should not approve the consignment for the hot-water line, since even a marginal shortfall in pressure rating at elevated service temperature increases the risk of pipe failure, leaks and associated safety hazards — the risk to occupant safety outweighs the convenience of accepting the batch. As a corrective measure, the consignment should be rejected and replaced with pipes of the correct CPVC grade and adequate pressure rating as per IS 15778, or, if retained, it may be redirected only to a low-pressure, cold-water, non-critical application with the plumbing engineer's explicit approval.

[Total Marks: 10]