MAH M Arch CET Building Technology Sample Paper – 2

Subject: Building Technology | Paper: 2 | Questions: 10 | Max Marks: 20 | Duration: 12 min

Instructions

- This paper contains **10 Multiple Choice Questions** (MCQs), each carrying **+2 marks** for a correct answer.
- There is **no negative marking** for wrong answers.
- Each question has **exactly one correct answer** out of four options (A–D).
- Recommended time: **12 minutes** (approx. 72 seconds per question).
- Mode of examination: **Computer Based Test (CBT)**.
- Detailed solutions with answer key are provided at the end of this paper.

Building Technology — Questions

Q1. Which of the following statements **correctly** describes the effect of the water-cement (w/c) ratio on concrete behaviour during mix design?

(A) A lower w/c ratio generally produces higher compressive strength and lower workability in fresh concrete.

(B) A higher w/c ratio increases compressive strength by improving overall cement hydration efficiency.

(C) The w/c ratio affects only the workability of fresh concrete and has no influence on hardened strength.

(D) Increasing the w/c ratio beyond 0.60 produces the same compressive strength as M50 grade concrete.

Q2. Which structural steel section provides approximately **equal moment of inertia about both principal axes** and is therefore most efficient for columns subject to biaxial bending?

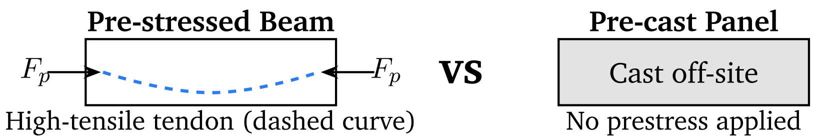
(A) Wide-flange I-section (ISMB)

(B) Channel section (ISMC)

(C) Equal-leg angle section (ISA)

(D) Circular Hollow Section (CHS)

Q3. Study the diagram below comparing two common concrete construction techniques and identify the statement that **correctly** distinguishes pre-stressed concrete from pre-cast concrete.



(A) Pre-cast concrete always incorporates high-tensile tendons under tension to resist service loads.

(B) Pre-stressed concrete must invariably be manufactured off-site in a factory casting yard.

(C) Pre-cast concrete refers to elements cast and cured off-site before being transported to site; pre-stressed concrete involves applying compressive prestress via tensioned tendons to counteract tensile stresses under load — these two concepts are independent.

(D) Both pre-stressed and pre-cast concrete are identical in structural principle and the terms are fully interchangeable.

Q4. In a **unitised curtain wall** system, how are the facade panels typically delivered to and installed on the building?

(A) Individual components (mullions, transoms, glass infills, and gaskets) are delivered to site separately and assembled piece by piece on the building face in a stick system approach.

(B) Complete storey-height units are factory-assembled and glazed, then hoisted into position on the building facade and interlocked with adjacent units.

(C) Glass panels are bonded directly to the primary structural frame using structural silicone only, with no mechanical fixings or framing elements.

(D) Only opaque spandrel panels are incorporated; vision glass is not permitted in a unitised curtain wall system.

Q5. In a cable-and-membrane tensile roof structure, what is the **primary structural mechanism** by which the system carries imposed loads?

(A) Bending action within the cable elements spanning between anchor points.

(B) Compressive strut action transferred from the membrane surface to edge cables.

(C) Shear resistance provided by the membrane fabric between the boundary cables.

(D) Tension in cable elements that transmit loads directly to masts, pylons, or ground anchorages.

Q6. Under the **LEED v4 BD+C** (Building Design and Construction) rating system, which credit category carries the **highest** total point allocation out of 110 base points?

(A) Energy and Atmosphere (EA)

(B) Water Efficiency (WE)

(C) Materials and Resources (MR)

(D) Indoor Environmental Quality (EQ)

Q7. Which of the following common building materials has the **highest embodied energy per unit mass** (MJ/kg), making it a critical consideration in net-zero and low-carbon construction?

(A) Fired clay brick

(B) Ordinary Portland cement concrete (M25 grade)

(C) Virgin (primary) aluminium

(D) Air-dried structural timber

Q8. In a rooftop rainwater harvesting system, which component is specifically installed to **divert and discard the initial runoff** from the roof surface before water enters the collection tank, in order to remove dust, bird droppings, and atmospheric pollutants?

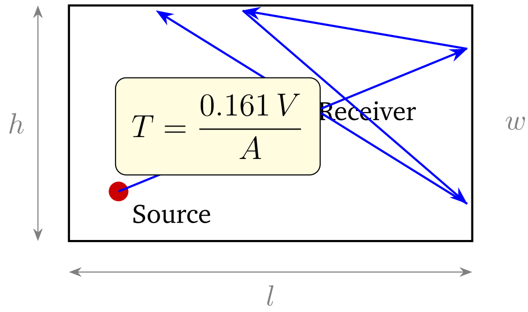
(A) Leaf-screen mesh filter fitted at the downpipe inlet

(B) First-flush diverter (rooftop washer)

(C) Slow sand filter installed inside the underground storage tank

(D) Overflow pipe connected to the municipal storm drain

Q9. A rectangular hall has volume V (m^3) and total sound absorption A (sabins). According to Sabine's formula, if the **volume of the hall is doubled** while the total sound absorption A is kept the same, how does the reverberation time T change?



(A) T remains unchanged, because the formula depends only on the absorption A.

(B) T is halved, because sound must travel a longer mean free path between reflections.

(C) T increases by a factor of four, since volume appears squared (V^2) in the formula.

(D) T doubles, because reverberation time is directly proportional to the volume V.

Q10. In a **traction elevator** (as distinct from a hydraulic elevator), which mechanical element **directly converts** the rotational output of the drive motor into the upward and downward movement of the elevator car?

(A) A grooved sheave (drive pulley) over which hoist ropes connecting the car and the counterweight are looped, driven by friction.

(B) A hydraulic cylinder and oil pump unit that pushes the car platform upward from below via fluid pressure.

(C) A winding drum that reels in or pays out wire rope attached directly to the car underframe.

(D) A pneumatic pressure-differential chamber that creates lift by varying air pressure above and below the car.

Detailed Solutions

Sol.1.

Solution

Difficulty: Intermediate • Chapter: Concrete Mix Design — Water-Cement Ratio

Quick Solution: Abrams' law: lower w/c ratio ⇒ fewer capillary pores ⇒ higher compressive strength; higher ratio ⇒ lower strength. IS 456: M50 requires w/c ≤ 0.40 while M10 allows up to 0.60. **Answer: (A).**

Concept — Water-Cement Ratio and Concrete Strength: The water-cement (w/c) ratio is the single most important parameter in concrete mix design. Abrams' w/c ratio law states that, for a given set of materials, the compressive strength of fully compacted hardened concrete depends chiefly on the w/c ratio: the lower the ratio, the higher the strength.

Step 1 — Physical mechanism: Only a portion of the mix water ($\sim$0.22–0.25 by mass of cement) is needed for complete chemical hydration. Excess water creates capillary pores in the hardened paste; these pores act as stress concentrators and reduce compressive strength. Lower w/c ⇒ fewer and smaller pores ⇒ denser paste ⇒ higher strength.

Step 2 — Code values (IS 456:2000, Table 5):

- M10 — max w/c: 0.60; M20 — 0.55; M25 — 0.50; M40 — 0.45; M50 — 0.40

Higher grades demand lower w/c; the reduced workability is compensated by chemical admixtures (plasticisers / superplasticisers).

Why other options are wrong:

- Option B: Raising w/c *decreases* strength by introducing additional pores; it does not improve hydration efficiency beyond the stoichiometric minimum.
- Option C: w/c ratio is the *primary determinant* of hardened strength, not merely a workability parameter.
- Option D: M50 grade requires a *lower* w/c (≤ 0.40), not a higher one; the statement is factually reversed.

Final Answer: Lower w/c ratio ⇒ higher compressive strength and lower workability ⇒ $\boxed{\text{A}}$

Answer: (A) Go Back to Q1

Sol.2.

Solution

Difficulty: Intermediate • Chapter: Structural Steel — Section Properties

Quick Solution: Circular Hollow Section (CHS): by symmetry $I_{xx} = I_{yy}$ about all centroidal axes, giving balanced stiffness for biaxial bending. I-sections and channels have $I_{xx} \gg I_{yy}$. **Answer: (D).**

Concept — Structural Steel Sections and Biaxial Bending: The second moment of area (moment of inertia) I about the two principal axes (I_{xx} and I_{yy}) governs bending stiffness and resistance. For a column subject to biaxial bending, equal I about both axes is most efficient.

Step 1 — Section comparison:

- **I-section (ISMB):** $I_{xx} \gg I_{yy}$ — efficient for uniaxial bending in one plane; weak about the minor axis.
- **Channel (ISMC):** $I_{xx} > I_{yy}$; open section with centroid offset, susceptible to torsion.
- **Equal-leg angle (ISA):** Principal axes rotated at 45°; low I values; used mainly as bracing or secondary members.
- **Circular Hollow Section (CHS):** By circular symmetry, $I_{xx} = I_{yy}$ about *any* axis through the centroid; closed section also maximises torsional resistance (St. Venant torsion).

Step 2 — Design implication: Columns under biaxial bending from wind or eccentric gravity loads require balanced stiffness in both orthogonal directions. CHS provides this inherently, without the need to check weak-axis bending separately.

Why other options are wrong:

- Option A: Wide-flange I-sections are optimised for uniaxial bending (beams) and are weak about the minor axis.
- Option B: Channel sections have strongly asymmetric stiffness and open cross-section torsional weakness.
- Option C: Equal-leg angles have low moments of inertia and are unsuitable as primary column sections.

Final Answer: Circular Hollow Section gives equal I about all centroidal axes $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q2

Sol.3.

Solution

Difficulty: Intermediate • Chapter: Concrete Construction Techniques

Quick Solution: Pre-cast = cast off-site; pre-stressed = structural technique using tensioned tendons. They are independent: a pre-cast beam may be unreinforced, conventionally reinforced, or pre-stressed. **Answer: (C).**

Concept — Pre-stressed Concrete vs Pre-cast Concrete: These two terms describe *different and independent* attributes of concrete construction. They are frequently confused because pre-stressed elements are often also pre-cast — but neither implies the other.

Step 1 — Definitions:

- **Pre-cast concrete** describes the *location of casting*. Elements (beams, columns, slabs, panels) are cast, vibrated, and cured at a factory or casting yard, then transported and erected on site. The reinforcement may be ordinary mild steel rebars *or* pre-stressing tendons.
- **Pre-stressed concrete** describes a *structural technique*. High-tensile steel tendons or wires are placed under tension so that the concrete element is pre-compressed; when service loads apply tensile stress, the pre-compression first has to be overcome before net tension (and potential cracking) can develop. Pre-stressing can be applied *in-situ* (post-tensioning) or in a factory (pre-tensioning).

Step 2 — Key independence: A pre-cast beam may be either conventionally reinforced (no prestress) or pre-stressed. A post-tensioned in-situ slab is pre-stressed but not pre-cast. The diagram in the question illustrates this distinction visually.

Why other options are wrong:

- Option A: Pre-cast concrete does *not* always use high-tensile tendons; conventional rebar is equally common.
- Option B: Pre-stressed concrete can be and often is cast in-situ (post-tensioning is standard for flat-plate buildings).
- Option D: The concepts are *fundamentally different* and not interchangeable.

Final Answer: Option C correctly and independently defines both terms $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q3

Sol.4.

Solution

Difficulty: Intermediate • Chapter: Building Envelope — Curtain Wall Systems

Quick Solution: Unitised curtain wall: complete storey-height panels are factory-glazed and quality-checked, then hoisted by crane and interlocked on the building face. Stick system = on-site piece-by-piece assembly. **Answer: (B).**

Concept — Unitised Curtain Wall System: Curtain walls are non-load-bearing external envelope systems that span between floor slabs. The two primary construction methods are the *stick system* and the *unitised system*.

Step 1 — Stick system vs Unitised system:

- **Stick system:** Vertical mullions and horizontal transoms are delivered as individual extrusions and assembled sequentially on the building face; glass or panel infills are installed last. Labour-intensive and weather-dependent.
- **Unitised system:** Complete storey-height (sometimes multi-panel) facade units are fully assembled, glazed, sealed, and quality-checked in the factory. On site, a crane hoists each unit into position where it hooks onto anchor brackets fixed to the slab edge. Male/female mullion profiles interlock with adjacent units and a pressure-equalised labyrinth seal provides weather-tightness without requiring on-site silicone application.

Step 2 — Practical advantages: Faster erection (one unit per crane lift), factory quality control, reduced scaffolding, and improved dimensional tolerance. Unitised systems dominate tall-building projects where speed and reliability are critical.

Why other options are wrong:

- Option A: Describes a stick system, which is the *alternative* to the unitised approach.
- Option C: Structural Silicone Glazing (SSG) bonds glass to frames using silicone, but the frames still attach to the structure via mechanical anchors; silicone alone cannot carry the structural facade load.
- Option D: Unitised systems routinely include vision glass as well as opaque spandrel zones.

Final Answer: Factory-assembled storey-height units hoisted and interlocked on-site $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q4

Sol.5.

Solution

Difficulty: Advanced • Chapter: Structural Forms — Cable and Membrane Tensile Structures

Quick Solution: Cables carry zero bending moment — only tension. Loads: membrane → edge cables (tension) → masts/anchorages. Compression only in masts, not in cables or membrane. **Answer: (D).**

Concept — Tensile Structures: Cable and Membrane: Tensile structures exploit the exceptional strength-to-weight ratio of high-tensile steel cables and woven/PTFE-coated synthetic membranes by placing every major structural element in *pure tension*, eliminating bending and compression from the primary load path.

Step 1 — Load path in a cable-and-membrane roof:

1. Imposed loads (wind, snow, self-weight) act on the membrane surface.
2. The membrane transfers load in biaxial tension to edge and ridge cables.
3. Edge cables transfer load in pure tension to the high points (masts or pylons).
4. Masts transfer load in compression to the foundations; the cables are anchored to ground anchorages or a compression ring beam.

At every stage the cable force is exclusively *tensile*.

Step 2 — Why cables cannot carry bending: A cable is a flexible element with no bending stiffness. Under any loading it adopts the funicular (pressure-line) shape corresponding to that load, so all internal forces are purely axial tension.

Why other options are wrong:

- Option A: Cables are geometrically flexible; they carry *zero* bending moment.
- Option B: Compression occurs in the masts and anchorage reactions, not in the cables or membrane.
- Option C: The membrane works in biaxial tension (doubly-curved anticlastic form), not in shear.

Final Answer: Tension in cables transmitting loads to masts/anchorages is the defining mechanism $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q5

Sol.6.

Solution

Difficulty: Beginner • Chapter: Green Building Rating Systems — LEED v4

Quick Solution: LEED v4 BD+C: Energy and Atmosphere = 33 points (highest). Rationale: energy is the largest slice of building lifecycle carbon. WE = 11, MR = 13, EQ = 16. **Answer: (A).**

Concept — LEED v4 BD+C Credit Categories and Point Allocation: LEED (Leadership in Energy and Environmental Design), administered by the US Green Building Council (USGBC), is the most widely used green building rating system internationally. LEED v4 BD+C awards up to **110 base points** across several categories.

Step 1 — Point breakdown (LEED v4 BD+C):

- **Energy and Atmosphere (EA): 33 points** — *highest single category*
- Location and Transportation (LT): 16 points
- Indoor Environmental Quality (EQ): 16 points
- Materials and Resources (MR): 13 points
- Water Efficiency (WE): 11 points
- Sustainable Sites (SS): 10 points
- Innovation (IN): 6 points; Regional Priority (RP): 4 points

Step 2 — Rationale: Operational energy use represents the single largest contribution to a building's lifetime carbon footprint, often exceeding 70% of total lifecycle impacts. LEED's highest point allocation to EA reflects this prominence and incentivises renewable energy, efficient HVAC, and building envelope performance.

Why other options are wrong:

- Option B: Water Efficiency carries only 11 points.
- Option C: Materials and Resources carries 13 points.
- Option D: Indoor Environmental Quality carries 16 points — significant, but only about half of EA's 33.

Final Answer: Energy and Atmosphere carries the maximum points (33) in LEED v4 BD+C $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q6

Sol.7.

Solution

Difficulty: Intermediate • Chapter: Sustainable Construction — Embodied Energy of Materials

Quick Solution: Virgin aluminium: Hall–Héroult smelting ≈150–200 MJ/kg. Next: virgin steel (∼35), fired clay brick (∼3–5), OPC concrete (∼1–2), timber (∼0.5–1.5 MJ/kg). **Answer: (C).**

Concept — Embodied Energy and Net-Zero Construction: Embodied energy is the cumulative energy required to extract, process, manufacture, and deliver a material to the point of use (cradle-to-gate boundary). In net-zero and low-carbon buildings, embodied energy is a key performance indicator alongside operational energy, since it represents an upfront carbon "debt" before the building even opens.

Step 1 — Approximate embodied energy values (cradle-to-gate):

- Air-dried structural timber: $\approx 0.5\text{–}1.5$ MJ/kg (low; stores biogenic carbon)
- OPC concrete M25 (whole mix): $\approx 1\text{–}2$ MJ/kg
- Fired clay brick: $\approx 3\text{–}5$ MJ/kg
- Recycled (secondary) steel: $\approx 10\text{–}15$ MJ/kg
- Virgin (primary) steel: ≈ 35 MJ/kg
- **Virgin (primary) aluminium:** $\approx \mathbf{150\text{–}200}$ **MJ/kg** — exceptionally high due to the electrolytic Hall–Héroult smelting process

Step 2 — Design implication: Aluminium curtain wall frames, cladding panels, and roof glazing systems carry enormous embodied energy; specifying high-recycled-content aluminium (secondary) or alternative materials (timber, steel) can significantly reduce embodied carbon.

Why other options are wrong:

- Option A: Fired clay brick (∼3–5 MJ/kg) is far below virgin aluminium.
- Option B: Concrete (∼1–2 MJ/kg per kg of mix) has low embodied energy per unit mass, although large volumes make total energy significant.
- Option D: Structural timber has among the *lowest* embodied energy and can be carbon-negative if sourced from certified forests.

Final Answer: Virgin (primary) aluminium has the highest embodied energy per kg $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q7

Sol.8.

Solution

Difficulty: Beginner • Chapter: Water Supply — Rainwater Harvesting Systems

Quick Solution: First-flush diverter captures and diverts the initial contaminated roof runoff (dust, bird droppings, pollutants) to waste before rain enters the storage tank. Leaf screens only remove coarse debris. **Answer: (B).**

Concept — Rainwater Harvesting: First-Flush Diverter: Between rainfall events, roof surfaces accumulate airborne particulates, bird droppings, leaf debris, algae, and dust. When rain begins, the first few millimetres of rainfall wash all these contaminants off the roof — this initial runoff (the *"first flush"*) is heavily contaminated and must be discarded before cleaner water enters the storage tank.

Step 1 — First-flush diverter (rooftop washer): A self-resetting device installed in the downpipe that automatically captures and diverts the initial flush volume to waste (or a soakaway pit), then switches the flow to the storage tank once the chamber is full. Design volume $=$ roof area (m^2) $\times$ first-flush depth (typically 1–2 mm). A slow-closing ball valve or float mechanism allows the diverted chamber to drain between events, resetting the diverter automatically.

Step 2 — System sequence: Rainfall $\rightarrow$ leaf screen (removes coarse debris) $\rightarrow$ **first-flush diverter** (discards contaminated initial runoff) $\rightarrow$ storage tank $\rightarrow$ slow sand filter (polishes stored water before use) $\rightarrow$ distribution.

Why other options are wrong:

- Option A: A leaf-screen mesh removes coarse physical debris (leaves, twigs) but does *not* remove dissolved or fine particulate contaminants in the initial runoff.
- Option C: A slow sand filter operates on *stored* water after collection; it is not positioned at the downpipe and has no diverting function.
- Option D: An overflow pipe manages excess storage volume; it carries clean(er) overflow away, not the initial contaminated runoff.

Final Answer: The first-flush diverter specifically captures and discards the initial contaminated runoff $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q8

Sol.9.

Solution

Difficulty: Intermediate • Chapter: Acoustic Design — Reverberation Time

Quick Solution: $T = 0.161V/A$. Doubling V (constant A): $T' = 0.161(2V)/A = 2T$. Volume appears with power 1 — not squared. Halving A (constant V) doubles T, not doubling V. **Answer: (D).**

Concept — Sabine's Formula for Reverberation Time: Wallace Clement Sabine (1900) derived the fundamental empirical formula for reverberation time T_{60} — the time for the sound pressure level to decay by 60 dB after the source ceases:

$$T = \frac{0.161\,V}{A}$$

where V is the room volume (m^3) and $A = \sum_i S_i\,\alpha_i$ is the total sound absorption in sabins (equivalent absorption area, m^2); S_i is the surface area and α_i the absorption coefficient of each surface.

Step 1 — Mathematical analysis (doubling V, constant A):

$$T' = \frac{0.161 \times 2V}{A} = 2 \times \frac{0.161V}{A} = 2T$$

The reverberation time **doubles**.

Step 2 — Physical interpretation: In a larger room, sound travels farther between successive reflections (longer mean free path $\bar{\ell} = 4V/S$). With the same absorbing surfaces, each reflection removes the same energy fraction, but reflections occur less frequently per second — so the total decay time is longer.

Why other options are wrong:

- Option A: T depends *linearly* on V; it cannot remain unchanged when V changes.
- Option B: T is halved when A is doubled (with V fixed), not when V is doubled.
- Option C: V appears as V^1 in Sabine's formula (not V^2), so a fourfold increase is impossible from doubling V alone.

Final Answer: T doubles because reverberation time is directly proportional to volume $V \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q9

Sol.10.

Solution

Difficulty: Intermediate • Chapter: Vertical Transportation — Elevator Systems

Quick Solution: Traction elevator: the grooved drive sheave (pulley) converts motor rotation into rope movement via friction; ropes connect car and counterweight. No hydraulics, no winding drum. **Answer: (A).**

Concept — Traction Elevator: Drive Mechanism: Traction elevators are the standard choice for buildings above five or six storeys. They differ fundamentally from hydraulic elevators in that the driving force is transmitted through *friction (traction)* between steel hoist ropes and a grooved sheave, rather than through fluid pressure.

Step 1 — Operating principle: An electric motor (AC induction or permanent-magnet synchronous) rotates the **drive sheave** (a grooved pulley). Multiple steel wire ropes (typically 6–8 per elevator) lie in the sheave grooves. One side of the ropes is attached to the elevator car; the other side to the counterweight. Friction between ropes and sheave grooves transmits the motor torque as a rope tension difference, moving the car up or down. The counterweight (typically car weight + 40–50% of rated load) balances most of the load, so the motor only needs to overcome the net imbalance plus friction.

Step 2 — Geared vs Gearless traction:

- **Geared:** Motor shaft connected to sheave via worm or helical gearbox; suited to low-to-mid-rise, speeds up to $\sim$2.5 m/s.
- **Gearless (MRL):** Motor directly coupled to sheave; suited to high-rise, speeds exceeding 10 m/s; machine-room-less (MRL) variants place all equipment in the shaft.

Why other options are wrong:

- Option B: A hydraulic cylinder and pump describes a *hydraulic* elevator — limited to low-rise (typically $\leq$ 6 floors) due to oil column pressure constraints.
- Option C: A winding drum elevator (drum machine) is an obsolete type no longer installed in commercial buildings; it is not a traction elevator.
- Option D: Pneumatic tube/capsule elevators are a novelty product for single-person residential use; they bear no engineering relation to commercial traction systems.

Final Answer: The grooved sheave driven by an electric motor defines the traction elevator $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q10

Answer Key

Q.	Ans.	Q.	Ans.	Q.	Ans.	Q.	Ans.	Q.	Ans.
1	A	2	D	3	C	4	B	5	D
6	A	7	C	8	B	9	D	10	A

Click on any answer letter above to jump directly to the detailed solution.