

# Course: Concrete Technology

Week 8: Midterm examination

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# Objective

The objective of this midterm examination is to assess students' understanding of the fundamental topics in Concrete Technology, including the role of constituent materials, the properties of fresh concrete, and the mechanical and durability characteristics of hardened concrete. Students are expected to demonstrate technical knowledge, critical thinking, and the ability to apply engineering concepts to practical construction scenarios.

# Instructions

- Section I: Multiple-Choice (20 pts): 20 questions, 1 point each; select the best answer.
- Section II: Integrative Questions (18 pts): 3 questions, 6 points each; provide clear and technically supported answers.
- Section III: Applied Case Study (12 pts): 1 case-based question applying concepts from Concrete Technology to a practical engineering scenario.



# **Section I: Multiple-Choice Questions**

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- **Question 1:**

What is the main function of curing water?

- A) Reduce the weight of concrete
- B) Accelerate setting
- C) Maintain cement hydration
- D) Improve the color of concrete

- **Question 2:**

What is the main product responsible for concrete strength?

- A) Calcium hydroxide
- B) Ettringite
- C) C-S-H gel
- D) Gypsum

- **Question 3:**

For a massive structure where minimizing thermal cracking is required, which type of cement is most suitable?

- A) Type I
- B) Type III
- C) Type IV
- D) Type V

- **Question 4:**

What happens during cement setting?

- A) Final strength develops
- B) All water evaporates
- C) The mixture loses plasticity
- D) Hydration stops

# Section I: Multiple-Choice Questions

- **Question 5:**

Why is unit weight used instead of specific gravity for transportation calculations?

- A) Because it is constant
- B) Because it does not include voids
- C) Because it considers the voids between particles
- D) Because it is easier to measure

- **Question 6:**

Which moisture condition is ideal for mix design?

- A) Oven-dry
- B) Oversaturated
- C) Saturated Surface Dry (SSD)
- D) Moist but unsaturated

- **Question 7:**

Which property measures the aggregate's resistance to abrasion?

- A) Toughness
- B) Hardness
- C) Elasticity
- D) Porosity

- **Question 8:**

What defines the maximum size of an aggregate?

- A) The sieve on which 50% is retained
- B) The largest visible particle size
- C) The smallest sieve through which 100% of the sample passes
- D) The average particle size

# Section I: Multiple-Choice Questions

- **Question 9:**  
What does the gradation curve represent?  
A) Concrete strength  
B) Particle size distribution  
C) Moisture content  
D) Aggregate density
- **Question 10:**  
What does the sand equivalent test (ASTM D2419) measure?  
A) Moisture content  
B) Proportion of undesirable fines  
C) Specific gravity  
D) Mechanical strength
- **Question 11:**  
What is the function of excess water in fresh concrete?  
A) Generate strength  
B) Act as a lubricant  
C) Reduce hydration  
D) Eliminate pores
- **Question 12:**  
What happens with high concentrations of sugar in water?  
A) They do not affect concrete  
B) They delay setting indefinitely  
C) They accelerate setting and reduce strength  
D) They improve durability

# Section I: Multiple-Choice Questions

- **Question 13:**

Which property defines the amount of work required to compact concrete?

- A) Segregation
- B) Workability
- C) Bleeding
- D) Density

- **Question 14:**

What is a cause of segregation?

- A) Homogeneous mixture
- B) Proper gradation
- C) Difference in densities
- D) Low water content

- **Question 15:**

What is the main product generated during cement hydration?

- A) Calcium carbonate
- B) C-S-H gel
- C) Iron oxide
- D) Sodium sulfate

- **Question 16:**

What happens if the cement content is excessive (>470 kg/m<sup>3</sup>)?

- A) Strength always increases
- B) It has no effect
- C) Strength may decrease
- D) Porosity is eliminated

# Section I: Multiple-Choice Questions

- **Question 17:**  
What is the minimum recommended curing time for concrete?  
A) 1 day  
B) 3 days  
C) 7 days  
D) 28 days
- **Question 18:**  
What does a high ultrasonic pulse velocity indicate?  
A) Low quality  
B) High porosity  
C) Dense and homogeneous concrete  
D) Presence of cracks
- **Question 19:**  
Which law describes water flow in concrete?  
A) Hooke's Law  
B) Darcy's Law  
C) Newton's Law  
D) Fourier's Law
- **Question 20:**  
How does American Concrete Institute define concrete durability?  
A) Ability to resist load  
B) Aesthetic capability  
C) Ability to resist environmental exposure and maintain properties  
D) Ability to deform



## **Section II: Integrative Questions**

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## Question 1

A reinforced concrete bridge deck is being designed for a coastal environment, where the structure will be exposed to high humidity, chloride-rich conditions, and significant daily temperature variations.

Using principles of concrete technology, analyze:

- 1) How the selection of cement, aggregates, water quality, and admixtures influences both fresh and hardened concrete behavior.
- 2) How fresh concrete properties such as workability, segregation resistance, and bleeding affect the final mechanical and durability performance.
- 3) How you would optimize the concrete mix design to achieve adequate constructability, strength, and long-term durability under these exposure conditions.

Support your answer using material-property relationships and engineering reasoning.

# Section II: Integrative Questions

## Question 2

A contractor reports that during the construction of a high-rise building, the concrete mixture initially met all design specifications, but several problems appeared during execution: rapid slump loss, difficult compaction, surface cracking after casting, and lower-than-expected 28-day compressive strength.

Based on concrete technology principles, evaluate:

1. Which material-related factors (cement type, aggregate properties, water content, and admixture dosage) may have contributed to these problems.
2. How deficiencies in fresh concrete properties can influence hydration, microstructure development, and hardened concrete properties.
3. What preventive measures should be implemented in future pours to improve both fresh and hardened concrete performance.

Explain the full cause–effect chain from material selection to structural performance.

# Section II: Integrative Questions

## Question 3

A project team aims to develop a more sustainable concrete mixture by reducing cement content and incorporating supplementary materials, while maintaining workability, mechanical strength, and durability requirements.

Using your understanding of concrete technology, discuss:

1. How reducing cement content and modifying the proportions of aggregates, water, and admixtures may affect fresh concrete properties.
2. How these changes influence hydration, porosity, strength development, permeability, and durability in the hardened state.
3. What balance must be achieved between sustainability, constructability, and long-term structural performance.

Provide an integrated engineering analysis considering both material science and practical construction implications.



## **Section III: Applied Case Study**

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A contractor is constructing a multi-story reinforced concrete building in a tropical urban environment. During construction, several problems are reported:

- Loss of slump and reduced workability during transportation and placement;
- Visible segregation and excessive bleeding during slab casting;
- Early-age plastic shrinkage cracks appearing within hours after finishing;
- At 28 days, compressive strength results are below the specified design value, and some structural elements show higher-than-expected permeability.

# Section III: Applied Case Study

As the project engineer, you are asked to diagnose the problem and recommend corrective actions.

1. **Raw Materials Analysis:**

Evaluate how the selection and quality of cement, aggregates, water, and admixtures may have contributed to the observed problems.

2. **Fresh Concrete Analysis:**

Explain how the observed fresh-state issues (loss of workability, segregation, bleeding, and plastic shrinkage) are interrelated and what mechanisms caused them.

3. **Hardened Concrete Analysis:**

Discuss how these fresh-state deficiencies can affect the compressive strength, permeability, and durability of hardened concrete.

4. **Engineering Solution:**

Propose a comprehensive strategy involving mix redesign, quality control, and construction practices to improve both fresh and hardened concrete performance.

Support your analysis using engineering principles and cause–effect relationships.

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