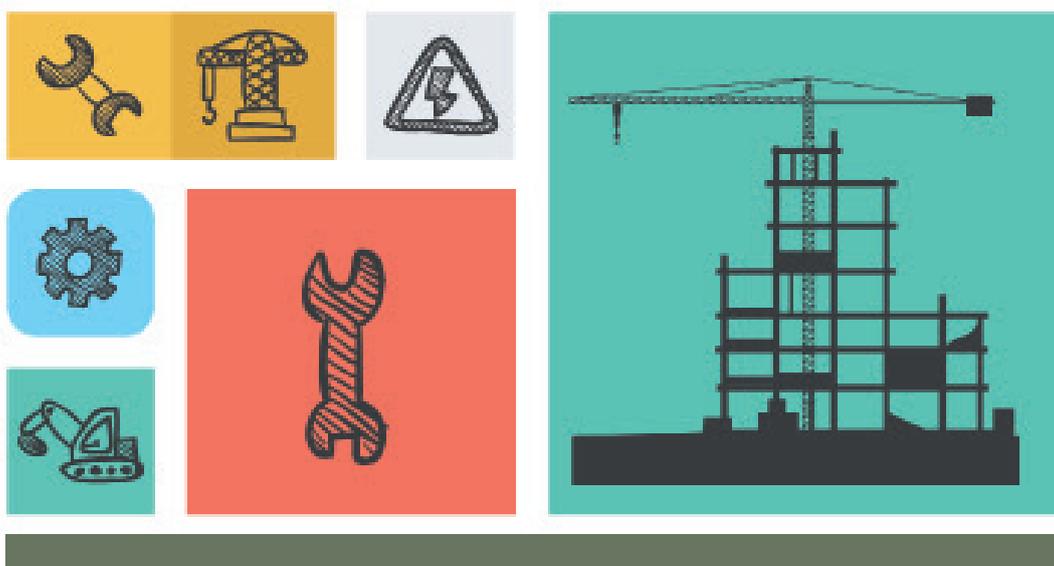


Engineering Fundamentals Exam

Study Guide For Civil Engineering Exam



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1. Objectives

The aim of this manual is to provide guidelines for the examinees about the exam structure, timing, percentage of question coverage and distribution among various topic areas. In essence, the manual represents the bridge between the developed Civil Engineering Standards and the actual phrased questions, which constitute the tests to be administered. It is designed to familiarize the examinees with the test questions formats and contents.

2. Contents

This study guide contains essential information for the examinees. Specifically, the following topics are presented in this manual:

- Exam structure, exam schedule and organization, exam type, eligibility for exam, and exam rules
- Organization of the exam framework
- Table of Specifications which includes an overview of the table, its structure and contents
- Sample of questions and solutions for the Civil Engineering discipline

3. Exam Structure

The exam is conducted in two sessions and the duration of each session is 3 hours.

3.1 General Engineering Exam

The first session covers the General Engineering topics. These include the following fourteen topics:

1. Mathematics
2. Probability and Statistics
3. Computer Literacy
4. Statics and Dynamics
5. Chemistry
6. Thermodynamics



7. Fluid Mechanics
8. Materials Science and Engineering
9. Electricity and Magnetism
10. Engineering Drawing
11. Engineering Economics
12. Project Management
13. Ethics
14. General Skills
 - a. Use analytical thinking (logical deductions, statements and assumptions, cause and effect, verbal reasoning, analyzing arguments, statements and conclusions, break a complex problem into smaller problems and solve them)
 - b. Use effective communication in writing, orally, and graphically
 - c. Work cooperatively with other team members to deliver the required outcomes
 - d. Set goals and ways for personal development
 - e. Strive for ways to resolve conflicts while being sensitive to others opinions
 - f. Be able to use time and available resources in an efficient way
 - g. Recognize and interpret environmental, social, cultural, political and safety considerations in engineering solutions.
 - h. Recognize decision making process
 - i. Recognize major engineering concepts outside the discipline.
 - j. Interpret uncertainties in measurements and calculations
 - k. Analyze and interpret data
 - l. Apply evaluation criteria and contemporary knowledge to select the optimum design from alternative solutions

3.2 Engineering Discipline Exam

The second session covers the Engineering Standards and is based on topics associated with one of the following engineering disciplines:

<i>Code</i>	<i>Discipline</i>
CE	Civil Engineering
CHE	Chemical Engineering
EE	Electrical Engineering
IE	Industrial Engineering



ME	Mechanical Engineering
SE	Structural Engineering

4. Exam Implementation

The exam consists of two sessions:

- The first session consists of General Engineering Exam. This session consists of 90 questions with a total time of 3 hours.
- The second session consists of Engineering Discipline Exam. This session consists of 50 questions with a total time of 3 hours.

5. Exam Type

The exam is initially paper-based and will become computer based in a later stage. The exam, in both sessions, is of a multiple choice type where each question has four choices for the answer. There is no negative marking for wrong answers.

6. Eligibility for the Exam

Bachelor degree holders in an Engineering discipline i.e., Chemical Engineering, Civil Engineering, Electrical Engineering, Industrial Engineering, Mechanical Engineering, and Structural Engineering.

7. Exam Rules

- Books, lecture notes, or any type of materials are not allowed in the exam. Necessary reference sheets, monographs, equations, relevant data from codes will be provided in the exam.
- Calculators approved by Exam authorities are allowed.
- Admission in the examination center will be only through authorized admission card
- Examinees are subjected to all the rules and procedures applied by National Center for Assessment in Higher Education (Qiyas)



8. Organization of the Exam Framework

The core topics constitute the basis of this Engineering Exam. Indicators are used to describe the knowledge to be tested in each topic. Each of these indicators is further subdivided into three major levels following the recent Bloom's taxonomy of learning levels (Remembering and Understanding; Applying and Analyzing; and Evaluating and Creating).

Example

Topic:	T1: Structural Analysis
Indicator:	CE-T1-08: Evaluate displacements and slopes in beams and frames using numerical and energy methods
Learning Level:	Applying and Analyzing (AA)

9. Table of Specifications

9.1 Overview

The Table of Specifications is a map which facilitates the transformation of the Engineering Standards for each Topic Area into balanced and coherent question sheets to be used in the proposed Exam. The Table of Specifications is essentially a tableau structure which distributes, vertically, the exam Questions among various Topic Areas in accordance with the applicable Engineering Standards and, horizontally, over various Learning Levels (Remembering and Understanding, Applying and Analyzing, Evaluating and Creating).



9.2 Structure and Contents

The table below constitutes the Table of Specifications for the Civil Engineering Discipline. The Table of Specifications contains the following columns:

9.2.1 Topic Area

These are the widely recognized Topic areas, which are covered in the Civil Engineering Discipline, namely:

1. Structural Analysis
2. Structural Design
3. Materials
4. Geotechnical Engineering
5. Water Resources Engineering
6. Environmental Engineering
7. Transportation Engineering
8. Construction Management
9. Surveying

9.2.2 % of Test

This column summarizes the total percentage (of the total test) allocated for each Topic Area.

9.2.3 Suggested Number of Questions

This column indicates the number of questions to be allocated for each Engineering Standard. The total number of questions per test conforms to the general guidelines which govern the total duration of the test. In the present case, 50 questions are included in each Discipline.

9.2.4 Engineering Standards

This column lists the Engineering Standards to be addressed under each Topic Area. Standards are coded **CE-TJ** (where **CE** denotes the Civil Engineering Discipline, **TJ** denotes the Topic Number **J**), whereas the Indicators are coded **CE-TJ-K** (where **K** denotes the Indicator number).

For example: **CE-T1-5** is for the question in Civil Engineering (CE) that represents Topic 1 (Structural Analysis) and Indicator 5.



9.2.5 Assigned Allocations among Learning Levels

The three sub-columns (Remembering and Understanding, Applying and Analyzing, and Evaluating and Creating) under this main column specify the question distribution among the three *Learning Levels*. For example, for the **Geotechnical Engineering** (CE-T4), there are two questions assigned to *Learning Level RU*, four questions for **AA** and one question for **EC**. It is to be noted that the *Learning Levels* used in the Table of Specifications represent the so-called cognitive levels/processes (levels of thinking) in the revised Bloom's taxonomy.

It is also important to note that the distribution of questions among various Topic Areas follows a careful and rigorous question allocation process, which ensures that appropriate relative levels of coverage are maintained for the various Learning Levels. In Civil Engineering Discipline, the distribution of questions (for all Topic Areas) among the three Learning Levels is 14 questions (28%) for Remembering and Understanding, 26 questions (52%) for Applying and Analyzing, and 10 questions (20%) for Evaluating and Creating.



Table of Specifications for Civil Engineering Exam

Topic Area	% of Test	# Q	Engineering Standard	Assigned Allocations of Questions among Learning Levels		
				Remembering and Understanding	Applying and Analyzing	Evaluating and Creating
T1- Structural Analysis	14	7	CE-T1	2	4	1
T2- Structural Design	14	7	CE-T2	0	3	4
T3- Materials	8	4	CE-T3	1	2	1
T4- Geotechnical Engineering	14	7	CE-T4	2	4	1
T5- Water Resources Engineering	14	7	CE-T5	2	4	1
T6- Environmental Engineering	12	6	CE-T6	2	3	1
T7- Transportation Engineering	12	6	CE-T7	2	3	1
T8- Construction Management	8	4	CE-T8	2	2	0
T9- Surveying	4	2	CE-T9	1	1	0
	100	50		14 (28%)	26 (52%)	10 (20%)



10. Sample Questions

A sample of questions is shown in the following tabular format in accordance with the following instructions.

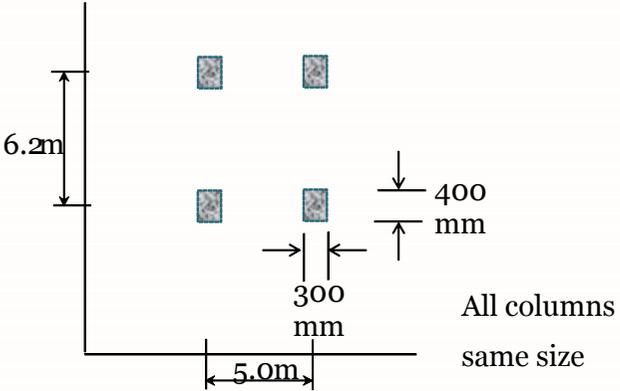
1. For Learning Levels
 - RU for Remembering and Understanding
 - AA for Applying and Analyzing
 - EC for Evaluating and Creating
2. References sheets are denoted in the last column of the Table



Table of Sample Questions

Q. No.	Topic Area	EA Code	Learning Level	Question Statement (Answer's Choices)	Answer	Expected Time (min)	Supplied Reference
1	Structural Analysis	CE-T1-01	RU	<p>A rectangular metal section ($b = 60 \text{ mm}$, $h = 100 \text{ mm}$) is subjected to a bending moment of 12 kN.m. The stress, in MPa (N/mm^2), in the extreme fiber is:</p> <p>A) 60 B) 90 C) 120 D) 150</p>	C	2 – 3	None

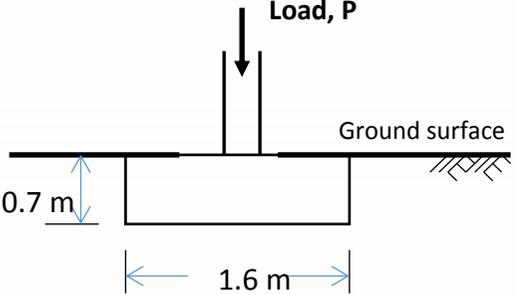


2	Structural Design	CE-T2-04	EC	 <p>The shown interior panel of flat slab is subjected to a total factored load (including self-weight, dead load and live load) of 15 kN/m^2. The magnitude of punching shear (V_u) and design shear strength (ϕV_c) are related to each other as:</p> <p>(Given $f_c' = 25 \text{ MPa}$ (normal weight concrete), $f_y = 420 \text{ MPa}$, effective depth (d) of the plate = 200 mm, strength reduction factor ϕ against shear = 0.75)</p> <p>A) $V_u > \phi V_c$</p> <p>B) $V_u < \phi V_c$</p> <p>C) $V_u = \phi V_c \neq 0$</p> <p>D) $V_u = \phi V_c = 0$</p>	B	3.5 – 4.5	Reference #2
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3	Materials	CE-T3-07	RU	<p>Segregation in concrete occurs when:</p> <ul style="list-style-type: none"> A) Cement gets separated from mixture due to excess water B) Cement fails to give adequate binding quality C) Coarse aggregates tend to separate out from the finer materials D) Two mixtures of different strengths are used in the same structure 	C	1- 1.5	None
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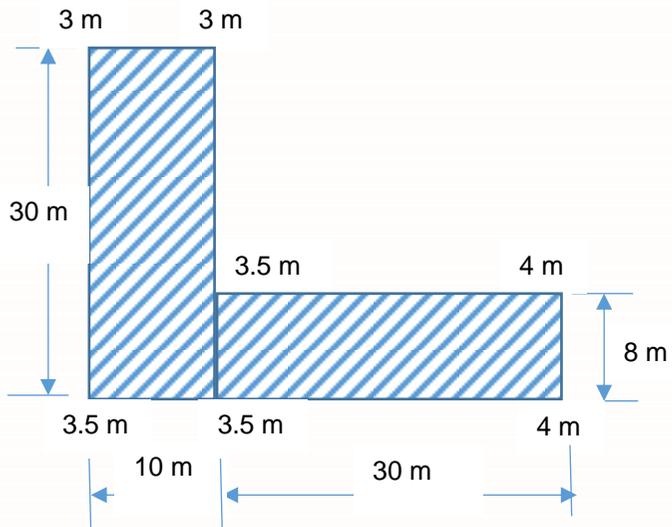
4	Geotechnical Engineering	CE-T4-09	EC	 <p style="text-align: center;"> $C' = 0$ $\Phi' = 30^\circ$ $\gamma' = 18 \text{ kN/m}^3$ </p> <p>A square footing (1.6 m x 1.6 m) carrying a concentric load P is going to be built on a sandy soil with properties as shown in the figure. If the water table is very deep, the ultimate bearing capacity (q_u), in kPa, according to Terzaghi's bearing capacity formula will be: ($\gamma_w = 10 \text{ kN/m}^3$)</p> <p>A) 254 B) 284 C) 386 D) 515</p>	D	3 – 4	Reference #4
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5	Water Resources Engineering	CE-T5-03	AA	<p>A 100-m long pipe has a diameter of 20-cm and $C_{HW} = 120$, carries a discharge of 30 liter/sec.</p> <p>The head loss, in cm, in the pipe is:</p> <p>A) 19 B) 28 C) 45 D) 58</p>	D	3 – 4	Reference #5
6	Environmental Engineering	CE-T6-06	AA	<p>In a BOD₅ determination, 40 mL of wastewater containing 2 mg/L DO, are mixed with 260 mL of dilution water containing 9 mg/L of DO. After 5 days of incubation the DO content of the mixture is 2.74 mg/L. The BOD₅ of the wastewater, in mg/L, is:</p> <p>A) 40 B) 45 C) 50 D) 55</p>	A	3 - 4	Reference #6

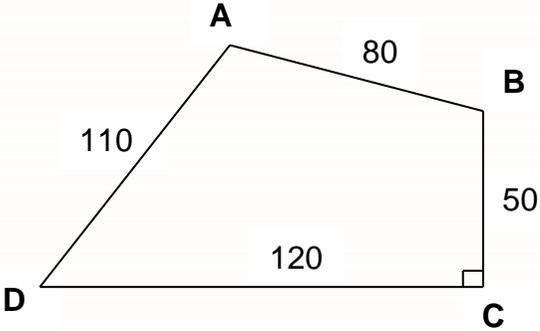


7	Transportation Engineering	CE-T7-08	RU	<p>In highway geometric design, superelevation is required to:</p> <ul style="list-style-type: none"> A) Allow trucks to maintain design speed and stability while climbing on a crest curve. B) Allow the drainage of water on circular curves, while maintaining design speed on a rainy day. C) Counteract centrifugal force, thus provide stability while maintaining design speed on horizontal curves. D) Provide aesthetic especially for urban roads. 	C	1.5 – 2	None
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8	Construction Management	CE-T8-07	AA	 <p>The diagram shows a basement excavation plan. It consists of two rectangular sections. The left section is 3.5 m wide and 30 m deep. The right section is 4 m wide and 8 m deep. The total width of the excavation is 7.5 m (3.5 m + 4 m). The total length is 30 m. The depth of excavation at each corner is indicated by arrows: 3 m at the top-left and top-right corners, 3.5 m at the bottom-left and bottom-middle corners, and 4 m at the bottom-right corner. A horizontal dimension of 10 m is shown from the left edge to the start of the second section, and 30 m is shown for the total length.</p> <p>The volume of excavation (in m³) required (bank measure) for the basement shown in the figure (values shown at each corner are depths of excavation) is:</p> <p>A) 1875 B) 1910 C) 1955 D) 1995</p>	A	3 – 4	None
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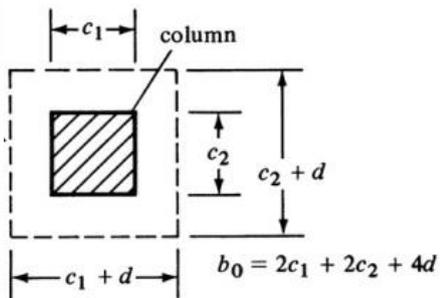
9	Surveying	CE-T9-04	AA	 <p>Compute the most approximate area of the land parcel shown in the figure, given that the dimensions are in meters.</p> <p>A) 7325 B) 7382 C) 7398 D) 8013</p>	B	3 – 4	Reference #9
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Reference #2

$$\text{Punching shear strength : } V_c = 2 \left(\frac{\lambda \sqrt{f'_c}}{6} \right) b_0 d$$

where, $\lambda = 1$ for normal weight concrete; f'_c = specified strength of concrete; b_0 = perimeter to resist the shear; and d = effective depth of the plate.



Reference #4

$$q_u = 1.3 c' N_c + q' N_q + 0.4 \gamma' B N_\gamma$$

BEARING CAPACITY FACTORS

Φ' (deg)	Terzaghi Parameters		
	N_c	N_q	N_γ
0	5.7	1.0	0.0
1	6.0	1.1	0.1
2	6.3	1.2	0.1
3	6.6	1.3	0.2
4	7.0	1.5	0.3
5	7.3	1.6	0.4
6	7.7	1.8	0.5
7	8.2	2.0	0.6
8	8.6	2.2	0.7
9	9.1	2.4	0.9
10	9.6	2.7	1.0
11	10.2	3.0	1.2
12	10.8	3.3	1.4
13	11.4	3.6	1.6
14	12.1	4.0	1.9
15	12.9	4.4	2.2
16	13.7	4.9	2.5
17	14.6	5.5	2.9
18	15.5	6.0	3.3
19	16.6	6.7	3.8
20	17.7	7.4	4.4
21	18.9	8.3	5.1
22	20.3	9.2	5.9
23	21.7	10.2	6.8
24	23.4	11.4	7.9
25	25.1	12.7	9.2
26	27.1	14.2	10.7
27	29.2	15.9	12.5
28	31.6	17.8	14.6
29	34.2	20.0	17.1
30	37.2	22.5	20.1
31	40.4	25.3	23.7
32	44.0	28.5	28.0



Reference #5

Hazen Williams Formula:

$$V = 0.85CR^{0.63}S^{0.54}$$

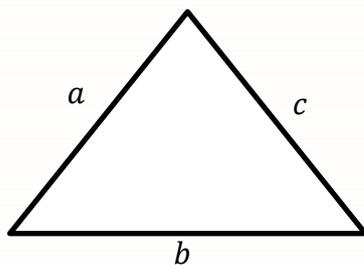
Reference #6

$$\text{BOD}_5 \text{ (mg/L)} = \frac{D1 - D2}{P}$$

$$P = \frac{\text{Volume of water sample, mL}}{300 \text{ mL}}$$

Reference #9

Given a triangle:



$$s = \frac{(a + b + c)}{2}$$

$$\text{Area, } A = \sqrt{s(s - a)(s - b)(s - c)}$$



11. Solution of the Sample Questions

Question #1:

Topic Area: Structural Analysis

Learning Level: Remembering and Understanding

Indicator:

CE-T1-01 Describe axial, torsional and normal stresses in different structural members

Question Statement:

A rectangular metal section ($b = 60 \text{ mm}$, $h = 100 \text{ mm}$) is subjected to a bending moment of 12 kN.m . The stress, in MPa (N/mm^2), in the extreme fiber is:

- A) 60
- B) 90
- C) 120
- D) 150

Answer:

C

Reference Sheet: None

Estimated Solution Time by Examinee: 2.0 – 3.0 minutes

Remarks: The objective of this question is to ensure that the examinee can formulate and determine stresses

Solution:

Normal stress due to bending at the extreme fiber is

$$\sigma = \frac{My_{\max}}{I} = \frac{M \frac{h}{2}}{\frac{bh^3}{12}} = \frac{6M}{bh^2} = \frac{6 \times 12 \times 10^6}{60 \times 100^2} = 120 \text{ N/mm}^2$$



Question #2:

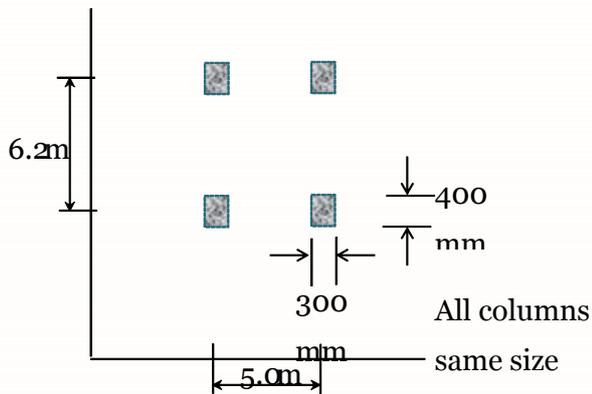
Topic Area: Structural Design

Learning Level: Evaluating and Creating

Indicator:

CE-T2-04 Design different types of slabs to satisfy design criteria and code provisions

Question Statement:



The shown interior panel of flat slab is subjected to a total factored load (including self-weight, dead load and live load) of 15 kN/m^2 . The magnitude of punching shear (V_u) and design shear strength (ϕV_c) are related to each other as:

- A) $V_u > \phi V_c$
- B) $V_u < \phi V_c$
- C) $V_u = \phi V_c \neq 0$
- D) $V_u = \phi V_c = 0$

Given $f'_c = 25 \text{ MPa}$ (normal weight concrete), $f_y = 420 \text{ MPa}$, effective depth (d) of the plate = 200 mm, strength reduction factor ϕ against shear = 0.75

Answer:

B

Reference Sheet: Reference #2

Estimated Solution Time by Examinee: 3.5 – 4.5 minutes



Remarks: The objective of this question is to ensure that the examinee can determine punching shear of flat surfaces

Solution:

Note: For punching shear, the critical section is taken at a distance $d/2$ from the face of the column.

Therefore, $b_0 = 2c_1 + 2c_2 + 4d = 2 \times 400 + 2 \times 300 + 4 \times 200 = 2200$ mm

$V_u = [\text{Panel area} - \text{Area enclosed by } b_0] \times q_u = [6.2 \times 5.0 - (0.4 + 0.2) \times (0.3 + 0.2)] \times 15 = 460.5$ kN

Design shear strength $= \phi V_c = \phi \times 2 \left(\frac{\lambda \sqrt{f'_c}}{6} \right) b_0 d = 0.75 \times 2 \left(\frac{1 \times \sqrt{25}}{6} \right) \times 2200 \times 200 = 550000$ N = 550 kN

$V_u < \phi V_c$ (Safe) *Ans. B*



Question #3:

Topic Area: Materials

Learning Level: Remembering and Understanding

Indicator:

CE-T3-07 Recognize various factors that affect different material strength and durability

Question Statement:

Segregation in concrete occurs when:

- A) Cement gets separated from mixture due to excess water
- B) Cement fails to give adequate binding quality
- C) Coarse aggregates tend to separate out from the finer materials
- D) Two mixtures of different strengths are used in the same structure

Answer:

C

Reference Sheet: None

Estimated Solution Time by Examinee: 1.0 – 1.5 minutes

Remarks: The objective of this question is to ensure that the examinee can recognize factors which affect the quality of concrete.

Solution:

Segregation in concrete is defined as separation of coarse aggregates from the finer materials



Question #4:

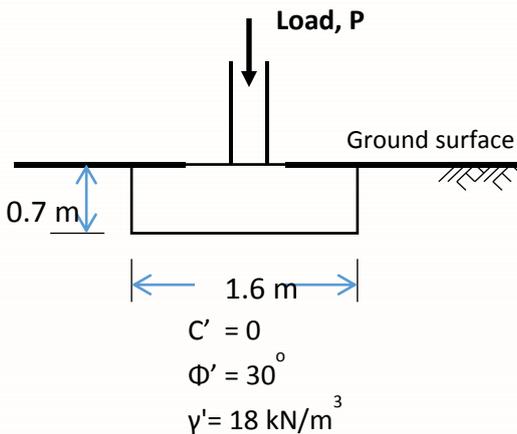
Topic Area: Geotechnical Engineering

Learning Level: Applying and Analyzing

Indicator:

CE-T4-09 Assess the bearing capacity and behavior of soils/rocks under loads for both shallow and deep foundations

Question Statement:



A square footing (1.6 m x 1.6 m) carrying a concentric load P is going to be built on a sandy soil with properties as shown in the figure. If the water table is very deep, the ultimate bearing capacity (q_u) according to Terzaghi's bearing capacity formula, in kPa, will be: ($\gamma_w = 10 \text{ kN/m}^3$)

- A) 254
- B) 284
- C) 386
- D) 515

Answer:

D

Reference Sheet: Reference # 4

Estimated Solution Time by Examinee: 3.0 – 4.0 minutes

Remarks: The objective of this question is to ensure that the examinee can define, formulate, and determine behavior of soils



Solution:

Terzaghi's Equation for a square footing is:

$$q_u = 1.3 c' N_c + q' N_q + 0.4 \gamma' B N_\gamma$$

For $\phi = 30^\circ$, from attached table, $N_c = 37.2$, $N_q = 22.5$, $N_\gamma = 20.1$

$$q' = 0.7(18) = 12.6 \text{ kPa}$$

$$q_u = 0 + 12.6 (22.5) + 0.4 (18)(1.6) (20.1)$$

$$q_u = 283.5 + 231.55$$

$$q_u = 515 \text{ kPa} \quad \text{Ans: D}$$



Question #5:

Topic Area: Water Resources Engineering

Learning Level: Applying and Analyzing

Indicator:

CE-T5-03 Analyze pressurized flows (pipelines, pipe networks, pumps)

Question Statement:

A 100-m long pipe has a diameter of 20-cm and $C_{HW} = 120$, carries a discharge of 30 liter/sec. The head loss, in cm, in the pipe is:

- A) 19
- B) 28
- C) 45
- D) 58

Answer:

D

Reference Sheet: Reference # 5

Estimated Solution Time by Examinee: 3.0 – 4.0 minutes

Remarks: The objective of this question is to ensure that the examinee can formulate and analyze pipe networks

Solution:

Area, $A = \frac{\pi D^2}{4} = \frac{\pi(0.2)^2}{4} = 0.0314 \text{ m}^2$, Wetted perimeter, $P \pi D = 0.2 * \pi = 0.628 \text{ m}$

Hydraulic Radius, $R = \frac{A}{P} = \frac{0.0314}{0.628} = 0.05$, Slope, $S = \frac{h_f}{L} = \frac{h_f}{100}$

Apply Hazen Williams Equation

$$V = \frac{Q}{A} = 0.85 C_{HW} R^{0.63} S^{0.54}$$

$$\frac{0.03}{0.0314} = 0.85 * 120 * (0.05)^{0.63} \left(\frac{h_f}{100}\right)^{0.54}$$

$\therefore h_f = 0.58 \text{ m or } 58 \text{ cm}$ **Ans: D**



Question #6:

Topic Area: Environmental Engineering

Learning Level: Applying and Analyzing

Indicator:

CE-T6-06 Determine parameters of wastewater reclamation, recycling and reuse

Question Statement:

In a BOD₅ determination, 40 mL of wastewater containing 2 mg/L DO, are mixed with 260 mL of dilution water containing 9 mg/L of DO. After 5 days of incubation the DO content of the mixture is 2.74 mg/L. The BOD₅ of the wastewater, in mg/L, is:

- A) 40
- B) 45
- C) 50
- D) 55

Answer:

A

Reference Sheet: Reference # 6

Estimated Solution Time by Examinee: 3.0 – 4.0 minutes

Remarks: The objective of this question is to ensure that the examinee can formulate and determine parameters of wastewater

Solution:

$$D_1 = (40 \times 2 + 260 \times 9) / 300 = 8.07 \text{ mg/L}$$

$$D_2 = 2.74 \text{ mg/L.}$$

$$\text{Dilution factor} = 40 / 300 = 0.133$$

$$BOD_5 = (8.07 - 2.74) / 0.133$$

$$BOD_5 = 40 \text{ mg/L} \quad \text{Ans: A}$$



Question #7:

Topic Area: Transportation Engineering

Learning Level: Remembering and Understanding

Indicator:

CE-T7-08 Design highway geometric elements

Question Statement:

In highway geometric design, super-elevation is required to:

- A) Allow trucks to maintain design speed and stability while climbing on a crest curve.
- B) Allow the drainage of water on circular curves, while maintaining design speed on a rainy day.
- C) Counteract centrifugal force, thus provide stability while maintaining design speed on horizontal curves.
- D) Provide aesthetic especially for urban roads.

Answer:

C

Reference Sheet: None

Estimated Solution Time by Examinee: 1.5 – 2.0 minutes

Remarks: The objective of this question is to ensure that the examinee can recognize the basics of highway design

Solution:

Super-elevation is required to counteract centrifugal force, thus provide stability while maintaining design speed on horizontal curves.



Question #8:

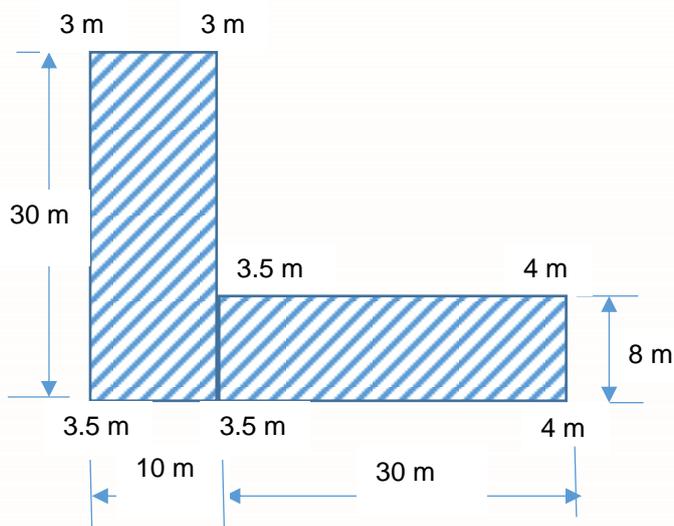
Topic Area: Construction Management

Learning Level: Applying and Analyzing

Indicator:

CE-T8-07 Design concrete formwork for beam, slab, column, and footings

Question Statement:



The volume of excavation, in m^3 , required (bank measure) for the basement shown in the figure (values shown at each corner are depths of excavation) is:

- A) 1875
- B) 1910
- C) 1955
- D) 1995

Answer:

A

Reference Sheet: None

Estimated Solution Time by Examinee: 3.0 – 4.0 minutes



Remarks: The objective of this question is to ensure that the examinee is able to analyze areas and volumes for design of footings

Solution:

Excavation Volume in Bank

$$= [(3+3+3.5+3.5)/4 \times 30 \times 10] + [(3.5+3.5+4+4)/4 \times 30 \times 8] = 1875 \text{ m}^3$$

Ans: A



Question #9:

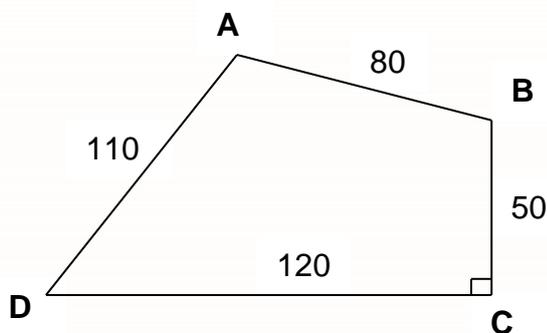
Topic Area: Surveying

Learning Level: Applying and Analyzing

Indicator:

CE-T9-04 Compare and compute cross-sectional areas

Question Statement:



Compute the most approximate area of the land parcel shown in the figure, the dimensions are in meters.

- A) 7325
- B) 7382
- C) 7398
- D) 8013

Answer:

B

Reference Sheet: Reference #9

Estimated Solution Time by Examinee: 3.0 – 4.0 minutes

Remarks: The objective of this question is to ensure that the examinee can determine area of any shape of land



Solution:

$$DB = [(50)^2 + (120)^2]^{0.5} = 130 \text{ m}$$

$$\text{Area of } \Delta BCD = 0.5 * 120 * 50 = 3000 \text{ m}^2$$

$$\text{Area of } \Delta ABD = [s(s-a)(s-b)(s-c)]^{0.5} \quad , \quad S = (110 + 80 + 130)/2 = 160 \text{ m}$$

$$\text{Area of } \Delta ABD = [160 (160 - 110)(160 - 80)(160 - 130)]^{0.5} = 4381.780 \text{ m}^2$$

$$\text{Total area} = 3000 + 4381.780 = 7381.780 \text{ m}^2$$

Ans: B



