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B. Sc. Engg. (CEE)/ 4th Sem. **27 May, 2024 (Group B).**

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

TERM	: FINAL EXAMINATION	SUMMER SEMESTER	: 2022-2023
COURSE NO	: CEE 4411	TIME	: 3 Hours
COURSE TITLE	: Engineering Materials and Concrete Technology	FULL MARKS	: 200

There are EIGHT questions. Answer SIX questions including Question 1 and Question No. 2. *<u>Question No. 1 and Question No. 2 are compulsory</u>*. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks. The Symbols have their usual meaning. CO, PO, and marks of each question are shown in the right side of each question.

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1 Concrete mix design is required for a bridge construction project based on the following data: CO3 PO3 (80)

Volume ratio of sand to total aggregate = 0.43
FM of fine aggregate = 2.6
FM of coarse aggregate = 6.6
Location of the Project : Gazipur
Specific gravity of cement = 2.96 (CEM Type II-B/M)
Specific gravity of sand (SSD) = 2.65
Specific gravity of coarse aggregate (SSD) = 2.80
Target/Required compressive strength (28 days) = 6000 psi
Minimum required slump = 175 mm
Maximum aggregate size = ¾ inch (20 mm), Aggregate type = Stone chips
Dosage of superplasticizer = 4 ml/kg of cement
Air content in concrete = 1.5%
(assume reasonable data, if necessary)

The following graphs are provided :

- Variation of compressive strength (28 days) with W/C (Fig. 1),
- Variation of cement content with compressive strength (28 days) for different aggregate size and slump value (Fig. 2).

(i) Prepare a mix design for the specified strength.
(ii) Prepare a mixture proportion table. Typical form of mixture proportion table is attached (Table 1).
(iii) Calculate the unit weight of concrete.
(iv) Calculate the volume ratio of the mix. Assume unit weights of cement, sand (SSD), and coarse aggregate (SSD) with void are 1400 kg/m^3, 1430 kg/m^3 and 1600 kg/m^3, respectively.
(v) Calculate the cost of concrete for one cubic meter. Assume the cost of 1 bag cement is Tk. 500, cost of 1 cft sand is Tk. 45, and cost of 1 cft stone chips is Tk. 250, cost of 1 liter admixture is 100 Tk, Cost of 200 liter water is Tk

20.

(vi) List the other costs those are to be considered to decide selling price of a cubic meter of concrete.

(vii) Calculate the compaction factor of the mix.

(viii) Determine the volume fractions that will be occupied by cement, water, sand, and coarse aggregate in one cubic meter of concrete. Make a brief discussion on the results.

(ix) What changes in the mix design are necessary, if it is decided to increase strength of concrete to 6500 psi?

(x) If the dust content of fine aggregate is increased, how it will influence the fresh and hardened properties of concrete?

(xi) If specific gravity of coarse aggregate at site is 2.70 instead of 2.80; calculate the amount of coarse aggregate necessary for making one cubic meter of concrete.

(xii) Is the proposed concrete is high strength concrete? Justify.

(xiii) If the trial mixes show that average strength of concrete is 5000 psi. What changes in mix design can be suggested?

(xiv) If the slump is found at 100 mm during a trial mix of the proposed mix, what changes are required in the mix design to get the minimum required slump?

(xv) Write the precautions that are necessary for concreting in a summer season.

(xvi) Write the steps that you will follow to do the mix design of concrete by ACI 211.

2 From a nearby market, aggregate samples (coarse and fine) were collected for a construction project. The sieve analysis data of the samples are summarized below: CO2 PO2 (20)

ASTM Sieve	Amount Retained (g)	
	Sand	Stone Chips
3 inch	0	0
1.5 inch	0	0
1.06 inch	0	0
¾ inch	0	0
½ inch	0	1100
3/8 inch	0	1400
#4	0	2000
#8	100	0
#12	100	0
#16	2	0
#30	2	0
#40	2	0
#50	79	0
#100	65	0
#200	50	400
Pan	100	100

(i) Calculate the FM of the samples.

(ii) Draw the grading curves of the samples in one graph paper (use the attached graph paper).

(iii) Comment on the samples based on the sieve analysis data and grading curves.

(iv) If the all materials of the coarse aggregate sample are retained on 3 inch sieve, what will be the FM of the sample?

(v) If all materials of the fine aggregate sample are passed through #100 sieve, what will be the FM of the sample?

Questions 3 to 8 are mapped with CO1 and PO1.

3 (a) Draw typical stress-strain curve of concrete. Explain the salient features of this curve. How do you determine the modulus of elasticity of concrete from this curve? Write the relationship between compressive strength and Young's modulus of concrete. (6)

(b) Compare creep and relaxation. (4)

(c) Define the following materials: (6)

- (i) Malleable material,
- (ii) Ductile materials, and
- (iii) Brittle materials.

(d) Explain the influence of the presence of salt in brick. (4)

(e) "Brick is not an environmentally friendly material" – Justify. (5)

4 (a) Compare flash setting and false setting of cement. How do you control flash setting and false setting of cement? (6)

(b) Write hydration reactions of cement. Explain morphology of hydration products of cement. (9)

(c) List the mineral admixtures that can be added with cement as per BDS EN 197-1-2001. (5)

(d) Explain the following types of cement: (5)

- (i) High early strength cement,
- (ii) Sulfate resisting cement, and
- (iii) White cement.

5 (a) Define workability of concrete. How do you measure workability of concrete? Explain some factors (at least five) related to workability of concrete. (10)

(b) Explain the characteristics of good quality sand. (5)

(c) Compare cold joint and construction joint in RC structures. Explain the possible locations for construction joints in a RC beam as per ACI 318-19. (5)

(d) Explain bleeding and segregation of concrete. (5)

6 (a) Discuss the following factors associated with the compressive strength of concrete: (5)

- (i) Fineness of cement,
- (ii) FM of sand,
- (iii) Shape of the coarse aggregate,
- (iv) Compaction, and
- (v) Curing.

(b) "Cylinder strength of concrete is less than the cube strength of concrete" – Why? (5)

(c) Write short notes on the followings: (10)

- (i) Self-compacting concrete,
- (ii) Ready mixed concrete,
- (iii) High strength concrete,
- (iv) Roller compacted concrete, and
- (v) Underwater concrete.

(d) Explain carbonation induced corrosion of steel in concrete with chemical reactions. (5)

7 (a) Explain the mechanism of bulking of sand. Also, explain the variation of bulking with the change in size of fine aggregate (coarse sand, medium sand, and fine sand). (6)

(b) Explain the mechanism of water reduction in concrete due to the use of chemical admixture. List the chemical admixtures listed in ASTM C494. (6)

(c) Discuss cathodic protection by discrete anode method and impressed current method. (5)

(d) "Cement is a hydraulic material but silica fume is a pozzonanic material" – Why? (4)

(e) Explain maturity of concrete. (4)

8 (a) Discuss the importance of seasoning of timber. (4)

(b) Write short notes on polar molecule and non-polar molecule and correlate these with hydrogen bond and Van Der Waal's force. (5)

(c) Explain the uses of rubber and plastics in the field of Civil Engineering. (5)

(d) Write short notes on hydrophilic material and hydrophobic material. (6)

(e) Calculate atomic radius and atomic packing factor for face centered plain cubic unit cell. (5)

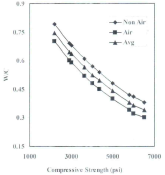

Fig. 1 W/C versus Compressive Strength (aggregate type = stone chips)

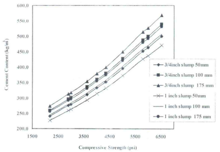

Fig. 2 Cement Content versus Compressive Strength (aggregate type = stone chips)

Table 1. Mixture Proportion of Concrete

W/C	s/a	Maximum Aggregate Size	Slump	Air Content	Unit Contents (kg/m3)				Super plasticize
%	%	mm	cm	%	C	W	FA	CA	ml/kg of cement

Table 2. Sieve Sizes

Traditional American and British Sieve Sizes

Aperture mm or μm	Approximate Imperial equivalent in.	Previous designation of nearest size	
		BS	ASTM
125 mm	5	—	5 in.
106 mm	4.24	4 in.	4.24 in.
90 mm	3.5	$3\frac{1}{2}$ in.	$3\frac{1}{2}$ in.
75 mm	3	3 in.	3 in.
63 mm	2.5	$2\frac{1}{2}$ in.	$2\frac{1}{2}$ in.
53 mm	2.12	2 in.	2.12
45 mm	1.75	$1\frac{3}{4}$ in.	$1\frac{3}{4}$ in.
37.5 mm	1.50	$1\frac{1}{2}$ in.	$1\frac{1}{2}$ in.
31.5 mm	1.25	$1\frac{1}{4}$ in.	$1\frac{1}{4}$ in.
26.5 mm	1.06	1 in.	1.06
22.4 mm	0.875	$\frac{7}{8}$ in.	$\frac{7}{8}$ in.
19.0 mm	0.750	$\frac{3}{4}$ in.	$\frac{3}{4}$ in.
16.0 mm	0.625	$\frac{5}{8}$ in.	$\frac{5}{8}$ in.
13.2 mm	0.530	$\frac{1}{2}$ in.	0.530 in.
11.2 mm	0.438	—	$\frac{7}{16}$ in.
9.5 mm	0.375	$\frac{3}{8}$ in.	$\frac{3}{8}$ in.
8.0 mm	0.312	$\frac{5}{16}$ in.	$\frac{5}{16}$ in.
6.7 mm	0.265	$\frac{1}{4}$ in.	0.265 in.
5.6 mm	0.223	—	No. $3\frac{1}{2}$
4.75 mm	0.187	$\frac{3}{16}$ in.	No. 4
4.00 mm	0.157	—	No. 5
3.35 mm	0.132	No. 5	No. 6
2.80 mm	0.111	No. 6	No. 7
2.36 mm	0.0937	No. 7	No. 8
2.00 mm	0.0787	No. 8	No. 10
1.70 mm	0.0661	No. 10	No. 12
1.40 mm	0.0555	No. 12	No. 14
1.18 mm	0.0469	No. 14	No. 16
1.00 mm	0.0394	No. 16	No. 18
850 μm	0.0331	No. 18	No. 20
710 μm	0.0278	No. 22	No. 25
600 μm	0.0234	No. 25	No. 30
500 μm	0.0197	No. 30	No. 35
425 μm	0.0165	No. 36	No. 40
355 μm	0.0139	No. 44	No. 45
300 μm	0.0117	No. 52	No. 50
250 μm	0.0098	No. 60	No. 60
212 μm	0.0083	No. 72	No. 70
180 μm	0.0070	No. 85	No. 80
150 μm	0.0059	No. 100	No. 100
125 μm	0.0049	No. 120	No. 120
106 μm	0.0041	No. 150	No. 140
90 μm	0.0035	No. 170	No. 170
75 μm	0.0029	No. 200	No. 200
63 μm	0.0025	No. 240	No. 230
53 μm	0.0021	No. 300	No. 270
45 μm	0.0017	No. 350	No. 325
38 μm	0.0015	—	No. 400
32 μm	0.0012	—	No. 450