University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2012
Program: B. Sc. Engineering (Civil)

Course Title: Engineering Materials | Course Code: CE 201
Time: 3 Hours | Full Marks: 150

There are EIGHT Questions. Answer **SIX QUESTIONS including Question No. 1 and Question No. 2. QUESTIONS 1 & 2 are COMPULSORY.**

1 Concrete mix design is required for mat foundation (thickness = 54 inch) of UAP City Campus project at Firmgate based on the following data: (40)

Volume ratio of sand to total aggregate = 0.40
Air Content = 1.5 % (air-entraining admixture is not used)
Specific gravity of cement = 2.95 (CEM Type II/B-M)
Specific gravity of sand (SSD) = 2.6
Specific gravity of coarse aggregate (SSD) = 2.65
Design compressive strength (28 days) = 4000 psi
Minimum required slump = 175 mm
Maximum aggregate size = ¾ inch, Aggregate type = Stone chips
Dosage of superplasticizer = 6 ml/kg of cement if W/C is less than 0.5.

The following graphs are provided :

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

Answer the following:

(i) Prepare a trial mix of concrete based on the given data,
(ii) Calculate the unit weight of the proposed trial mix,
(iii) Prepare a mixture proportion table of the proposed trial mix,
(iv) Calculate the compaction factor of the mix,
(v) Calculate the volume ratio of the mix. Assume unit weights of cement, sand (SSD), and coarse aggregate (SSD) with void are 1375 kg/m^3, 1350 kg/m^3 and 1350 kg/m^3, respectively,
(vi) Calculate unit cost of concrete based on the current unit rates of materials,
(vii) Estimate the materials in weight and volume (cement, water, sand, and coarse aggregate) required to make a segment of the mat of 100 ft long and 100 ft wide,
(viii) Assume 2% surplus water in sand over SSD condition and the amount of bulking of sand is 15%. Make proper adjustment of the proposed mix,
(ix) Compare the absolute volume of the ingredients in the mix and make comments, and
(x) Compare the weight of the ingredients in the mix and make comments.

2 For a bridge construction project, the recommended FMs are 2.6 for sand and 6.6 for stone chips. From a nearby market, sand and stone chips samples were collected and sent to the Concrete Laboratory of University of Asia Pacific (UAP) for sieve analysis. The sieve analysis data are given below: (22)

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
1/2 inch	0	4000
3/8 inch	0	500
#4	0	450
#8	140	0
#12	70	0
#16	70	0
#30	70	0
#40	5	0
#50	5	0
#100	5	0
#200	40	0
Pan	45	50

Answer the following:

(i) Calculate FM of the samples (sand and stone chips),

(ii) Draw grading curves of the samples,

(iii) Discuss the possible ways to improve the FM of the samples to the recommended values,

(iv) Comment on the samples based on the sieve analysis data and grading curves, and

(v) From other source, another sand sample was collected and FM was found to be 2.2. In what proportions, the sand samples are to be mixed to achieve the required FM of sand?

Sieve openings for different sieves are provided (refer to the attached table).

3 (a) Draw typical stress-strain curves of concrete with the change of compressive strength. Explain the remarkable changes in mechanical properties of concrete with the change of compressive strength. (2.5)

(b) Define initial tangent modulus, secant modulus, and tangent modulus. How do you determine Young's modulus from a stress-strain curve of concrete? (2.5)

(c) Define the following mechanical properties of a material: (3)

(i) Toughness,

(ii) Ductility, and

(iii) Fatigue strength.

(d) Write a short note on the worldwide consumption of concrete and its ingredients. How are concrete industries polluting our environment? (3)

(e) Why is drying of raw brick necessary before burning? What is the preferable (3)

moisture content in raw brick before burning?

(f) What is a pug mill? How do you check the consistency of brick earth before moulding? (3)

(g) Write the functions of frog mark on brick. (2)

(h) What is efflorescence? Explain the effect of efflorescence of bricks on the quality of construction works. (3)

4 (a) Draw a flow diagram of manufacturing of cement in an integrated plant. Discuss the process of grinding clinker in a ball mill (based on your experience on a visit to Seven Rings Cement factory at Gazipur). (5)

(b) What do you mean by hydration of cement? Write the hydration reactions of cement and discuss the morphology of the hydration product. (4)

(c) Compare fly ash cement and OPC with respect to the following: (5)

(i) Heat of hydration,
(ii) Early strength,
(iii) Long-term strength,
(iv) Workability of fresh concrete, and
(v) Microstructure of hardened concrete.

(d) Discuss the effect of fineness of cement on the following: (3)

i) Compressive strength of concrete at the early age,
ii) Compressive strength of concrete after a long term,
iii) Heat of hydration of cement,
iv) Micro cracking in concrete,
v) Durability of concrete, and
vi) Cost of cement.

(e) Mention the common type of cements that are used in Bangladesh with their composition. (3)

(f) Compare initial setting time and final setting time of cement. (2)

5 (a) Discuss sulfate attack of concrete with chemical reactions. Write the possible measures that you can suggest against sulfate attack of concrete. (5)

(b) What are the main causes of early deterioration of concrete structures in Bangladesh? (5)

(c) Define workability of concrete. How is it measured? Discuss the effect of the following factors on workability of concrete: (4)

i) Shape of the aggregate,
ii) Cement content,
iii) W/C, and
iv) Fineness modulus of sand.

(d) Discuss the effect of W/C ratio on compressive strength, permeability, and durability of concrete. (4)

(e) Compare entrained air and entrapped air in concrete. What is the purpose of using air entraining admixture in concrete? Is it necessary to use air entraining admixture in Bangladesh for general construction works? (4)

6 (a) Discuss the influence of the following factors on compressive strength of concrete: (5)

(i) Sand to aggregate volume ratio,
(ii) Size of coarse aggregate,
(iii) Shape of coarse aggregate,
(iv) Compaction, and

(v) Curing.

(b) "Cube strength of concrete is higher than the cylinder strength of concrete" – Why? (2)

(c) Write short notes on the following: (6)
(i) High performance concrete,
(ii) Ferrocement,
(iii) Maturity of concrete,
(iv) Setting and hardening of cement,
(v) Normal consistency of cement, and
(vi) FRP.

(d) Write short notes on the following: (5)
(i) Alkali silica reaction,
(ii) Workability of concrete,
(iii) Chloride threshold level,
(iv) Segregation, and
(v) Plastic shrinkage.

(e) Discuss the possible measures against concrete construction works in a hot environment. (2)

(f) "High strength concrete is susceptible to autogeneous shrinkage" – Why? What measures are to be taken against it? (2)

7 (a) What is carbonation of concrete? Discuss with chemical reaction. How does carbonation cause corrosion of steel bar inside concrete? (3)

(b) Discuss corrosion of steel in concrete with anodic and cathodic reactions. (5)

(c) What is cathodic protection? Compare cathodic protection applied by impressed current system and discrete anode system. (3)

(d) Write short notes on the following: (6)
i) Formation of annual rings of a tree,
ii) Use of plastics in Civil Engineering works,
iii) Crystal structure and amorphous structure, and
~~iv) Maturity of concrete.~~

(e) "Fly ash shows pozzonanic activity but slag shows hydraulic activity" – Why? (2)

(f) Discuss the empirical relationships for the following: (3)
i) Compressive strength and tensile strength of concrete, and
ii) Compressive strength and Young's modulus of concrete.

8 (a) Explain three different defects of timber. (3)

(b) Explain three industrial forms of timber. (3)

(c) What are the objectives of seasoning of timber? (2)

(d) Write short notes on the following: (9)
(i) Use of rubber in Civil Engineering works,
(ii) Atomic packing factor for the face centered cubic unit cell,
(iii) Ingredients of paints,
(iv) Metallic coating,
(v) Vulcanization, and
(vi) Hexagonal close packed unit cell.

(e) What is bulking of sand? Explain briefly. (2)

(f) Draw stress-strain curves for rubber, copper, and steel and explain their behavior. (3)

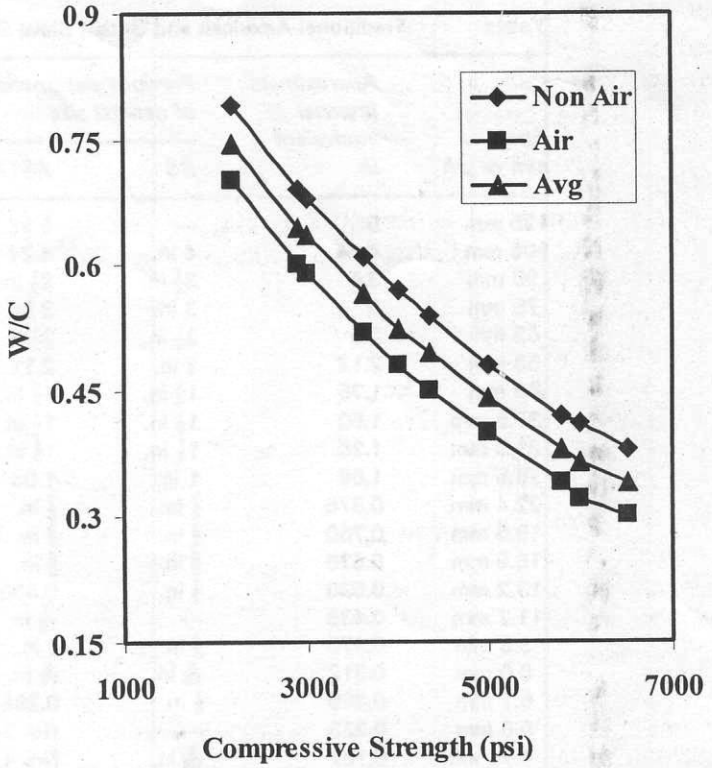

Fig. W/C versus Compressive Strength (aggregate type = stone chips)

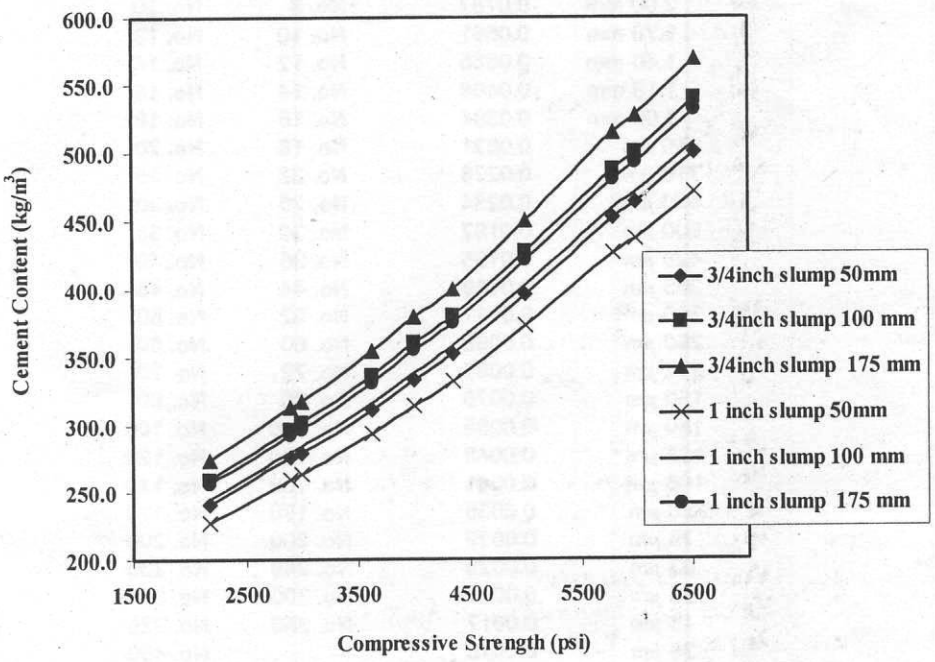

Fig. Cement Content versus Compressive Strength (aggregate type = stone chips)

Table 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