University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 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 columns of UAP City Campus project at Firmgate based on the following data: (40)

Volume ratio of sand to total aggregate = 0.37
Air Content = 1.5 % (air-entraining admixture is not used)
Specific gravity of cement = 3.1 (OPC cement)
Specific gravity of sand (SSD) = 2.65
Specific gravity of coarse aggregate (SSD) = 2.65
Design compressive strength (28 days) = 5000 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 1400 kg/m^3, 1450 kg/m^3 and 1400 kg/m^3, respectively,
(vi) Calculate cost of concrete per cubic meter 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 five columns of ground floor. Height of the ground floor is 12 feet and section of column is 30 inch by 30 inch.
(viii) Assume 5% surplus water in sand over SSD condition and the amount of bulking of sand is 20%. Make proper adjustments in mixture proportions.
(ix) If it is necessary to make another mixture proportion of concrete of compressive strength 4000 psi, what possible changes are necessary in the mixture proportions of concrete?

(x) If it is necessary to make another mixture proportion of concrete of compressive strength 6000 psi, what possible changes are necessary in the mixture proportions of concrete?

2 For a culvert 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	1000
3/8 inch	0	1000
#4	0	2000
#8	0	950
#12	50	0
#16	70	0
#30	70	0
#40	70	0
#50	70	0
#100	5	0
#200	70	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 3.2. 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 steel for different grades (lower to higher). Explain the changes in mechanical properties of steel with the change of grades. (2.5)

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

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

(i) Malleability,
(ii) Creep and
(iii) Fatigue strength.

(d) Write a short note on worldwide cement consumption of cement with its influence to the global environment. (3)

(e) Write down the main field tests of bricks. (3)

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

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

(h) Discuss the functions of lime, silica, and alumina in brick earth. (3)

4 (a) Draw the flow diagram of cement manufacturing process. Also, draw a schematic diagram of rotary kiln (used for cement manufacturing) and discuss the physical and chemical changes that happen in the different zones of the kiln. (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 blended 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) Write short notes on rapid hardening cement, slow setting cement and sulfate resisting cement. (5)

(e) Define normal consistency, initial setting time, and final setting time of cement and also write their standard values as per ASTM. (3)

5 (a) Discuss seawater attack (due to carbonation, chloride, and sulfate) of concrete with chemical reactions. (8)

(b) What is the significance of concrete cover in reinforced concrete structural members? "More cover concrete is necessary for structural members in contact with ground or water" – Why? (3)

(c) Define workability of concrete. How is it measured? Discuss the effect of the following factors on workability of concrete: (3)

i) Cement content,
ii) W/C ratio and
iii) 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 are the purposes of using air entraining admixture in concrete? "It is not necessary to use air entraining admixture in Bangladesh for general construction works" - Why? (4)

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

(i) FM of sand,
(ii) Ambient temperature,
(iii) Grading of 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) Self compacting concrete,
   (ii) Porous concrete,
   (iii) Maturity of concrete,
   (iv) Setting and hardening of cement,
   (v) Fineness of cement and
   (vi) Soundness of cement.

(d) Write short notes on the following: (5)
   (i) Alkali silica reaction (ASR),
   (ii) Laitance,
   (iii) Honeycomb,
   (iv) Segregation and
   (v) Bleeding.

(e) Discuss the possible measures that are to be carefully considered for casting concrete in a cold environment. (2)

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

7 (a) "The steel bars in concrete are protected from corrosion" – How? Explain the process of initiation of corrosion of steel in concrete due to carbonation and chloride. (3)

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

(c) Write the possible measures to stop early corrosion of steel bars in concrete in marine environment. (3)

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

(e) "Fly ash shows pozzolanic activity but OPC 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) Write the objectives of seasoning timber. (3)

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

(c) Discuss the functions of each ingredient of paint. (2)

(d) Write short notes on the following: (9)
   (i) Use of plastic in Civil Engineering works,
   (ii) Atomic packing factor for the body centered cubic unit cell,
   (iii) Ingredients of varnish,
   (iv) Electroplating,
   (v) Vulcanization and
   (vi) Atomic radius of face centered cubic unit cell.

(e) What is bulking of sand? Compare bulking of fine sand, medium sand, and coarse sand. (2)

(f) Write short notes on cold joint and construction joint. (3)

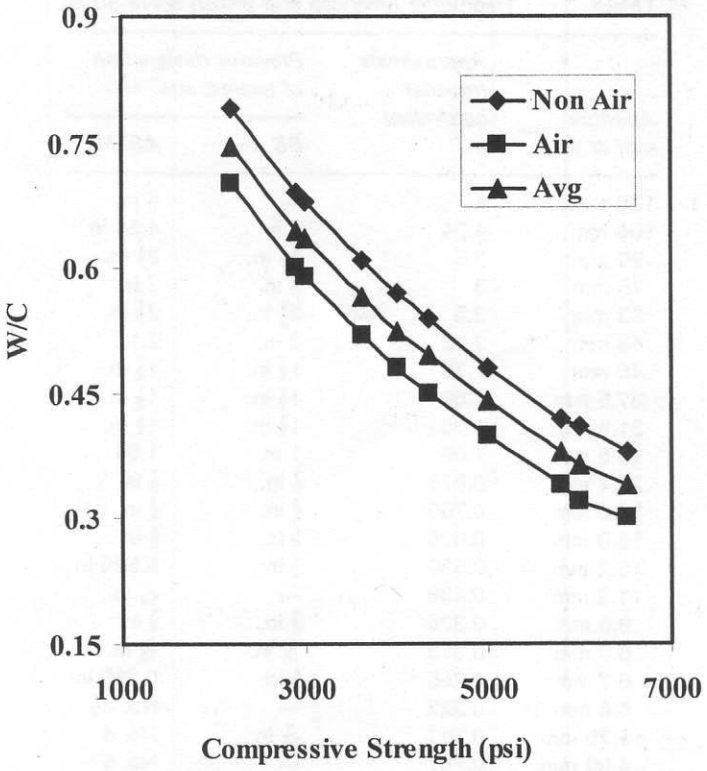

Fig. W/C versus Compressive Strength (aggregate type = stone chips)

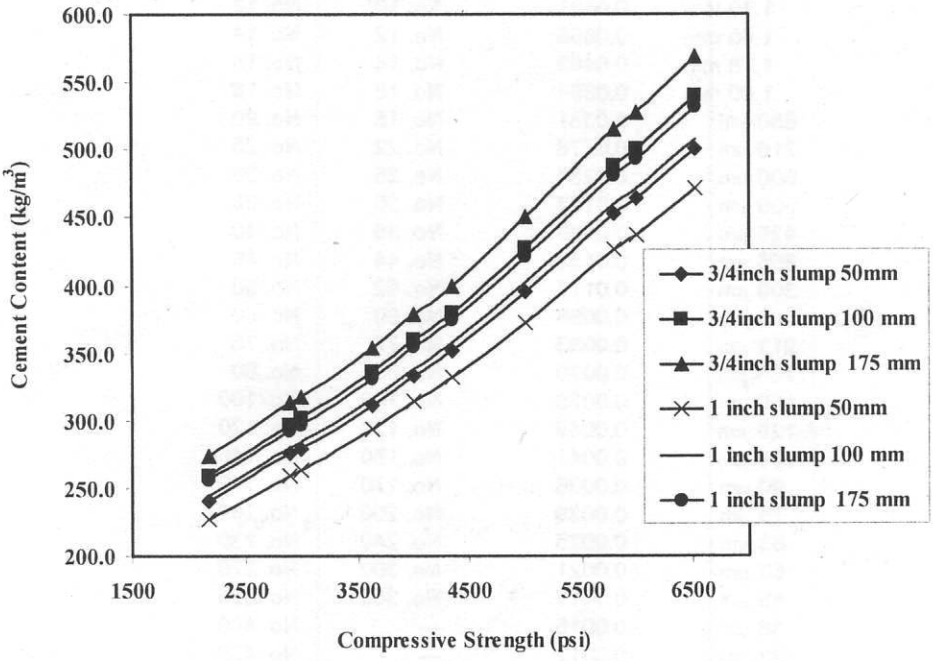

Fig. Cement Content versus Compressive Strength (aggregate type = stone chips)

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