University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2019
Program: MSc in Civil Engineering (MSc/M.Eng)

Course Title: Advanced Design of Concrete Structures — Course Code: CE 6108
Time: 3 hours — Credit Hour: 3.00 — Full Marks: 150

Assume reasonable values for any missing data. Symbols used have their usual meanings.
[Use $f_c' = 30\ N/mm^2$ and $f_y = 420\ N/mm^2$ for all design]

QUESTION 1 [30 MARKS]

The typical floor plan of 9 storeyed residential building is shown in **Figure 1**. The slabs of the floor are supported by beams (300 mm x 750 mm). The **corner slab panel (A)** as shown in **Figure 1** has to be designed. The slab is subjected to 2.5 kN/m^2 dead load due to random wall and finishes (excluding self weight of slab) and 2 kN/m^2 live load. The thickness of slab could be assumed as 175 mm.

a. Justify whether **strip method** would be more economical analysis method as compared to conventional co-efficient method through analysis of short span of slab panel A. [15]

b. Design the **short span** of slab **panel A** both for positive and negative moments obtained based on strip method analysis. [15]

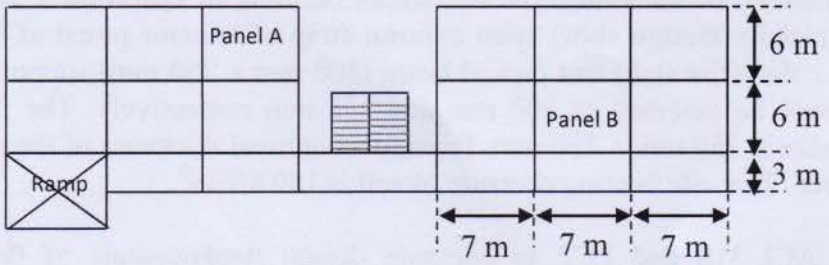

Figure 1(a). Floor slab plan

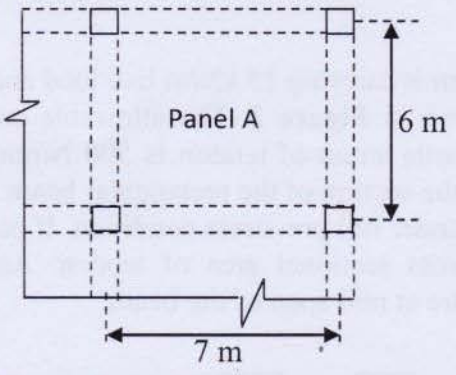

Figure 1(b). Details of corner slab

Table 1: Moment coefficients of corner slab (short span)

Span Ratio	Positive Moment		Negative Moment
	Live load	Dead Load	
0.85	0.043	0.036	0.066

QUESTION 2 [30 MARKS]

The first floor slab (ground floor roof slab) of the building of **Question 1** is constructed with waffle slab. The dead load of the slab due to random wall (excluding self-weight) is 2.5 kN/m^2. Design the long span of slab **panel "B" (slab and rib)** of the floor as shown in **Figure 1**. Check for punching shear and show reinforcement details of slab and rib. Assume square grid of ribs with 600 mm x 600 mm spacing. The co-efficient are shown in Table 2 and 3 could be used to analyze the slab. The column size could be assumed as 750 mm x 750 mm. [30]

Table 2: Distribution of total factored static moment (M_0) for flat slab of interior span

Factored Moment (slab without edge beam)	
Negative	Positive
0.65	0.35

Table 3: Moment coefficients of interior slab

Span Ratio	Positive Moment		Negative Moment
	Live load	Dead Load	
1	0.027	0.018	0.045

QUESTION 3 [30 MARKS]

a. The foundation of the 9-storeyed residential building of **Question 1** has to be constructed with mat foundation. **Design short span column strip of interior panel of the mat.** The thickness of first floor slab (flat slab) and typical beam (300 mm x 750 mm) supported floor slab (2nd to roof floor) could be assumed as 200 mm and 175 mm respectively. The floor height is 3.3 m and column size is 750 mm x 750 mm. Provide an optimal thickness of the mat considering punching shear force. The safe bearing pressure of soil is 180 kN/m^2. [20]

b. Review ACI 318 and EC2 to compare design fundamentals of flexural members through developing design equations of reinforced concrete beam for flexure. [10]

QUESTION 4 [30 MARKS]

a. The post-tensioned pre-stress girder of 10 meter span is carrying 15 kN/m live load and 30 kN/m dead load (including self-weight of beam) as shown in **Figure 2**. The allowable compressive stress of concrete is 22.5 N/mm^2 (0.45 f_c') and tensile stress of tendon is 500 N/mm^2. **Justify** through **preliminary design** of the beam, whether the section of the rectangular beam 250 mm x 600 mm would be adequate for mid-span moment under full pre-stress condition. If not, propose optimal dimension of the beam with required cross sectional area of tendon. Assume, the eccentricity of the tendon is 200 mm below the centre at mid span of the beam. [15]

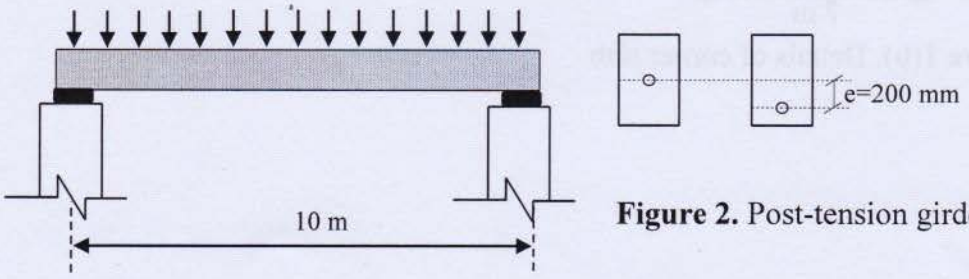

Figure 2. Post-tension girder

b. The cantilever stair of residential building as shown in **Figure 3** has been supported by beam "FB1". The stair would cause 240 kN.m torsion on the beam (FB1) and thus, the design torsion of the beam would be 120 kN.m. The cross section of 8 m long main beam (FB1) could be assumed as 250 mm x 750 mm. Design the beam for torsion only. Assume required data for design the beam. [15]

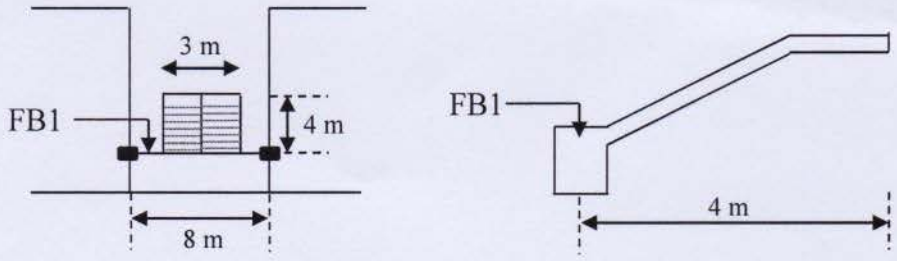

Figure 3. Cantilever stair

QUESTION 5 [30 MARKS]

a. The beam "DB" on ramp as shown in **Figure 4** has to support the **column C1**. The column is located a centre of the beam. The design load of column C1 is 1500 kN. Assume the column size is 400 mm x 400 mm. **Design** the beam **"DB"** as deep beam and show reinforcement details. [15]

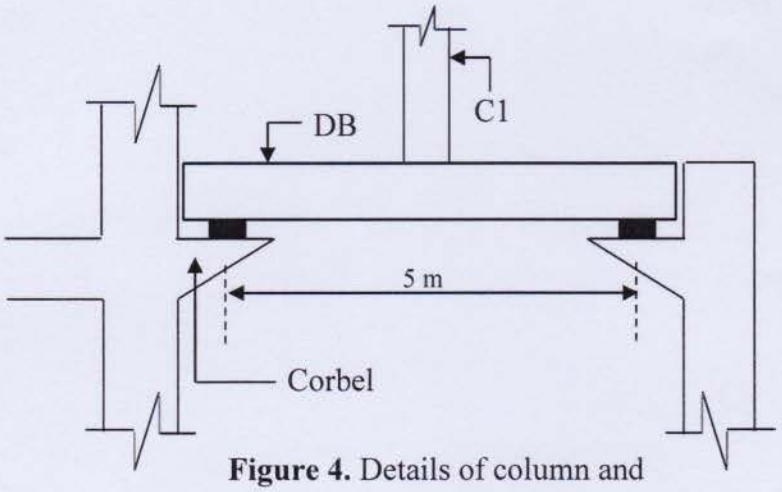

Figure 4. Details of column and beam on ramp

b. Design the corbel of **Question 5(a)** as shown in **Figure 4** for flexural reinforcement only. The dimension of corbel should be as per specifications of design code. [15]

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2019
Program: Master in Civil Engineering

Course title: Natural Hazards and Disaster Management | Course code: CE 6006
Time: 3 hours | Full marks: 100

Answer all questions.

1. Explain the targets and guiding principles of the Sendai Framework for Disaster Risk Reduction: 2015-2030. 15

2. a) Explain the difference between the magnitude and intensity of an earthquake hazard. 5
   b) Outline the *Modified Mercalli Intensity Scale* for measuring the severity of an earthquake hazard. 10

3. Do you agree that international water cooperation is necessary to increase coping capacity and reduce vulnerability against flood related hazards in Bangladesh? Justify your answer with data and fact based analysis. 15

4. Do you think that drought hazard in Bangladesh turns into a man-made disaster due to excessive ground water withdrawal? Justify your answer with data and fact based analysis. 15

5. a) Explain the climate change action plan adopted by the *2009 Climate Change Strategy and Action Plan* of Bangladesh. 10
   OR
   b) Evaluate how the use of alternative energy sources instead of fossil fuel source can help increasing resilience against global warming related hazards.

6. a) Summarize different steps of assessment and mitigation of landslide hazards. 10
   OR
   b) Summarize the *policy process model* of emergency management.

7. a) Summarize different components of disaster relief or disaster aid. 10
   OR
   b) Explain your understanding about "disaster diplomacy".

8. a) Summarize ten ecological and social consequences of desertification hazards. 10

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2019
Program: M.Sc. Engineering (Civil)

Course Title: Fecal Sludge Management (FSM) Course Code: CE 6315
Time: 3 hours Full Marks: 100

Answer the following questions:
(Assume reasonable value for missing data, if any)

1 (a) Explain the variability of fecal sludge characteristics with respect to following operational factors – (i) sludge storage duration, (ii) liquid infiltration, and (iii) sludge collection method. **[10]**

(b) A FS treatment plant is to treat an estimated 350 m^3 of septage per week. The septage has an average solids content of 1%. A thickening tank will be used to produce a solid content of 5% (50 g TS/L). The sludge will then be treated on unplanted drying beds to achieve at least 20% solids content in 9 days. The treatment plant will be actively operated 5 days/week. **[20]**

Design the treatment plant employing unplanted drying beds with key design parameters given below:

Parameter	*Symbol*	*Value*	*Units*
Hydraulic loading on drying beds	V_s	10	m^3/day
Mean TSS conc in separated sludge	C_{TSS}	50	g TS/L (or Kg TS/m^3)
Hydraulic loading depth, maximum	Z	200	mm
Dewatering time	t_d	9	days
Operating frequency per week	f_{op}	5	Days/week

2. (a) What are the key treatment mechanisms in planted drying beds employed for fecal sludge treatment? Explain them briefly. What important roles are played by the macrophytes (plants) in treating fecal sludge in planted drying beds? **[15]**

(b) A municipal authority in Bangladesh would like to establish a fecal sludge treatment plant (FSTP) employing planted drying beds and is in the process of securing land for the plant. Determine the total area and the number of beds required specifically for the planted sludge drying beds only. **[15]**

The following data and sludge characteristics can be used.
Estimated annual fecal sludge emptied: 10,000 m^3/year
Average total solids (TS) content of raw FS: 30,000 mg/L (or 30 kg TS/m^3)
Consider the TS loading rate: 200 kg TS/ m^2/ year

3. What are the immediate challenges for implementing FSM in Bangladesh? How these challenges could be addressed? Why Institutional and Regulatory Framework (IRF) for implementing FSM in Bangladesh has been formulated? **[15]**

4. Using neat sketches, briefly explain the operating principles of the following fecal sludge treatment technologies: **[25]**

a) Anaerobic Baffled Reactor (ABR)
b) Unplanted Drying Bed
c) Co-composting of Fecal Sludge and Organic Solid Waste
d) LaDePa Sludge Pelletizer
e) Janicki Omni Processor

OR

5. Partially stabilized fecal sludge (FS) is being collected mostly from septic tanks to Settling-thickening tank for solids-liquid separation. The followings are the results from field studies on the performance of Settling-thickening tanks: **[25]**

Initial raw FS concentration:	$C_{i(SS)}$ = 5 g SS/L
Concentration of thickened sludge:	C_t = 80 g SS/L (to be achieved)
Expected settling efficiency:	e = 80% of SS
Influent flow:	Q = 140 m^3/day
FS treatment plant opening time:	7 hr/day; 5 days/week; 52 weeks/year
Daily peak flow co-efficient:	C_p = 1.6
Final settling velocity based on SVI tests:	V_c = 0.5 m/hour
A loading period of one week:	N = 5 = number of TP opening days/week

Determine the settling-thickening tank surface area, S, and the volume of the thickened sludge storage zone, V_t (see equations in the next page). Approximately configure the settling-thickening tank with appropriate length-width ratio which may tentatively vary between 1:10 to 1:5, and also showing four different layers that develop in the settling-thickening tank.

$$S = \frac{Q_p}{V_u}$$

Where:
S = surface of the tank (m^2)
Q_p = influent peak flow (m^3/h)
V_u = upflow velocity (m/h)
$Q_p = Q \cdot C_p/h$,

Where:
Q = mean daily influent flow
C_p = peak coefficient
h = number of operating hours of the treatment plant

$$V_t = \frac{Q \cdot C_i \cdot e \cdot N}{C_t}$$

Where:
V_t = volume of thickened sludge storage zone (m^3)
Q = mean FS daily inlet flow (m^3/day).
C_i = suspended solids mean concentration of FS load (g/L)
e = expected settling efficiency (= proportion of suspended solids separated, as %)
N = duration of the FS load for one cycle in days
C_t = suspended solids mean concentration of thickened sludge after the loading period (g/L)

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2019
Program: Master of Civil Engineering (MCE)

Course Title: Advanced Concrete Technology | Course Code: CE 6201
Time: 3 hours | Credit Hour: 3.00 | Full Marks: 150

Answer all questions

QUESTION 1 [35 MARKS]

Reinforced concrete (RC) tunnel will be constructed under the river. Since the RC tunnel will be exposed to water, a better mechanical and durability performance of concrete is needed to build the tunnel. To ensure the mechanical and durability performances of the concrete, three types of cement (C1, C2 and C3) have been chosen, and chemical compositions of cements were determined by X-ray fluorescence. The chemical constituent of cements (C1, C2 and C3) are given in Table 1.

Table 1: Chemical constituent of cements (C1, C2 and C3)

Bulk Oxide Content	CaO	SiO_2	Al_2O_3	Fe_2O_3	MgO	SO_3	K_2O	Na_2O	LOI
C1	58	21	9	4	3	1	1	0.6	2
C2	48	8.5	15	3.1	1.1	2.5	0.9	1.1	2.3
C3	66	21	6	2.5	1.4	2	0.3	0.9	3

(i) Calculate the silica modulus, alumina modulus and hydraulic modulus of three types of cement (C1, C2 and C3) that have been chosen for RC tunnel construction. **[9]**

(ii) Using Bogue's equation, calculate the major chemical compounds of three types of cement (C1, C2 and C3). If these three types of cement are used to make RC tunnel, explain the expected performance of concrete mixes made with those three types of cement regarding the following: (a) thermal stress and strain due to temperature increase in concrete, (b) mechanical strength and (c) corrosion of concretes. **[18]**

(iii) Based on the silica modulus, alumina modulus, hydraulic modulus and Bogue analysis, propose a suitable cement for the RC tunnel construction and justify your selection with proper comments. **[8]**

QUESTION 2 [16 MARKS]

"Incorporation of supplementary cementitious material (e.g., fly ash) in Ordinary Portland Cement decreases the amount of Calcium Hydroxide [$Ca(OH)_2$], and enhance the mechanical and durability performances of concrete". Justify the statement with chemical reactions, figures, and proper comments.

Or

"The purpose of air entrainment in concrete is to protect concrete from cracks due to freezing and thawing cycles". Explain the statement using the schematic diagram, proper mechanism and comments.

QUESTION 3 [17 MARKS]

"The workability depends on numerous factors, no single test is thought to be sufficient to express this property of fresh concrete". If the statement is true, then write the list of test methods required to be carried out. Explain one of the test procedure to investigate the workability of fresh concrete, and also write the advantages and disadvantages of this method.

QUESTION 4 [25 MARKS]

Micro concrete has recently gained popularity in Bangladesh due to better mechanical and durability performances which reduction of the dead load and ensures the longer service life of the structure. Within this context, 10 reinforced concrete (RC) slabs will be constructed for the domestic airport in Dhaka.

The following necessary data are provided for the mix design of micro concrete:
Target compressive strength = 150 MPa
Specific gravity of Portland composite cement = 3.10
Specific gravity of fine aggregate (SSD) = 2.8
Specific gravity of water = 1.0
Water to cement ratio (weight basis) = 0.20
Fine aggregate to cement ratio (weight basis) = 1.2
Air content = 1% (air-entraining admixture is not used)
Maximum slump = 120 mm
Maximum size of aggregate = 4.5 mm

Since micro concrete does not contain coarse aggregate (maximum size of aggregate: 4.5 mm), concrete can be considered as mortar for the calculation. Consider weight basis mix design for the calculation. Superplasticizer as chemical admixture is used which is not considered during the calculation. Determine the following:

(i) Estimate the amount of each ingredient (cement, aggregate and water) of micro concrete necessary for the 10 RC slabs (8.0 m x 3.5 m x 0.25 m), 18 beams (size: length = 2.0 m, width = 0.32 m and height = 0.6 m), and 20 cylinders (size: diameter = 100 mm and height = 200 mm) for compressive and tensile strength tests. Assume 30% extra volume is necessary due to total loss of concrete during casting. **[17]**

(ii) To enhance the ductility and fatigue behavior of micro concrete, steel fiber is added at 2% of total concrete volume. Calculate the total amount of steel fibers is required for casting all slabs, beams and cylinders. Assume the density of steel fiber is equal to the density of steel. **[3]**

(iii) To ensure better mechanical and durability of micro concrete, 2.36 mm, 1.7 mm, 0.6 mm and 0.3 mm size of aggregates are used 10%, 20%, 30% and 40%, respectively. Estimate the amount of each size of aggregate for casting all the slabs, beams and cylinders. **[5]**

QUESTION 5 [16 MARKS]

Using the schematic diagram, explain the mechanism of the alkali-aggregate reaction and its impact on the mechanical and durability performances of concrete.

Or

Describe the deterioration of concrete due to carbonation with chemical reactions, and explain the measurement technique of the carbonation depth of concrete.

QUESTION 6 [16 MARKS]

Draw the schematic diagram of the concrete thermometer and show different parts of it. Explain the effect of elevated temperature on the chemical and physical processes of concrete.

Or

Discuss briefly the rebound hammer test to carry out a Non-Destructive Test on the concrete structure. Explain what are the factors that affect the rebound number during assessing the compressive strength of concrete via rebound hammer test.

QUESTION 7 [25 MARKS]

The reinforced concrete (RC) retaining wall will be constructed to hold back earth as shown in Figure 1. The following necessary data are provided for the RC retaining wall to calculate the pressure on formwork induced by fresh concrete.

Given data:
Concrete type: OPC with a retarder
Density of concrete = 2550 kg/m^3
Concrete temperature at placement = 20 °C
Uniform volume supply rate = One 6 m^3 truck every 20 min
Length of retaining wall = 20 m

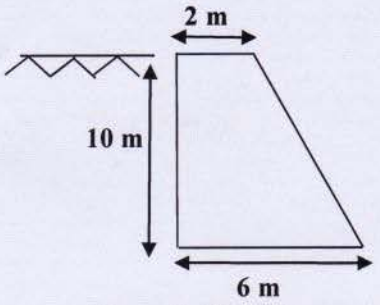

Figure 1: Retaining wall

Table 2: Values of coefficients C1 and C2

Walls: C1 = 1.0	
Columns: C1 = 1.5	
Concrete:	**Value of C2**
Ordinary Portland Cement (OPC) without admixture	0.3
OPC with any admixture, except a retarder	0.3
OPC with a retarder	0.45
Blended cement containing less than 70% slag without admixture	0.45
Blended cement containing less than 70% slag with any admixture, except a retarder	0.45
Blended cement containing less than 70% slag with a retarder	0.6
Blended cement containing more than 70% slag	0.6

(i) Calculate the lateral pressure of fresh concrete at every 2.0 m height of the RC retaining wall. **[15]**

(ii) Draw the pressure envelope for formwork design. **[5]**

(iii) Explain how cement types and temperature of fresh concrete affect concrete pressure on formwork. **[5]**

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2019
Program: Master in Civil Engineering

Course title: Natural Hazards and Disaster Management | Course code: CE 6006
Time: 3 hours | Full marks: 100

Answer all questions.

1. Explain the targets and guiding principles of the Sendai Framework for Disaster Risk Reduction: 2015-2030. 15

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