University of Asia Pacific
Department of Civil Engineering
Final Examination – Spring 2024
Program: M.Sc. Engineering (Civil)

Course Title: Groundwater Hydraulics | Course Code: CE 6606
Time: 2 hours | Credit Hour: 3:00 | Full Marks: 50

There are five (5) questions. Answer All questions.

1 Briefly explain the different mechanisms where surface water becomes groundwater and vice versa. (10)

2 (a) Draw 'Retention Curve' and explain the phenomena behind 'hysteresis'. (6)
(b) Write short notes on (1) wettability, (2) contact angle. (4)

3 (a) What are the different saturation stages? Explain with figures. (5)
(b) What are the damages caused by the land subsidence. (5)

4 (a) Derive Ghyben-Herzberg relation between fresh and saline water. (5)
(b) Write down the methods of controlling saline water intrusion in the aquifer and the factors on which the different methods depend on. (5)

5 (a) What are the various sources of saline water? (4)
(b) The following figure shows a flow net under a concrete dam. Calculate the discharge for the homogeneous isotropic foundation whose k = 10^{-4}m/s. (6)

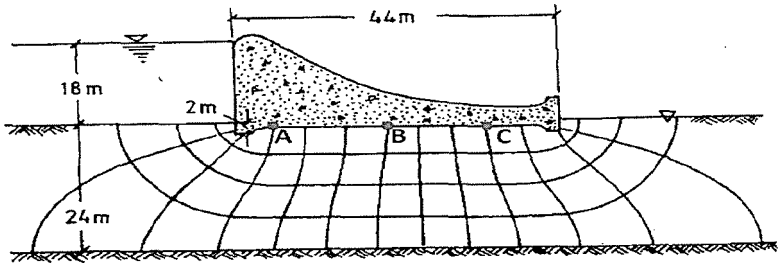

Figure : Flow net under a concrete dam

University of Asia Pacific
Department of Civil Engineering
Final Examination, Spring 2024
Program: M.Sc. in Civil Engineering

Course Title: Repair and strengthening of concrete structures — Course Code: CE 6204
Time: 3 hours — Credit Hour: 3.00 — Full Marks: 100

QUESTION 1 [20 MARKS]

a. Propose suitable material and method to retrofit offshore (marine) structure, justify your selection through comparative study of existing materials and methods. [10 Marks]
b. Explain debonding mechanisms of externally bonded method for flexural and shear strengthening of RC beam. [10 Marks]

QUESTION 2 [20 MARKS]

A six storeyed apartment building as shown in **Figure 1** has been planned to change as warehouse (live load 6 kN/m^2) of a garment through retrofitting of structure. The slabs of the floor are supported by beams (300 mm x 600 mm). Thickness of existing slab is **150** mm, reinforced with 10 mm @ 175 mm c/c at bottom (mid span) and10 mm @ 150 mm c/c at top (support) in both directions.

a. Evaluate and justify whether the slab **panel S1 (only for maximum support moment)** needs to be retrofitted / strengthened to be used as warehouse. Assume required data for analysis, strength of steel is 275 MPa and concrete is 18 MPa. Coefficient of moments as shown in **appendix** could be used to obtain design moments for increased floor load. [10 Marks]

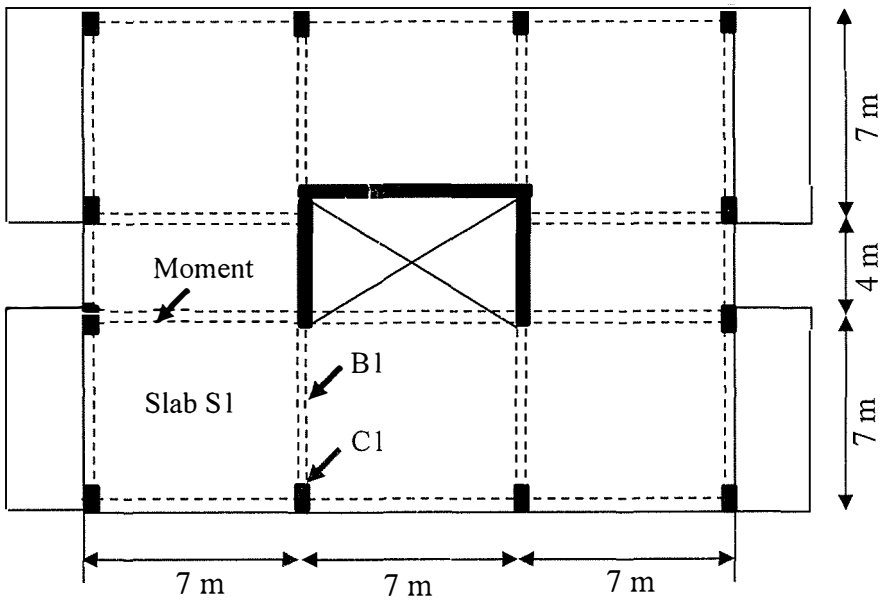

Figure 1. Floor plan of 6 storeyed building

b. Design the slab **panel S1 (maximum support moment only)** for flexural strengthening (retrofitting) using externally bonded steel plate. Assume required data to design the slab. [10 Marks]

QUESTION 3 [20 MARKS]

The **beam "B1"** of slab (shown in **Figure 1**) is flexural reinforced with 3-20 mm at bottom (mid-span) and 4-20 mm at top (support) and shear reinforced with 10mm @ 150 mm c/c (two leg). Size of the beam is 300 mm x 600 mm. Because of the increased load of warehouse, the design **moment at mid-span** of the beam is 450 kN.m and design **shear** near the support is 400 kN.

a. Evaluate, whether the beam is required to be retrofitted for **flexure (mid-span)** and **shear** due to increased actions. Assume required data for analysis, strength of steel is 420 MPa and concrete is 20 MPa. [10 Marks]
b. Design the beam for maximum mid-span moment and shear using externally bonded CFRP laminate. Assume required data to design the beam. [10 Marks]

QUESTION 4 [20 MARKS]

The ground floor **column C1** of the retrofit project of **Question 2** as shown in **Figure 1** is reinforced with 8-16 mm main bar. Size of the column is 375 mm x 375 mm. Strength of steel is 420 MPa and concrete is 20 MPa. Apply approximate method (area method) to obtain the design load of the column. Design the column for increased **axial load** using conventional **section enlargement** method.

QUESTION 5 [20 MARKS]

The ground floor **column C1** the project **(Question 2 and 4)** is subjected to 350 kN design shear force due to lateral load (seismic). It is reinforced with 10 mm @ 150 mm c/c tie bar, strength of the bar is 275 MPa. **Formulate the design equation** to retrofit the column for **shear force** using jacketing with CFRP wrap. Design the column for **shear** using **jacketing** method with CFRP wrap. Modulus of elasticity of CFRP wrap is 165 GPa and thickness is 0.25 mm.

Appendix:

Table 6.6.8: Coefficients for Negative Moments in Slabs †

$M_{a,neg} = C_{a,neg} w l_a^2$

$M_{b,neg} = C_{b,neg} w l_b^2$

Where, w = total uniform dead plus live load per unit area

Span Ratio, $m = \frac{l_a}{l_b}$	Moment Coefficient	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
										
1.00	$C_{a,neg}$		0.045		0.050	0.075	0.071		0.033	0.061
	$C_{b,neg}$		0.045	0.076	0.050			0.071	0.061	0.033

University of Asia Pacific
Department of Civil Engineering
Final Examination, Spring 2024
Program: M.Sc. in Civil Engineering

Course Title: Earth Dams and Stability of Slopes | Credit Hour: 3.0 | Course Code: CE 6405
Time: 3 hours | Full Marks: 200

(Assume reasonable value of missing data, if any)

Answer the Following Questions:

1. (a) With neat sketch list the possible boundary conditions for drawing flow net for an earth dam. **(7)**
   (b) What are the principal functions of filter? Also mention the basic requirements of filter. **(8)**
   (c) List the criteria for designing granular filter as recommended by U.S. Army Corps of Engineers. Also mention the criteria for gradation of filter materials in relation to slots and holes in pipes used for collecting the seepage water. **(10)**

2. Design a horizontal drainage blanket of length 400 feet constructed on a permeable foundation of an earth dam to remove seepage quantities of $5ft^3$/day and 10 ft^3/day through per foot of dam and its foundation, respectively. **(15)**

3. Discuss briefly with neat sketches the various measures commonly used for controlling seepage through an earth dam. **(15)**

4. Show with neat sketches the different types of cracks observed in earth dams and also mention the possible reasons for origin of these cracks. **(15)**

5. With neat sketch derive the fundamental differential equation for blanket of finite permeability and of uniform thickness. What are the solutions of this equation for finite blanket and infinite blanket? Also verify the solutions. **(15)**

6. For a zoned earth dam of height 55 m and crest width 10 m, a 1.25 m thick impervious layer of permeability 6×10^{-8} m/s continues indefinitely on the upstream and downstream side of the centrally placed core. The permeability of foundation material and height of water head are 3×10^{-5} m/s and 50 m, respectively. The side slopes of the dam and core are 1 : 3 (vertical : horizontal) and 1 : 2 (vertical : horizontal), respectively. Depth of foundation of the dam is 35 m and saturated unit weight of the impervious layer is 19 kN/m^3. Design a loading berm for the earth dam. Compacted unit weight of berm material is 17 kN/m^3. **(15)**

7. (a) Define effective opening size (EOS), O_{95} and transmissivity of a geotextile sample. **(7)**
   (b) A permittivity test was carried out on a geotextile sample of diameter 120 mm and of thickness 3.85 mm under a head of 2 cm. During the test a discharge of 1000 cm^3 was collected in 10 seconds. Compute the vertical (cross-plane) permeability and permittivity of the sample. **(8)**
   (c) List the criteria for identifying soils susceptible to downslope migration. Also draw neatly the recommended filter systems for soils susceptible to downslope migration. **(10)**

8. (a) A dry cohesive-frictional soil deposit of height 4 m exists in an infinite slope. The slope angle is 20°. The values of effective cohesion (c′) and effective angle of internal friction (ϕ') of the soil are 35 kN/m^2 and 15°, respectively. Dry unit weight of the soil is 16 kN/m^3. Find (i) factor of safety of the slope with respect to sliding (ii) factor of safety of the slope with respect to cohesion assuming friction has been fully mobilized along the slip surface, and (iii) critical height of the slope.

   If seepage occurs parallel to the slope (i.e., water table is at the slope surface), then determine (i) factor of safety of the slope with respect to sliding, and (ii) critical height of the slope. Saturated unit weight of the soil is 20 kN/m^3. **(18)**

(b) A cut is to be made in a soil of unit weight 17 kN/m^3. The values of effective cohesion (c′) and effective angle of internal friction (ϕ') of soil are 25 kN/m^2 and 15°, respectively. The cut slope makes an angle of 70° with the horizontal. Using Culmann's Method, determine the height of the cut slope that will have a true factor of safety of 2.5? Also determine the critical height of the cut. **(10)**

(c) The upstream slope of an earth dam of height 6 m was constructed at an angle of 60°. The values of saturated unit weight, cohesion and angle of internal friction of the dam material are 19 kN/m^3, 27 kN/m^2 and 10°, respectively. Using Taylor's Method, compute (i) the factor of safety of the slope when the reservoir is full to the top level of the slope, and (ii) the factor of safety of the slope when a sudden drawdown occurs.

If the same slope is to be excavated in a very deep layer of the soil with $\phi = 0$, then what will be the factor of safety of the slope? **(12)**

9. (a) What are the basic requirements of a revetment? Also list different types of revetments with at least two examples of each type. **(10)**

(b) What general criteria should be considered during design of a revetment for an earth dam? **(5)**

(c) The following data were obtained for design of revetment using cement concrete (CC) blocks for protecting the upstream slope of an earth dam against the erosive actions of currents and waves of the Meghna river at Chandpur site.

Average flow velocity = 2.5 m /sec; Specific gravity of CC block = 2.30
Mass density of CC block = 2300 kg/m^3; Angle of repose of CC block = 40°
Ratio of water depth and revetment size = 5
Upstream Slope of earth dam = 1 : 2 (vertical : horizontal)
Wind speed = 30 m/sec; Wind duration = 2 hour; Fetch length = 15 km
Strength coefficient = 5 and damage coefficient = 6

CC blocks (cubical shape) will be hand placed in single layer with geotextile filter. The edges of the CC blocks are exposed and the CC blocks are subjected to normal turbulence with very rough flow (Depth and velocity distribution factor, $K_h = 1$).

Characteristics of waves are shown in Table 1.

Estimate the size (thickness) of CC blocks capable of withstanding the actions of currents and waves. **(20)**

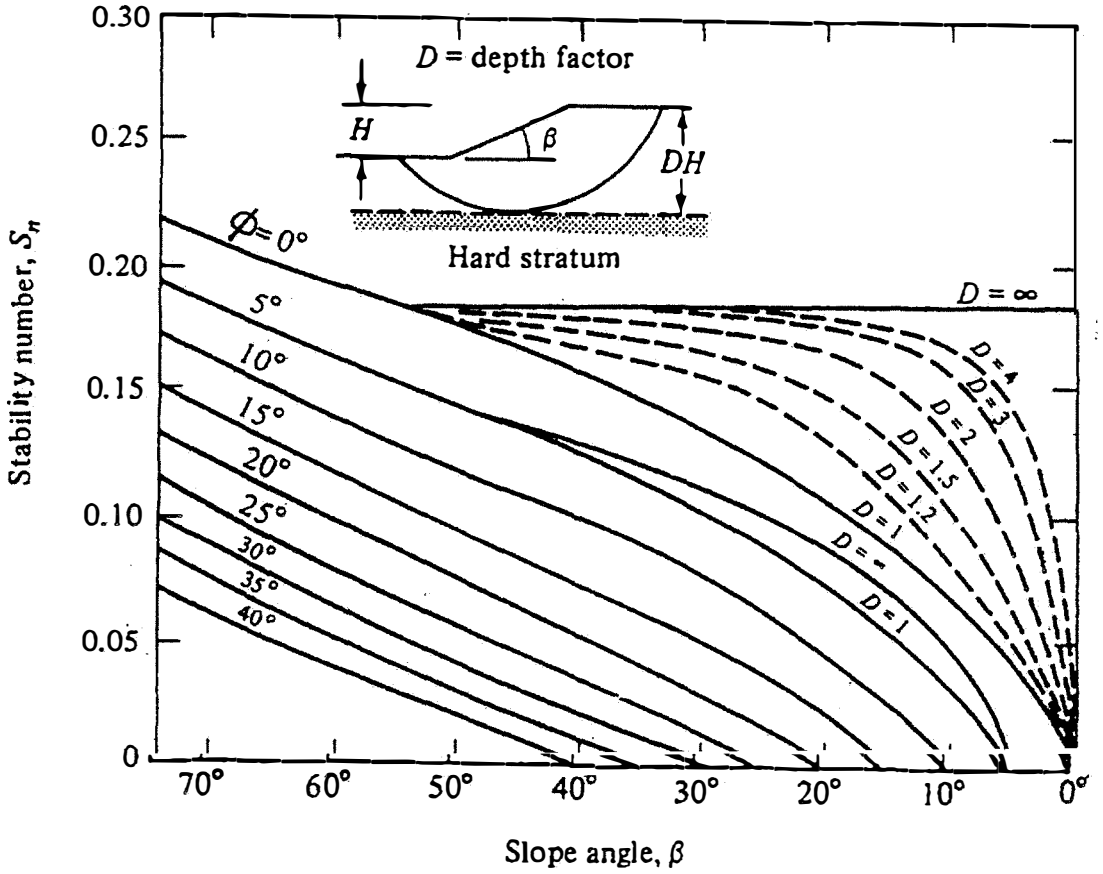

Chart 1 Taylor's Stability Chart

Table 1 Characteristics of Waves

Wind speed (m/sec)	Minimum duration of wind (hour)	Fetch length (km)	Wave height (m)	Wave period (sec)
15	1.00	5.0	0.7	2.8
	1.75	10.0	0.9	3.3
	2.25	15.0	1.2	3.8
30	0.75	5.0	1.3	3.5
	1.50	10.0	1.8	4.5
	2.00	15.0	2.0	5.0

Note: The following Equations and Tables can used to solve Question No. 9 (c).

(a) Stability of Revetment against Current Attack

(i) Neil (1972)

$D = 0.034V^2$

$D = Spherical\ diameter\ of\ boulder$
$V = Velocity\ of\ current$
$D_n = 0.81D, \quad D_n = cubical\ dimension$

(ii) JMBA (BWDB, 1993)

$$D_n = \frac{0.7V^2}{2(S_s - 1)g} \times \frac{2}{\left\{log_{10}\left(6 \times \frac{h}{D}\right)\right\}^2} \times \frac{1}{\{1 - (sin\theta/sin\phi)^2\}^{0.5}}$$

$S_s = Specific\ gravity\ of\ revetment\ material$
$h = Depth\ of\ water$
$\theta = Bank\ slope\ in\ degree$
$\phi = Angle\ of\ repose\ of\ revetment\ material$

(iii) Pilarczyk (BWDB, 1993)

$$D = \frac{V^2}{36g(S_s - 1)\psi_{cr}\left(\frac{h}{D}\right)^{1/6}}$$

$\psi_{cr} = Critical\ Shields\ parameter\ or\ Shields\ constant$

(iv) Pilarczyk (BRTC, 2010)

$$D_n = \frac{0.035V^2}{2g\Delta_m} \times \frac{\phi_{sc}}{\psi_{cr}} \times \frac{K_T K_h}{K_S}$$

$\Delta_m = Relative\ density\ of\ revetment\ material$

$$\Delta_m = \frac{\rho_s - \rho_\omega}{\rho_\omega}$$

$\rho_s = Mass\ density\ of\ revetment\ material$
$\rho_\omega = Mass\ density\ of\ water$
$\phi_{sc} = Stability\ factor\ for\ current$
$\psi_{cr} = Critical\ Shields\ parameter\ or\ Shields\ constant$
$K_T = Turbulance\ intensity\ factor$
$K_h = Depth\ and\ velocity\ distribution\ factor$

$$K_S = Slope\ factor = \left\{1 - \left(\frac{sin\theta}{sin\phi}\right)^2\right\}^{1/2}$$

(b) Stability of Revetment against Wave Attack

(i) Hudson's Formula (BWDB, 1993)

$$D_n = \frac{H_s}{\Delta_m}\left(\frac{tan\theta}{K_D}\right)^{\frac{1}{3}}$$

$H_s = Significant\ wave\ height$
$\Delta_m = Relative\ density\ of\ revetment\ material$
$K_D = Damage\ coefficient$

(ii) Pilarczyk's Formula (BWDB, 1993)

$$D_n = \frac{H_s}{S_s - 1} \times \frac{1}{\beta} \times \frac{E^{\frac{1}{2}}}{cos\theta}$$

$\beta = Strength\ coefficient$
$E = Wave\ breaker\ similarity\ parameter\ or\ wave\ breaking\ parameter$

$$E = \frac{1.25T}{\sqrt{H_S}} tan\theta$$

$T = Wave\ period$

(iii) Pilarczyk (BRTC, 2010)

$$D_n = \frac{H_s \xi_z^b}{\Delta_m\, \psi_\mu\, \phi_{s\omega}\, cos\theta}$$

$\psi_\mu = System\ specific\ stability\ upgrading\ factor$
$\phi_{s\omega} = Stability\ factor\ for\ incipient\ motion\ due\ to\ wave\ loads$
$\xi_z = Wave\ breaker\ similarity\ parameter\ or\ wave\ breaking\ parameter$
$b = Wave\ structure\ interaction\ coefficient$

Critical Shield's Parameter, Ψ_{cr}

Revetment Type	Ψ_{cr}
Riprap, small bags	0.035
Placed blocks, geobags	0.05
Blockmats	0.07
Gabions	0.07 to 0.10
Geomattresses	0.07

Values of Stability Factor (Pilarczyk, 1998)

Revetment Type	Stability factor, ϕ_{sc}	
Cover layer	Continuous protection	Exposed edges transitions protection
Randomly placed, broken riprap and boulders	0.75	1.5
CC blocks, cubical shape, randomly placed in multi layer	0.80	1.50
CC blocks, cubical shape hand placed in single layer chess pattern	0.65	1.25
Riprap and placed blocks; Sand fill units	1.0	1.50
Block mats, gabions, washed-in blocks, geobags, concrete filled geobags and geomattresses, wiremesh mattress	0.5	1.00
Gabions/mattress filling by stones	0.75	1.5

Turbulence Intensity Factor, K_T (Current) (FAP 21/22)

Turbulence Intensity	K_T (Gabions, Mattress)	K_T (Others)
Normal turbulence in rivers	1.0	1.0
Non-uniform flow with increased turbulence, mild outer bends	1.0	1.5
High turbulence, local disturbances, sharp outer bends	1.0	2.0
Jet impact, screw race velocity, hydraulic jump	3.0 - 4.0	3.0 - 4.0

Coefficients for Design of Various Cover Materials against Wave Attack

Revetment type	Stability factor for incipient motion (φ)	Stability upgrading factor (ψ_μ)	Interaction coefficient (b)
Randomly placed, broken riprap and boulders	2.25 - 3.00	1.00 - 1.33	0.50
CC blocks, cubical shape, randomly placed in multilayer	2.25 - 3.00	1.33 - 1.50	0.50
CC blocks, cubical shape, hand placed, single layer (geotextile filter)	2.25	2.00	0.67 - 1.00
CC blocks, cubical shape, hand placed in single layer, chess pattern (geotextile on sand)	2.25	1.50	0.67 - 1.00
CC blocks cable connected	2.25	1.80	0.67
Wire mesh mattress	2.25	2.50	0.50
Gabions/mattress filling by stone	2.25	2.50	0.50

University of Asia Pacific
Department of Civil Engineering
Final Examination, Spring 2024
Program: M.Sc. in Civil Engineering

Course Title: GIS and Remote Sensing in Transportation | Course Code: CE6513

Time: 3 hours | Credit Hour: 3 | Full Marks: 100

All questions are mandatory. Numbers in parentheses indicate marks assigned to each.

1. Suppose you are a Highway Engineer designing a national highway. The alignment goes through private lands; you will prepare land acquisition maps. Your manager wants you to prepare them with GIS.
   a. What kinds of data will you need to do this job? **(10)**
   b. What is the sequence of activities to prepare the land acquisition maps? You may draw figures to explain your answer. **(15)**

2. Use of satellite imagery:
   a. What is the meaning of NDVI? Write down its formula. What can you find out with NDVI maps? **(12)**
   b. What is the meaning of NDWI? Write down its formula. What can you find out with NDWI maps? **(13)**

3. Digital Elevation Models:
   a. How does DEM/DTM/DSM help in civil engineering projects? Cite 3 examples of their application in Civil Engineering. **(10)**
   b. Name 3 sources of satellite DEM data **(8)**
   c. How can you prepare accurate DEM for a project site? **(7)**

4. Global Navigation Satellite System (GNSS):
   a. Name the four active GNSS currently in operation and their owner countries. **(12)**
   b. How does a GNSS integrate GIS and Remote Sensing? **(13)**