L-3/T-1/WRE **Date: 25/10/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2020-2021

Sub: **WRE 301** (Open Channel Hydraulics)

Full Marks: 280 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Show that for curvilinear flow the total pressure head can be expressed as

total pressure head = $y\left(1 \pm \dfrac{v^2}{gr}\right)$ **(10)**

(b) The velocity distribution in the plane of a vertical sluice gate discharging free flow is shown in figure 1. Calculate the discharge per unit width of the gate. **(20)**

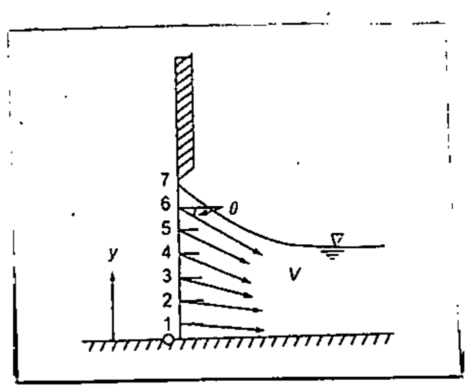

Figure 1 for question 1(b)

location	1	2	3	4	5	6	7
Velocity (m/s)	2.3	2.5	2.6	2.6	2.5	2.1	0.0
θ(degrees)	5	10	15	20	25	30	-
y(m)	0.05	0.10	0.15	0.20	0.25	0.30	0.35

(c) Compute the velocity distribution coefficient along a vertical in a wide channel when the depth of flow in the channel is 5m. The velocity distribution is given as $u = 4\left(\dfrac{z}{y}\right)^{\frac{1}{2}}$. Determine the total discharge if the width is 100m. **(16 ⅔)**

2. (a) Define specific energy. Show that for a triangular section the critical depth can be expressed as, **(10)**

$$y_c = \sqrt[5]{\frac{2aQ^2}{gz^2}}$$

Contd P/2

WRE 301
Contd... Q. No. 2

(b) A 3m wide rectangular channel carries a discharge of 3 m^3/s at a depth of 1.0 m. If the width is to be reduced to 2.0m and bed raised by 10 cm, what would be the depth in the contracted section? What maximum rise in the bed level is possible without affecting the depth of flow upstream of the transition. Neglect all energy losses. **(16)**

(c) An overflow spillway has its crest at 125.40 m elevation and a horizontal apron at an elevation of 95.00m on the downstream side. Find the tailwater elevation required to form a hydraulic jump when the elevation of the energy line is 127.90 m. The C_d for the flow can be assumed as 0.755. The energy loss for the flow over the spillway can be neglected. **($20\frac{2}{3}$)**

3. (a) Water flows in a horizontal rectangular channel 8m wide at a depth of 0.52 m and a velocity of 15.6 m/s. If a hydraulic jump forms in this channel, determine **(27)**

a. the type of jump

b. The downstream depth needed to form the jump

c. The horsepower dissipation in the jump

d. The efficiency of the jump

e. The relative height of the jump

f. The length of the jump using Sliverster formula

g. What would be the length of the jump if the channel was laid on a slope of 1 horizontal and 0.15 vertical

h. Calculate the sequent depth of the jump for this slope.

i. What would happen to the jump when the tailwater depth is 4.96m

(b) Proportion a USBR stilling basin type II with neat sketch for the following data: **($19\frac{2}{3}$)**

Design discharge : 15870 m^3/s
TW level : 17.26 m
Basin width : 227.1 m
Elevation of ground : 0.00 m
Velocity at the foot of the spillway: 24.70 m/s
Assume necessary values for missing data

4. (a) Show that for the best hydraulic trapezoidal section is half of a regular hexagon. **(10)**

(b) Define the following terms **($16\frac{2}{3}$)**

i. Maximum permissible velocity
ii. Angle of repose
iii. Final regime
iv. Afflux

(c) Estimate the afflux for a bridge having four piers with semicircular noses and tails each 40 ft the long and 10 ft the wide. During a flood peak of 45000 cfs the total width of the stream was 390 ft and the average depth at downstream section was 19.4 ft. **(20)**

Contd P/3

WRE 301

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define steady flow with examples. Can uniform flow be unsteady? Justify your answer. **(10)**

   (b) Derive the Chezy formula. What are the underlying assumptions in this formula? **(15)**

   (c) A wide channel carries water at a depth of 0.80 m and laid on a bed slope of 0.00020. If the channel has equivalent sand grain roughness of 0.05 cm, compute the velocity at a depth of 20 cm from the water surface. Assume logarithmic velocity distribution profile. What will be the magnitude of shear stress? **($21\frac{2}{3}$)**

6. (a) Explain the statement, "Uniform flow seems to be self-adjusting and any deviation from the condition '$W\sin\theta = F_f$' tends to reestablish this condition". **(10)**

   (b) Mention the salient features that must be considered in selecting a channel reach for flood discharge computation. Briefly describe the 'slope-area' method for computing flood discharge. **(15)**

   (c) A channel consists of a main section and two side sections with respective roughness, energy and momentum coefficients as shown in figure 2. Compute the total discharge and the mean velocity of flow for the entire section. Given, the bed slope is $S_0 = 0.0008$. Also compute the numerical value of *n* for the entire section. **($21\frac{2}{3}$)**

7. (a) Derive the dynamic equation of steady gradually varied flow with necessary assumption. **(10)**

   (b) Explain why 'H1' profile is not physically possible in gradually varied flow, Draw a qualitative flow profile as a result of decrease in bed surface roughness in a mild slope channel. **(15)**

   (c) A rectangular channel with b = 5 m, α = 1.15 and n = 0.025 has three reaches arranged serially. The bottom slopes of these reaches are 0.0020, 0.008 and 0.009, respectively. For a discharge of 15 m^3/s in the channel, name and sketch qualitatively the resulting flow profiles. **($21\frac{2}{3}$)**

8. (a) Draw the possible flow profiles in: (i) steep slope channel and (ii) critical slope channel. **(10)**

   (b) Briefly explain how the flow profile in a wide rectangular channel can be determined applying Bresse method. **(15)**

Contd P/4

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Contd... Q. No. 8

(c) A dam is constructed on a trapezoidal channel with bottom width of 6 m, side slope 1V:2H, n = 0.025 is laid on a slope of 0.0030 and carries a discharge of 30 m^3/s. The depth produced by the dam immediately upstream of it is 3.5 m. Compute the resulting flow profile. Consider the normal depth and critical depth as 2.5 m and 1.5 m, respectively. Given, the energy coefficient is 1.15. **($21\frac{2}{3}$)**

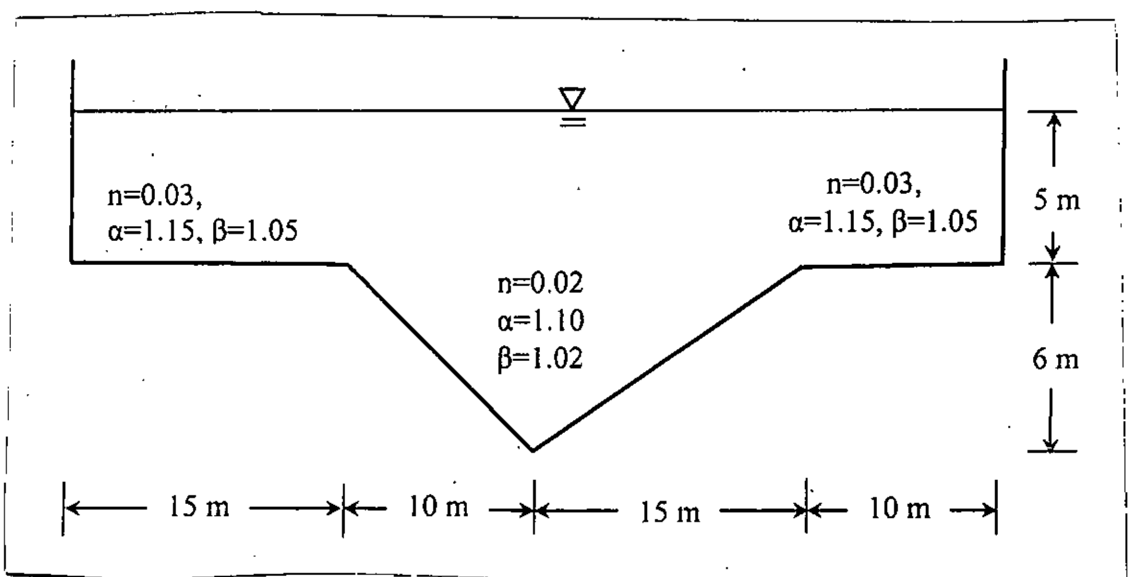


Figure 2 for Question 6(c)

L-3/T-1/WRE **Date: 29/09/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2020-2021

Sub: **WRE 327** (GIS and Remote Sensing)

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

Symbols denote their usual meanings. Assume reasonable values if any data is missing.

1. (a) Explain critical spectral region. How can you differentiate among different landuses, such as bare soil, crop land and forest, with the help of remote sensing data? **($6\frac{1}{3}$)**

(b) What is atmospheric absorption? How do the atmospheric compounds play a major role in the design of spectral sensors' wavelength? **(6)**

(c) Write down the differences between (i) Black body radiation and grey body radiation (ii) Along track scanner and across track scanner; (iii) spectral and radiometric resolution. **(6)**

(d) Write a short note on Planck's radiation law. A planetary body with an emissivity of 0.99 radiates maximum energy at 0.6 micrometer wavelength. Determine the maximum emitted radiation by this object. **(5)**

2. (a) What are the relative advantages and disadvantages of sensors that are on satellites over those carried on aircraft? Mention the name of a satellite with the appropriate wavelength at which images should be acquired to track storm in the Bay of Bengal. Justify your answers. **($6\frac{1}{3}$)**

(b) What are the factors that affect atmospheric scattering? Write down the difference between Rayleigh and Mie scattering. **(6)**

(c) Derive the emission temperature of the sun and the earth. Given, solar luminosity is 3.9×10^{26} watts and radius of the sun is 6.96×10^{8} m. **(6)**

(d) Write down the differences between a synthetic aperture radar and a real aperture radar? Why radar is side-looking? **(5)**

Contd P/2

3. (a) Compute the vegetation indices EVI, SAVI and NDVI from a Landsat image acquired over Rajshahi in Low gain state. Following data were obtained from the image: Digital numbers in blue band, near-infrared band and red band are 30, 160 and 90, respectively. Given, day of the year = 152, earth-sun distance = 1.01 (astronomical unit); solar zenith angle = 23°. Use Table 1 for information regarding Landsat 7 ETM satellite. Assume reasonable value if any data missing. **($8\frac{1}{3}$)**

(b) Write down the environmental and meteorological applications of shortwave infra-red, thermal infra-red and microwave remote sensing. **(6)**

(c) (i) What are the advantages of enhanced vegetation index over normalized difference vegetation index?

(ii) How the sensor parameters and object parameters influence the received signal of a radar? **(6)**

(d) What are the advantages and disadvantages of radar remote sensing? **(3)**

4. (a) Describe the terrain induced radar image distortions with neat sketches. **($6\frac{1}{3}$)**

(b) What are the radar polarization modes? How would you select modes for monitoring the trunk and crown of a broadleaf tree? Explain with sketch. **(6)**

(c) How can remote sensing be applied in monitoring the deforestation of Sundarbans over the last two decades? Also mention the name of a satellite and spatial, temporal and spectral resolutions that you think would be appropriate for this purpose. Justify your answer. **(6)**

(d) Write a short note on a marine observation satellite and mention the application of its different bands. **(5)**

Table 1 for Question 3(a)

ETM+ spectral range, post-calibration dynamic ranges, and mean exoatmospheric solar irradiance ($ESUN_\lambda$).

L7 ETM+ Sensor ($Q_{calmin} = 1$ and $Q_{calmax} = 255$)

Band	Spectral range	Center wavelength	$LMIN_\lambda$	$LMAX_\lambda$	$G_{rescale}$	$B_{rescale}$	$ESUN_\lambda$
Units	μm		$W/(m^2$ sr μm)		(W/m^2 sr μm)/DN	$W/(m^2$ sr μm)	$W/(m^2$ μm)
Low gain (LPGS)							
1	0.452–0.514	0.483	−6.2	293.7	1.180709	−7.38	1997
2	0.519–0.601	0.560	−6.4	300.9	1.209843	−7.61	1812
3	0.631–0.692	0.662	−5.0	234.4	0.942520	−5.94	1533
4	0.772–0.898	0.835	−5.1	241.1	0.969291	−6.07	1039
5	1.547–1.748	1.648	−1.0	47.57	0.191220	−1.19	230.8
6	10.31–12.36	11.335	0.0	17.04	0.067087	−0.07	N/A
7	2.065–2.346	2.206	−0.35	16.54	0.066496	−0.42	84.90
PAN	0.515–0.896	0.706	−4.7	243.1	0.975591	−5.68	1362

WRE 327

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) 'GIS is a complete system rather than just a software' -- justify this statement by briefly describing the various components of GIS. **(6)**

(b) How can GIS be used as a decision-making tool? Explain with relevant examples. **(6)**

(c) What are the limitations of CAD data model and Graphical-Computer Cartography model compared to GIS? **($6\frac{1}{3}$)**

(d) What is RDBMS? Comment on its suitability for handling geographic queries. **(5)**

6. (a) Write short notes on: (i) Geoid (ii) Georeferencing **(4)**

(b) What is IDL? Why is IDL curved? How is time adjusted when crossing this line? **(5)**

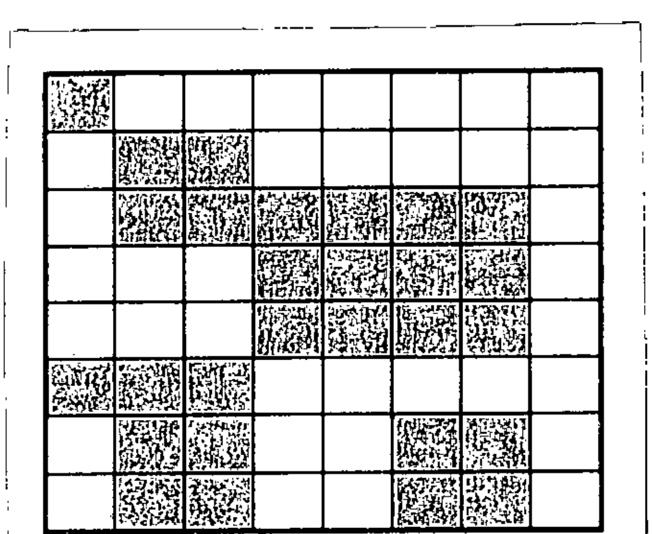
(c) Why is cylindrical projection system globally more popular than polar or conical projection system? What are the limitations of cylindrical projection system? **(8)**

(d) What is BTM? Why was BTM invented even though a system (UTM) covering the whole earth already existed? **($6\frac{1}{3}$)**

7. (a) Compare between Kriging and Inverse distance weighted (IDW) interpolation methods. **($4\frac{1}{3}$)**

(b) What are sliver polygons and weird polygons? Why do they occur? Describe briefly the methods for detecting and editing them. **(8)**

(c) Why are compression techniques necessary? Compress the following raster data using (i) Run length encoding and (ii) Block encoding compression techniques. Which one is more efficient in this case and why? **(11)**



8. (a) What are the salient features of raster data representation in GIS? Draw schematic diagrams of raster representation methods using (i) the largest share rule and (ii) the central point rule. $(4\frac{1}{3})$

(c) What is TIN data model? Describe its uses, advantages, and disadvantages. (7)

(d) Explain the following types of generalization rules of GIS data: (i) Aggregation, (ii) Refinement, (iii) Collapse, (iv) Enhancement (7)

(e) How does GPS receiver use triangulation to determine its position on the earth surface? (5)

L-3/T-1/WRE **Date : 15/10/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2020-2021

Sub : **CE 321** (Structural Analysis and Design I)

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **SEVEN** questions in this section. Answer any **FIVE**.

1. Determine (i) the velocity pressure (both windward and leeward), (ii) the design wind pressure (both windward and leeward), and (ii) the design wind force at each node of frame A of the four-storied residential building shown in the Figure 1. Assume that wind blows from west to east. **(28)**

   Location of the building: Bhola

   Basic wind speed = 155.45 mph

   Type of surface roughness: Open terrain with scattered obstructions having heights less than 25 ft.

   Structure type: MWFRS (rigid)

   Enclosure classification of the building: Open building

   Topographic factor: 1.00

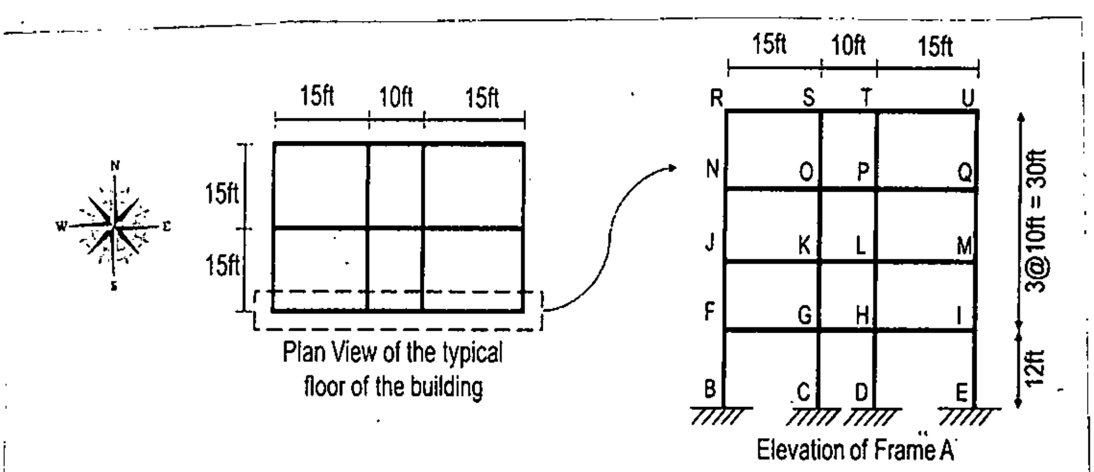


Figure 1

2. For the residential building shown in Figure 1, using the Equivalent Static Force Method, calculate **(28)**

   (i) the Design Spectral Acceleration

   (ii) The base shear

   (iii) the seismic load at each story of the building, assume the vertical distribution of base shear is linear i.e., k = 1.

   (iv) Also, according to BNBC 2020, comment on constructing reinforced concrete OMRF instead of reinforced concrete IMRF for the provided data.

Contd P/2

CE 321/WRE

Contd ... Q. No. 2

Given,

Dead load of the building = 220 psf per floor

Live load of the building = 65 psf per floor

Location of the building: Dhaka

Site Class: SC

Type of Seismic Force-Resisting System: reinforced concrete IMRF

Normalized Acceleration Response Spectrum: 2.875

3. From question No. 1, considering only the windward design wind force on frame A, shown in Figure 1, use the portal method to draw the axial force, shear force, and bending moment diagrams of beam JK and column PL. **(28)**

4. Draw the approximate bending moment diagram for the girders FG and GH of frame A shown in Figure 1. Also draw the approximate shear diagram for the girder LM of frame A. Consider only the vertical loads on the contributed area, and the load combination is – 1.6 LL + 1.2 DL **(28)**

   Dead load of the building = 220 psf per floor

   Live load of the building = 65 psf per floor

5. Approximately estimate the force in each member of the given truss in Figure 2. **(28)**

   (i) Assume diagonals can carry only tensile force

   (ii) Assume diagonals can carry both tensile and compressive forces.

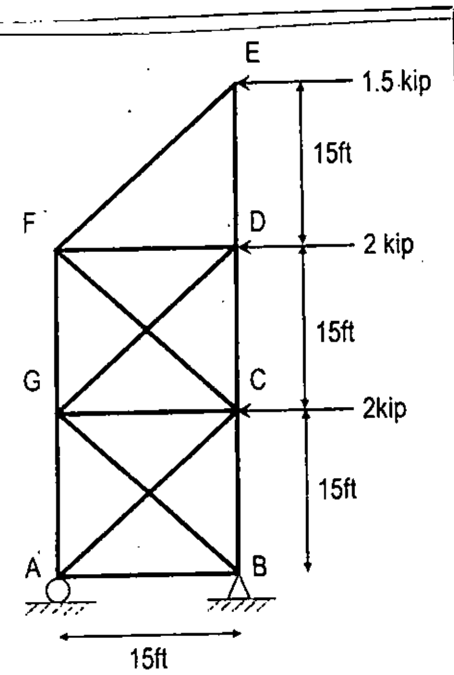


Figure 2

Contd P/3

6. (a) If a parabolic three-hinged arch carries a uniformly distributed load over the entire span, show that there will be no bending moment at any section. **(18)**

(b) Determine the resultant forces at the pins A, B, and C of the three-hinged roof truss, as shown in Figure 3. Internal hinge is placed at B. **(10)**

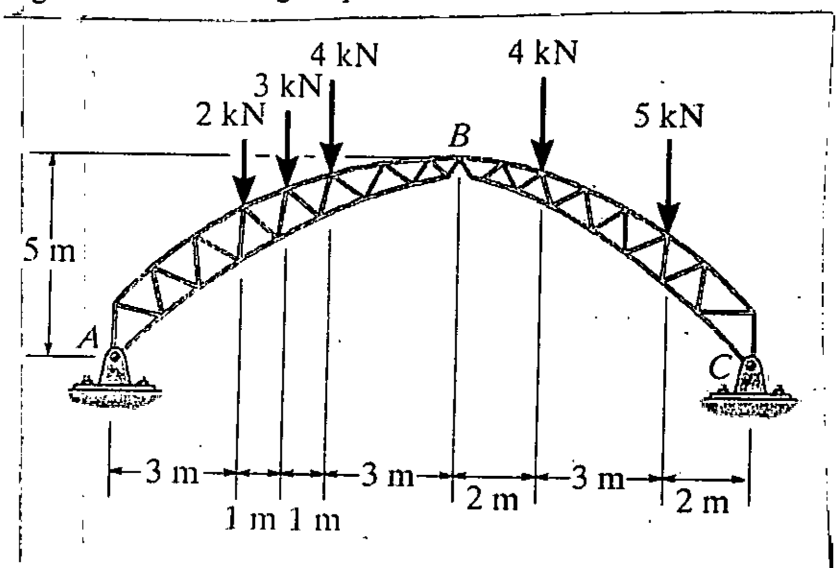


Figure 3

7. (a) Identify all the zero-force members in the roof truss shown in Figure 4. **(8)**

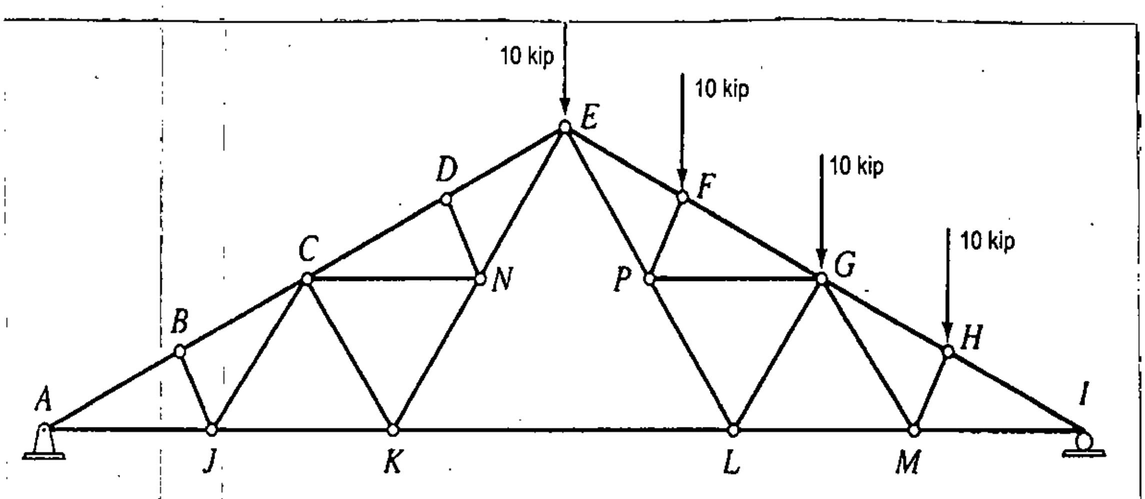


Figure 4

(b) A suspension bridge of 120 m span has two three-hinged stiffening girders supported by two cables having a central dip of 12 m. The roadway has a width of 6 m. The dead load on the bridge is 5 kN/m^2 while the live load is 10 kN/m^2 which acts on the left-half of the span. Find the maximum tension of the cable for the given situation. **(20)**

CE 321/WRE

SECTION – B

There are **SEVEN** questions in this section. Answer any **FIVE**.

8. (a) A uniform live load of 2 kip/ft and a single concentrated live force of 6 kip are placed on the floor beams shown in Figure 5. If the beams also support a uniform dead load of 350 lb/ft. Determine **(28)**

   (i) The maximum positive shear in panel CD of the girder, and

   (ii) The maximum negative moment in the girder at D.

9. Draw (approximately) the moment diagram for column AJI of the portal shown in Figure 6. Assume all truss members and the columns to be pin connected at their ends. Also determine the force in members HG, HL, and KL. **(28)**

10. Draw influence line diagram of the support reactions, axial force of LM and HL of the truss shown in Figure 7. **(28)**

11. Determine the horizontal deflection at joint D of the given truss in Figure 8. The cross-sectional area of all members is 1200 mm^2. The modulus of elasticity of the material is 20k kN/mm^2. **(28)**

12. Determine the maximum moment and maximum shear force at the mid-point of the simply supported beam caused by the wheel loads shown in Figure 9. **(28)**

13. Using the virtual work method, determine the displacement at point D and rotation at C of the beam shown in Figure 10. Assume EI as constant. **(28)**

14. Draw influence line diagrams of the support reactions, influence line diagrams of moment at mid-span, and influence line diagram of shear force at one-third of the span from the support of the cantilever beam shown in Figure 11. Also, using the virtual work method, determine the maximum deflection at the free end of the beam. **(28)**

Table 1: Importance Factor, I (Wind Loads)

Occupancy Category[1] or Importance Class	Non-Cyclone Prone Regions and Cyclone Prone Regions with V = 38-44 m/s	Cyclone Prone Regions with V > 44 m/s
I	0.87	0.77
II	1.0	1.00
III	1.15	1.15
IV	1.15	1.15

Table 2: Velocity Pressure Exposure Coefficients, K_h and K_z

Height above ground level, z	Exposure (Note 1)			
	A		B	C
(m)	Case 1	Case 2	Case 1 & 2	Case 1 & 2
0-4.6	0.70	0.57	0.85	1.03
6.1	0.70	0.62	0.90	1.08
7.6	0.70	0.66	0.94	1.12
9.1	0.70	0.70	0.98	1.16
12.2	0.76	0.76	1.04	1.22
15.2	0.81	0.81	1.09	1.27
18	0.85	0.85	1.13	1.31
21.3	0.89	0.89	1.17	1.34
24.4	0.93	0.93	1.21	1.38
27.41	0.96	0.96	1.24	1.40
30.5	0.99	0.99	1.26	1.43
36.6	1.04	1.04	1.31	1.48
42.7	1.09	1.09	1.36	1.52
48.8	1.13	1.13	1.39	1.55
54.9	1.17	1.17	1.43	1.58
61.0	1.20	1.20	1.46	1.61
76.2	1.28	1.28	1.53	1.68
91.4	1.35	1.35	1.59	1.73
106.7	1.41	1.41	1.64	1.78
121.9	1.47	1.47	1.69	1.82
137.2	1.52	1.52	1.73	1.86
152.4	1.56	1.56	1.77	1.89

Table 3: External Pressure Coefficients, C_p main wind force resisting system - Method 2 (All Heights)

Wall Pressure Coefficients, C_p			
Surface	L/B	C_p	Use With
Windward Wall	All values	0.8	q_z
Leeward Wall	0-1	-0.5	q_h
	2	-0.3	
	≥ 4	-0.2	
Side Wall	All values	-0.7	q_h

Table 4: Seismic Design Category of Buildings

Site Class	Occupancy Category I, II and III			
	Zone 1	Zone 2	Zone 3	Zone 4
SA	B	C	C	D
SB	B	C	D	D
SC	B	C	D	D
SD	C	D	D	D
SE, S_1, S_2	D	D	D	D

Table 5: Response Reduction Factor, Deflection Amplification Factor and Height Limitations for Different Structural Systems

Seismic Force–Resisting System	Response Reduction Factor, R	System Overstrength Factor, Ω_o	Deflection Amplification Factor, C_d	Seismic Design Category B	Seismic Design Category C	Seismic Design Category D
				Height limit (m)		
C. MOMENT RESISTING FRAME SYSTEMS (no shear wall)						
1. Special steel moment frames	8	3	5.5	NL	NL	NL
2. Intermediate steel moment frames	4.5	3	4	NL	NL	35
3. Ordinary steel moment frames	3.5	3	3	NL	NL	NP
4. Special reinforced concrete moment frames	8	3	5.5	NL	NL	NL
5. Intermediate reinforced concrete moment frames	5	3	4.5	NL	NL	NP
5. Ordinary reinforced concrete moment frames	3	3	2.5	NL	NP	NP

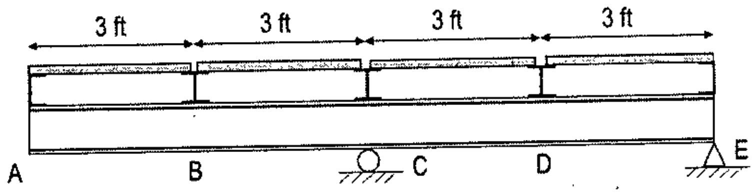


Figure 5

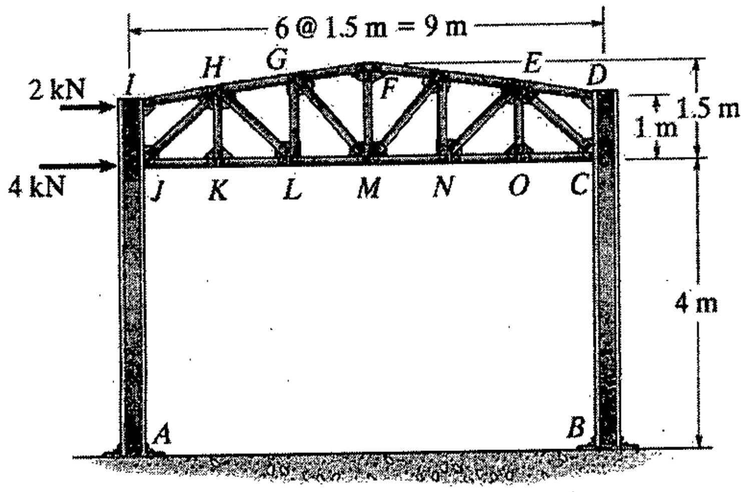


Figure 6

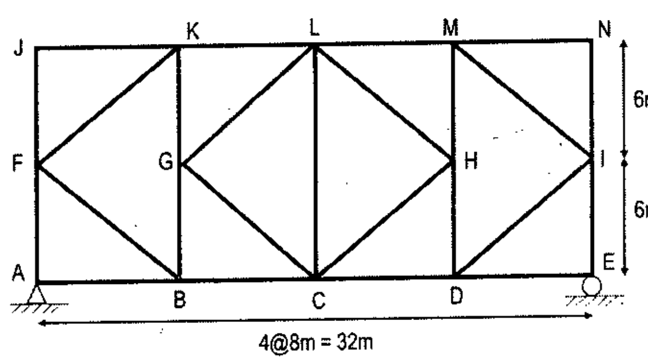


Figure 7

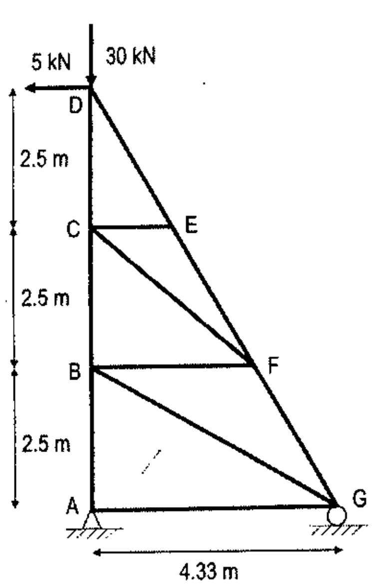


Figure 8

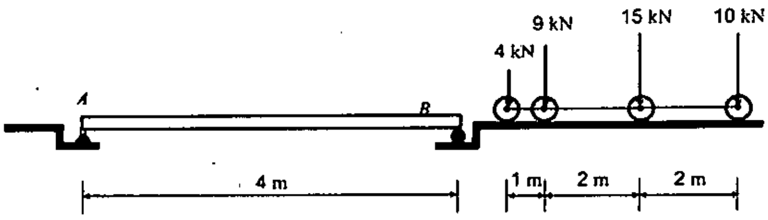


Figure 9

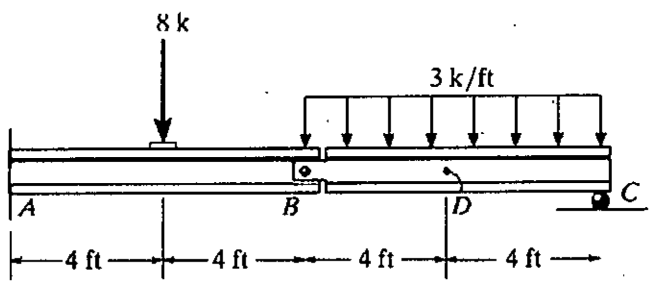


Figure 10

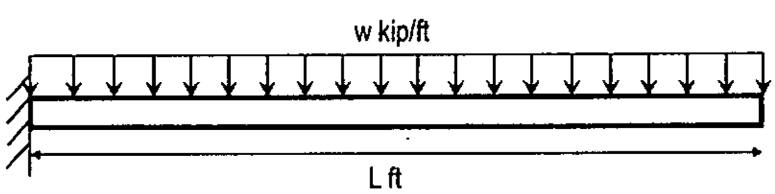


Figure 11

L-3/T-1/WRE **Date: 24/09/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2020-2021

Sub: **CE 381** (Principles of Soil Mechanics)

Full Marks: 280 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

Assume reasonable value of missing data (if any).

1. (a) What do you mean by hydraulic gradient? Derive an expression for critical hydraulic gradient. **($15\frac{2}{3}$)**

   (b) Derive an expression for equivalent permeability for vertical flow in layered soil. **(15)**

   (c) Write short notes on: **(8×2=16)**

   (i) Secondary consolidation settlement

   (ii) Flow net and its properties

2. (a) Explain with neat sketches, the phenomena of capillary rise in soils. How do you calculate the pore water pressure at a point in capillary rise in a partially saturated soil? **($11\frac{2}{3}$)**

   (b) Fig. 1 shows a sheet pile wall that has been driven into a homogeneous isotropic soil overlying impermeable layer. The coefficient of permeability of the soil is 1.5×10^{-3} cm/sec. Reproduce Fig. 1 in your exam script or in a graph paper to proper scale. **(35)**

   (i) Draw the flow net for the flow problem.

   (ii) Determine the total seepage loss per meter width of the sheet pile.

   (iii) Show pore water pressure at points along any one flow line.

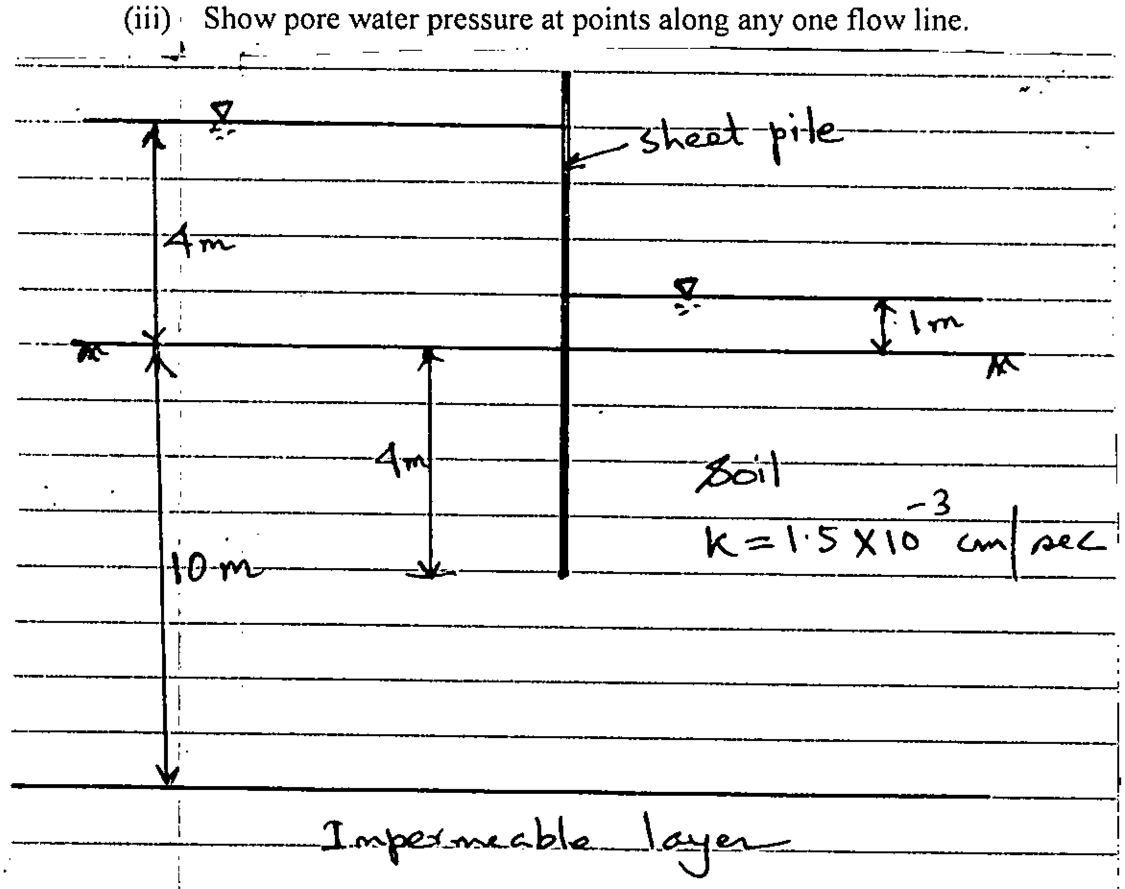
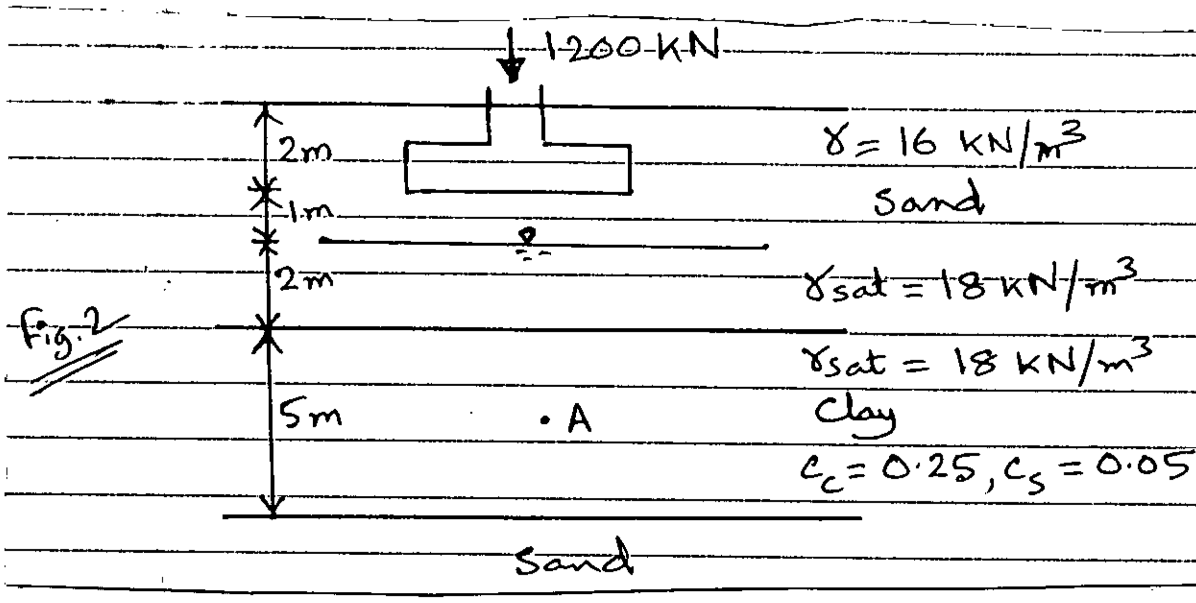


Fig. 1

3. (a) A 2m × 2m square footing is subjected to a load of 1200 kN. Determine the consolidation settlement in the clay layer of Fig. 2 due to this load. **(26⅔)**



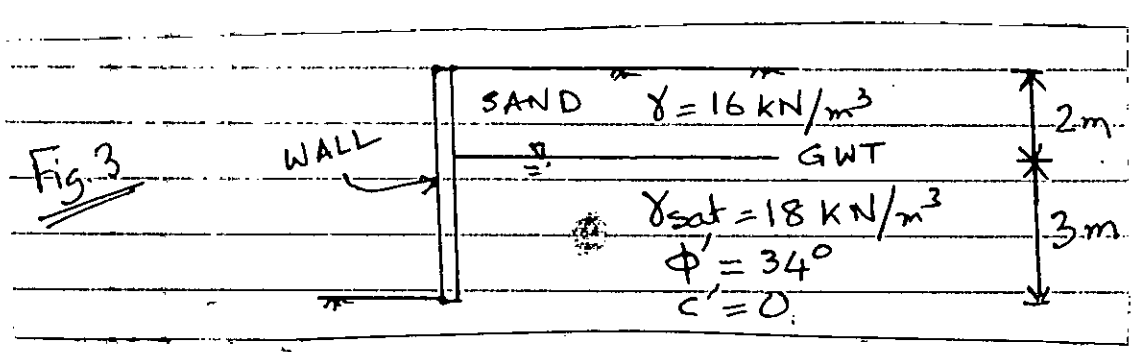
[Given: Preconsolidation pressure determined on clay sample taken from depth of 7.5 m (pt. A) is 120 kPa]

(b) Fig. 3 shows a 5 m high wall retaining sandy soil, which has been compacted to a high density. Determine the lateral pressure acting on the wall for the following two cases. Make appropriate assumptions for missing data (if any) and select appropriate lateral earth pressure coefficients. **(20)**

(i) Case I: Wall is restrained from any movement

(ii) Case II: Wall is allowed to yield.

[Given: $k_0 = 1 - sin\phi'$ for normally consolidated sand, $k_0 = (1 - sin\phi')(OCR)^{sin\phi}$ for over consolidated sand, $k_a = tan^2(45° - \phi'/2)$, $k_p = tan^2(45° + \phi'/2)$]



4. (a) For the retaining wall of height H in Fig. 4, show that for the trial wedge ABC, the resultant active force acting on unit length of wall is given by: **(24)**

$$P_a = \frac{1}{2}\gamma H^2\left[\frac{cos(\theta-\beta)cos(\theta-\alpha)sin(\beta-\phi)}{cos^2\theta\, sin(\beta-\alpha)sin(90° + \theta + \delta - \beta + \phi)}\right]$$

where δ = angle of friction between soil and wall.

γ = unit weight of soil.

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Contd.... for Q. No. 4(a)

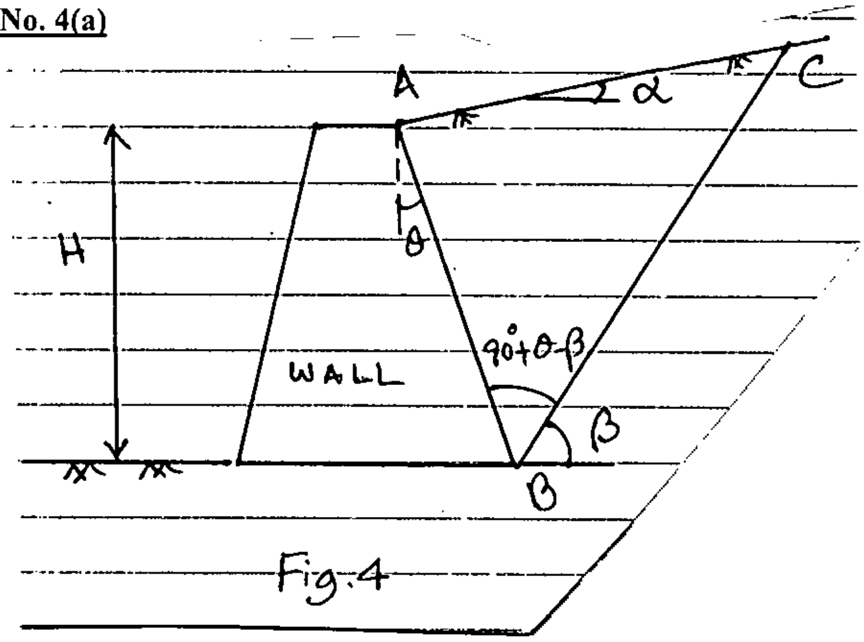

Fig.4

(b) With neat sketch, briefly describe how preconsolidation pressure (σ'_c) is graphically determined using consolidation test data. **(12)**

(c) Why tensile cracks develop in cohesive soils? Derive an expression for depth of tensile crack. **(10⅔)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) During a subsoil exploration program, undisturbed normally consolidated silty clay samples were collected in Shelby tubes from location A as shown in Figure 5. Following are the results of four drained, direct shear tests conducted on the clay samples with each having a diameter of 63.5 mm and height of 32 mm. (i) Determine the drained angle of friction for the silty clay soil using graphical method. (ii) Determine the shear strength of the clay in the field at location A. **(24⅔)**

Test no.	Normal force (N)	Shear force at failure (N)
1	84	28.9
2	168	59.6
3	254	89.1
4	360	125.3

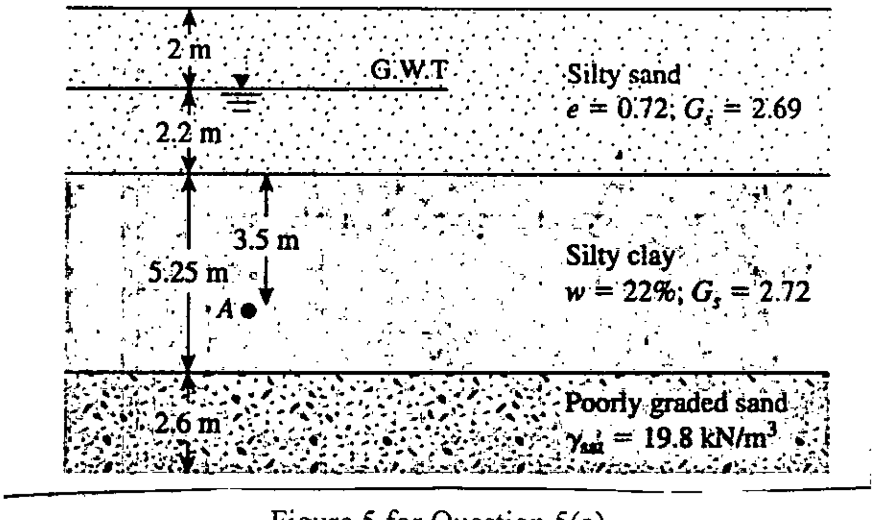

Figure 5 for Question 5(a)

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Contd.... for Q. No. 5(a)

(b) How can you estimate the shrinkage limit of a soil from plasticity chart using the procedure stated by Holtz and Kovacs, 1981? Describe with appropriate illustration. **(10)**

(c) Briefly describe the three mechanisms by which water is attracted to clay particles. **(12)**

6. (a) For the embankment shown in Figure 6, determine the vertical stress increases at points A, B, and C. **($28\frac{2}{3}$)**

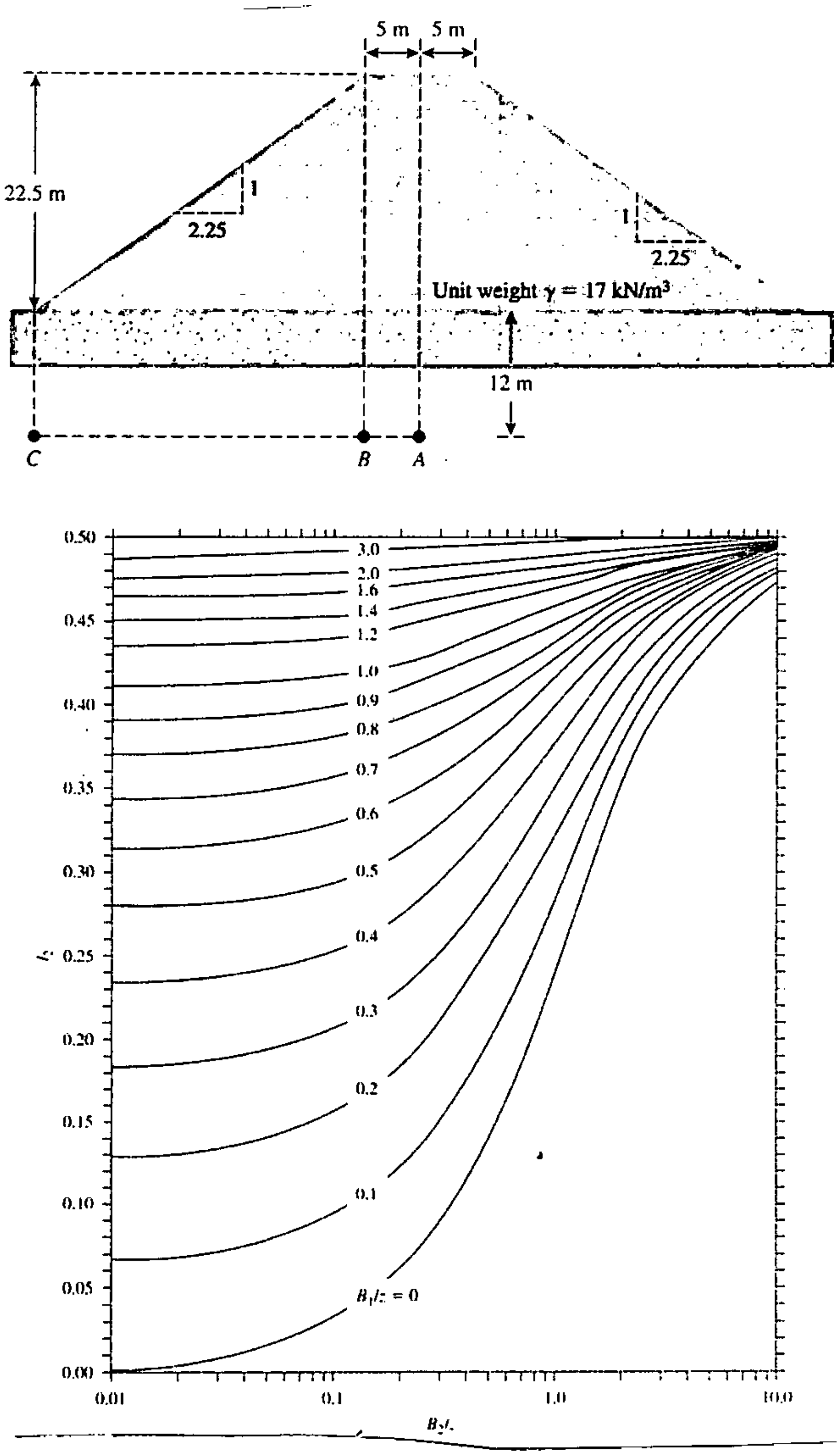

Figure 6 for Question 6(a)

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Contd.... for Q. No. 6

(b) Briefly describe the effect of compaction on structure of clay soils with proper illustration. **(8)**

(c) Using phase diagram, show that $e = \frac{G_s \gamma_w}{\gamma_d} - 1$. **(10)**

7. (a) The results of CU tests conducted on three soil specimens extruded from a Shelby tube are shown in Figure 7. $\sigma_{3,specimen-1}$ = 30 kPa, $\sigma_{3,specimen-2}$ = 60 kPa, and $\sigma_{3,specimen-3}$ = 100 kPa. Draw the Mohr's circles to determine the undrained and drained strength parameters of the tested soil. Note: Failure is often taken to correspond to the maximum deviator stress attained or the deviator stress at 15% axial strain, whichever is obtained first during the performance of a test. **($18\frac{2}{3}$)**

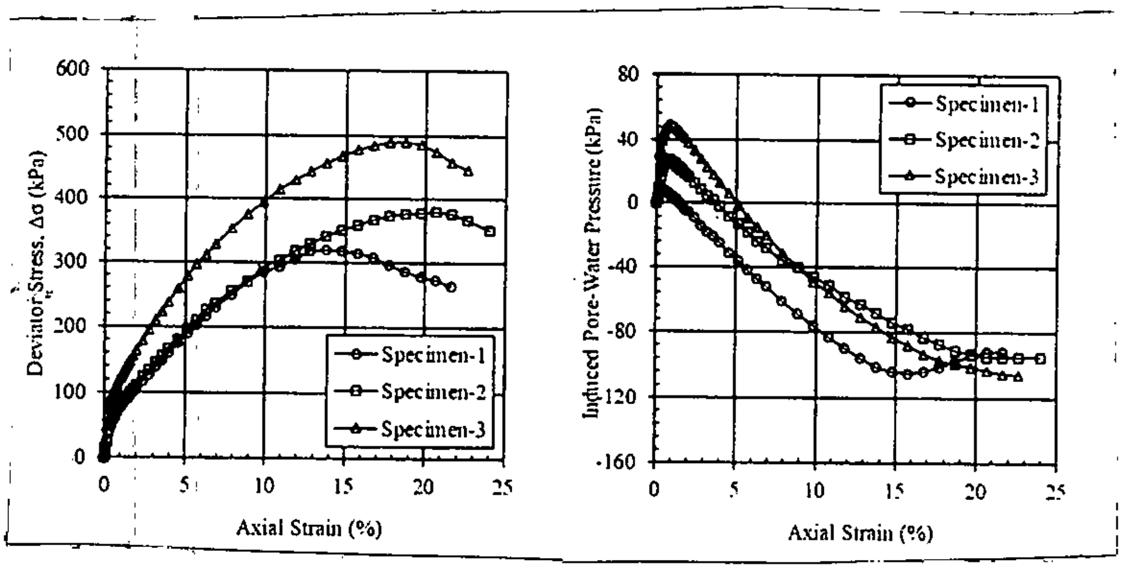

Figure 7 for Question 7(a)

(b) Write down the comparison between the AASHTO and Unified soil classification systems. **(6)**

(c) Write short notes on: effective grain size of soil, gap graded soil, fall cone method of determining LL, suitability number, pole method of finding stresses along a plane. Use appropriate illustrations where necessary. **(22)**

8. (a) Show with proper illustrations that the value of β in the Calding's equation for a rectangular vane is $\frac{2}{3}$ for uniform mobilization of undrained shear strength. **(10)**

Contd P/6

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Contd.... for Q. No. 8

(b) An embankment having crest width and height of 25 ft and 15 ft, respectively should be constructed for a project. The slope is 1V:2H on both sides of the embankment. For the embankment soil, γ_d = 110 pcf. The soil for the embankment has to be brought from a borrow pit. The soil at the borrow pit has the following: e = 0.68, G_s = 2.68, and w = 10%. Determine the volume of soil from the borrow pit that will be required to construct the embankment 2000 ft long. **(6⅔)**

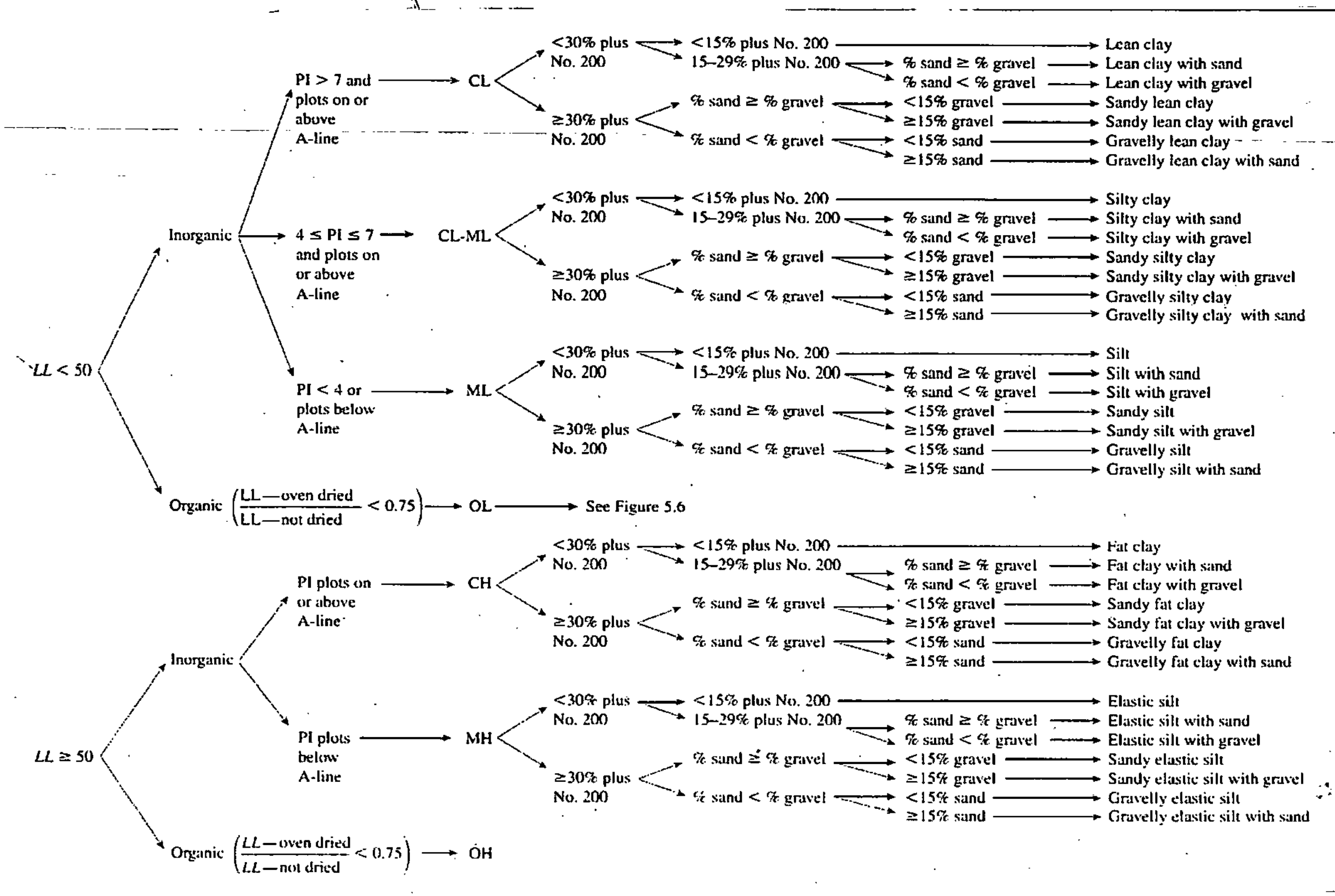
(c) Classify the following soils using the Unified Soil Classification System. Give the group symbols and the group names. Use the charts given in below. **(30)**

Sieve Size	Percent passing				
	A	B	C	D	E
No. 4	94	98	100	100	100
No. 10	63	86	100	100	100
No. 20	21	50	98	100	100
No. 40	10	28	93	99	94
No. 60	7	18	88	95	82
No. 100	5	14	83	90	66
No. 200	3	10	77	86	45
0.01 mm	---	---	65	42	26
0.002 mm	---	---	60	17	21
Liquid limit	---	---	63	55	36
Plasticity index	NP	NP	25	28	22

Group symbol		Group name
GW	<15% sand	Well-graded gravel
	≥15% sand	Well-graded gravel with sand
GP	<15% sand	Poorly graded gravel
	≥15% sand	Poorly graded gravel with sand
GW-GM	<15% sand	Well-graded gravel with silt
	≥15% sand	Well-graded gravel with silt and sand
GW-GC	<15% sand	Well-graded gravel with clay (or silty clay)
	≥15% sand	Well-graded gravel with clay and sand (or silty clay and sand)
GP-GM	<15% sand	Poorly graded gravel with silt
	≥15% sand	Poorly graded gravel with silt and sand
GP-GC	<15% sand	Poorly graded gravel with clay (or silty clay)
	≥15% sand	Poorly graded gravel with clay and sand (or silty clay and sand)
GM	<15% sand	Silty gravel
	≥15% sand	Silty gravel with sand
GC	<15% sand	Clayey gravel
	≥15% sand	Clayey gravel with sand
GC-GM	<15% sand	Silty clayey gravel
	≥15% sand	Silty clayey gravel with sand
SW	<15% gravel	Well-graded sand
	≥15% gravel	Well-graded sand with gravel
SP	<15% gravel	Poorly graded sand
	≥15% gravel	Poorly graded sand with gravel
SW-SM	<15% gravel	Well-graded sand with silt
	≥15% gravel	Well-graded sand with silt and gravel
SW-SC	<15% gravel	Well-graded sand with clay (or silty clay)
	≥15% gravel	Well-graded sand with clay and gravel (or silty clay and gravel)
SP-SM	<15% gravel	Poorly graded sand with silt
	≥15% gravel	Poorly graded sand with silt and gravel
SP-SC	<15% gravel	Poorly graded sand with clay (or silty clay)
	≥15% gravel	Poorly graded sand with clay and gravel (or silty clay and gravel)
SM	<15% gravel	Silty sand
	≥15% gravel	Silty sand with gravel
SC	<15% gravel	Clayey sand
	≥15% gravel	Clayey sand with gravel
SC-SM	<15% gravel	Silty clayey sand
	≥15% gravel	Silty clayey sand with gravel

Figure ~~4~~ 8 for Question 8(c): Flowchart group names for gravelly and sandy soils

Figure 9 for Question 8(c): Flowchart group names for inorganic silty and clayey soils



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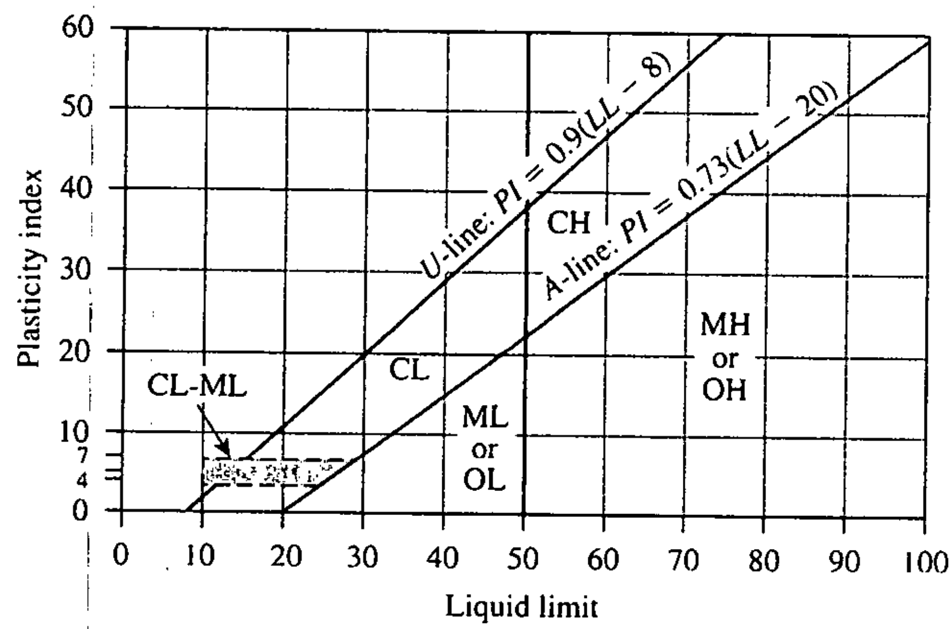

Figure ~~8~~ 10 for Question 8(c): Plasticity chart