Set A

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2017
Program: B.Sc in Civil Engineering

Course Title: Principles of Accounting   Course: ACN 301   Credit : 2.0

Time : 2 hours   Full marks : 50

[N.B. Answer all from the following Questions]

Question No 01

(a) GPH Ispat Ltd. specializes in manufacturing steel. The product is well accepted by consumers, and the company has a large number of orders to keep the factory production at 10,000 tons per month. GPH's monthly manufacturing cost and other expense data are as follows:

Factory manager's salary	BDT 50,000
Maintenance costs on factory building	3000
Advertising for steel	100,000
Sales commissions	50,000
Depreciation on factory building	7000
Rent on factory equipment	50,000
Insurance on factory building	30,000
Raw materials	200,000
Utility costs for factory	8000
Supplies for general office	2000
Wages for assembly line workers	320,000
Depreciation on office equipment	5000
Miscellaneous materials (lubricants, solders, etc.)	7000

INSTRUCTIONS:

Prepare an answer sheet with the following column headings:

	Product Costs			
Cost Item	Direct Materials	Direct Labor	Manufacturing Overhead	Period Costs

Enter each cost item on your answer sheet, placing the BDT amount under the appropriate headings. Total the BDT amounts in each of the columns. Calculate the monthly product cost.

(6.5)

(b) An analysis of the accounts of Zuniga Manufacturing reveals the following manufacturing cost data for the month ended June 30, 2017.

Inventories	**Beginning**	**Ending**
Raw materials	Tk.9,000	
Tk.13,100		
Work in process	5,000	7,000
Finished goods	9,000	6,000

Costs incurred:
Raw materials purchases Tk.54,000
Direct labor Tk.57,000
Indirect labor Tk.5,500
Factory insurance Tk.4,000
Factory Machinery depreciation Tk.4,000
Factory machinery repairs Tk.1,800
Factory utilities Tk.3,100
Miscellaneous factory costs Tk.1,500. Assume that all raw materials used were direct materials.

INSTRUCTIONS:
Prepare the cost of goods manufactured schedule for the month ended June 30, 2017. **(6)**

Question No 02

Tanaka Company is considering three new projects, each requiring an equipment investment of Tk.25,000. Each project will last for 3 years and produce the following cash inflows.

Year	**AA**	**BB**	**CC**
1	Tk. 2,000	Tk. 9,500	Tk.13,000
2	7,000	9,500	10,000
3	18,000	9,500	9,000

The equipment's salvage value is zero. Tanaka uses straight-line depreciation. Tanaka's required rate of return is 12%.

INSTRUCTIONS:

I. Compute the payback period for each project.
ii. Compute the net present value of each project. Which projects will you accept?

(12.5)

Question No 03

Wales Company sells small commercial spaces of a mall that sell for Tk.3000 each. Each shop has similar floor space and facility. For the coming year, management expects fixed costs to total Tk.200,000 and variable costs to be Tk.2000 per unit.

INSTRUCTIONS:

(a) Compute the break-even point.
(b) Compute the break-even sales.
(c) Compute contribution margin (CM) ratio.
(d) Compute the margin of safety assuming actual sales are Tk.750,000.
(e) Compute the break-even in units to earn net income of Tk.120,000.
(f) Due to tough market competition management at Wales is thinking of reducing the selling price to Tk.2900 per commercial space. If the selling price is reduced, compute the break-even in units to earn the net income of Tk.120,000.
(g) Prepare income statement assuming 450 unit sold.

(12.5)

Question NO 04

Selected financial data of Target and Wal-Mart for a recent year are presented here (in millions).

Income Statement Data for Year 2016

	Target Corporation	**Wal-Mart Stores, Inc.**
Net sales	Tk.61,471	Tk.374,526
Cost of goods sold	41,895	286,515
Selling and administrative expenses	16,200	70,847
Interest expense	647	1,798
Other income (expense)	1,896	4,273
Income tax expense	1,776	6,908
Net income	**Tk. 2,849**	**Tk. 12,731**

Balance Sheet Data (End of Year 2016)

Current assets	Tk.18,906	Tk. 47,585
Noncurrent assets	25,654	115,929
Total assets	**Tk.44,560**	**Tk.163,514**
Current liabilities	Tk.11,782	Tk. 58,454
Long-term debt	17,471	40,452
Total stockholders' equity	15,307	64,608
Total liabilities and stockholders' equity	**Tk.44,560**	**Tk.163,514**

Beginning-of-Year Balances (Jan 01, 2016)

Total assets	Tk.37,349	Tk.151,587
Total stockholders' equity	15,633	61,573
Current liabilities	11,117	52,148
Total liabilities	21,716	90,014

Other Data

Average net receivables	Tk. 7,124	Tk. 3,247
Average inventory	6,517	34,433
Net cash provided by operating activities	4,125	20,354

INSTRUCTIONS:

For each company, compute the following ratios and make comment about the two company's performance from the comparison of those ratios:

i. Current Ratio = Current Assets/Current Liabilities
ii. Asset turnover = Revenue/ Average total Assets
iii. Return on assets = Net Income/ Average total Assets
iv. Debt to total assets = Total Liabilities/ Total Assets
v. Profit margin = Net income/ Revenue
vi. Acid-test ratio = (Current Assets-inventory)/Current Liabilities
vii. Accounts receivable turnover = Revenue/ Average Accounts Receivable
viii. Return on common stockholders' equity = Net Income/ Average common stockholders' equity
ix. Inventory turnover = Cost of goods sold/ Average Inventories

(12.5)

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2017
Program: B. Sc Engineering (Civil)

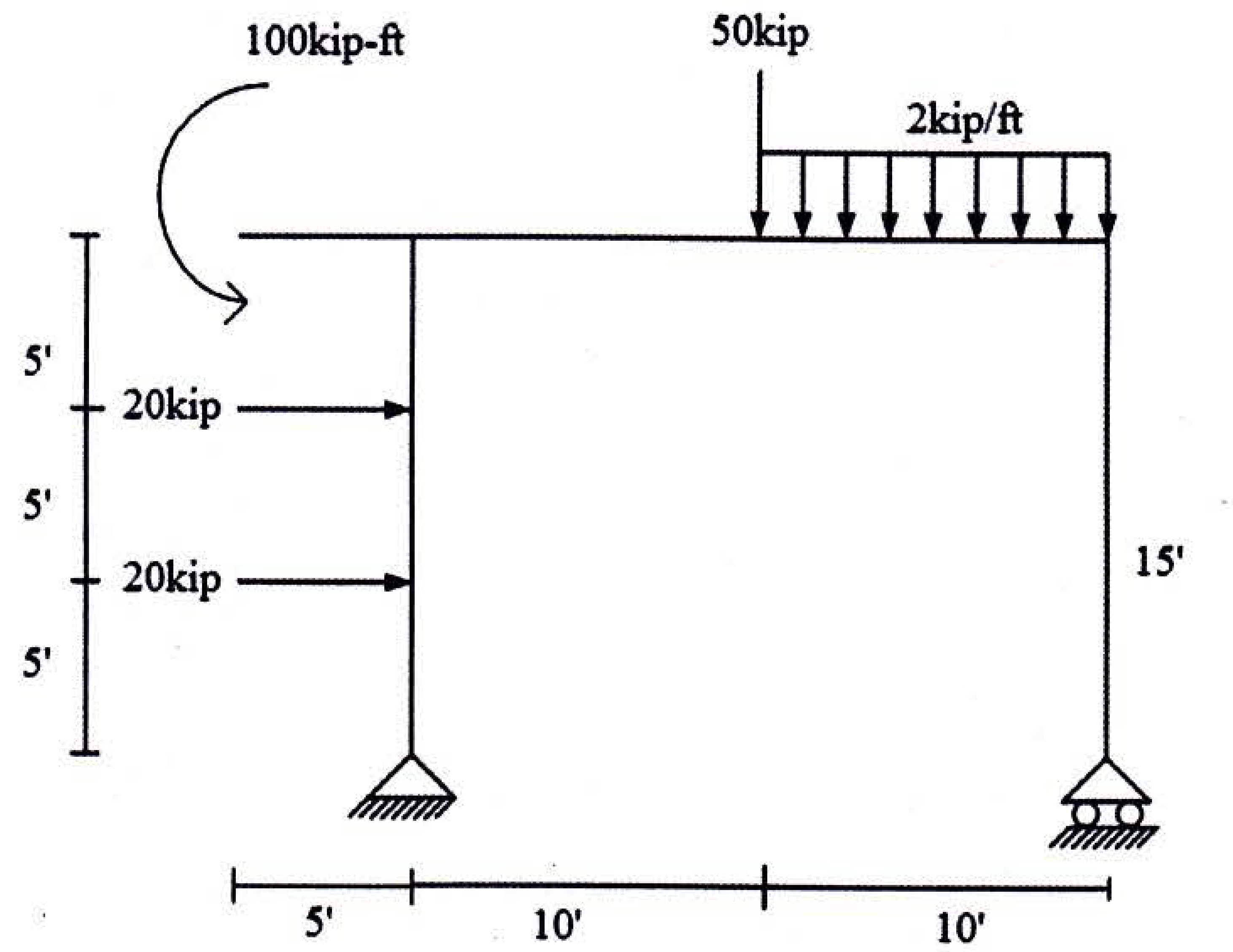
Course Title: Structural Engineering I
Time: 3.00 Hours

Course Code: CE 311
Full Marks: 100 (=10×10)

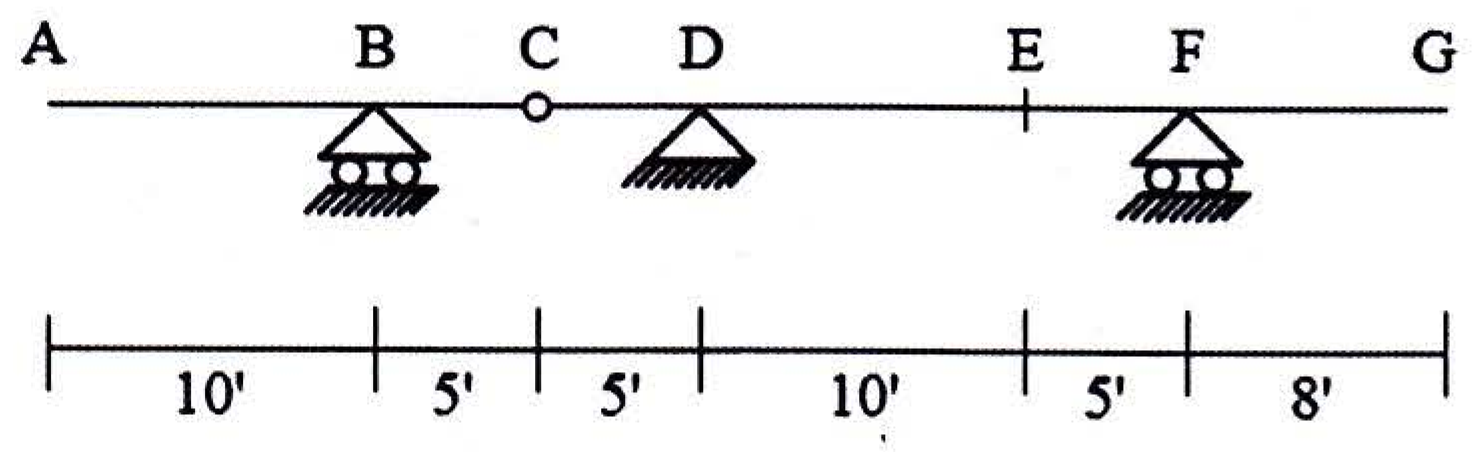
Part A

*There are **fourteen (14)** questions. Answer any **ten (10)**.*
Assume any missing data reasonably.

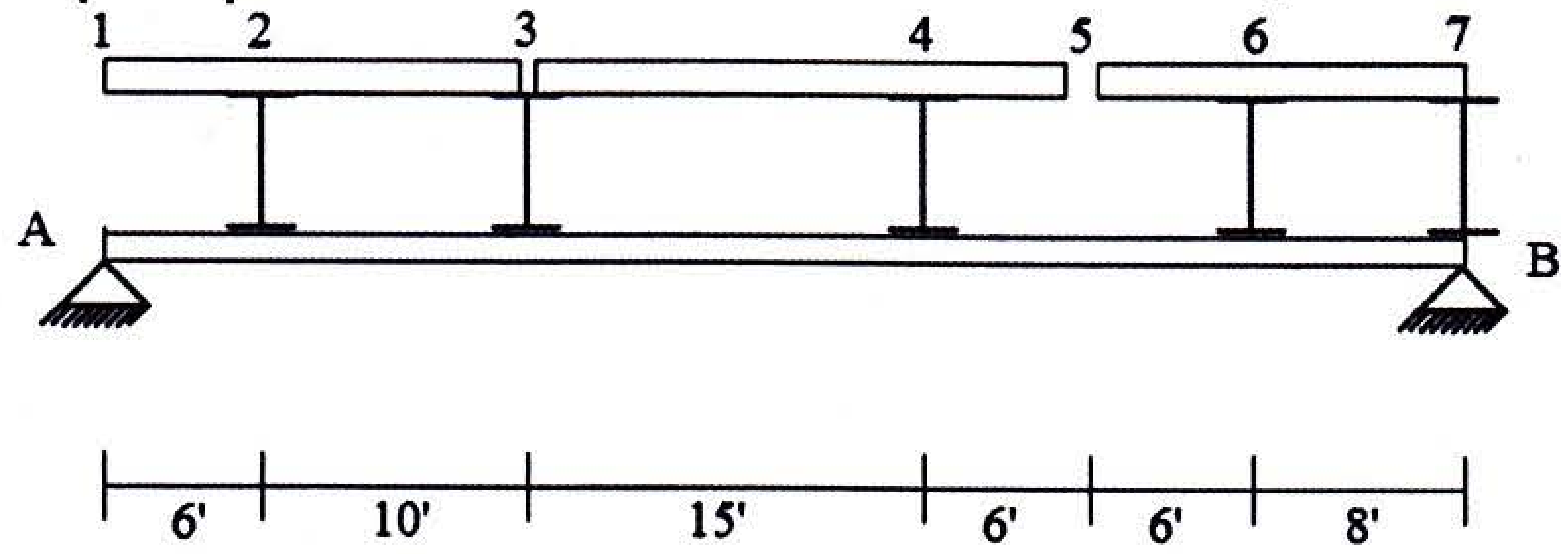
1. Draw the shear force and bending moment diagram for the structure shown in the figure below.



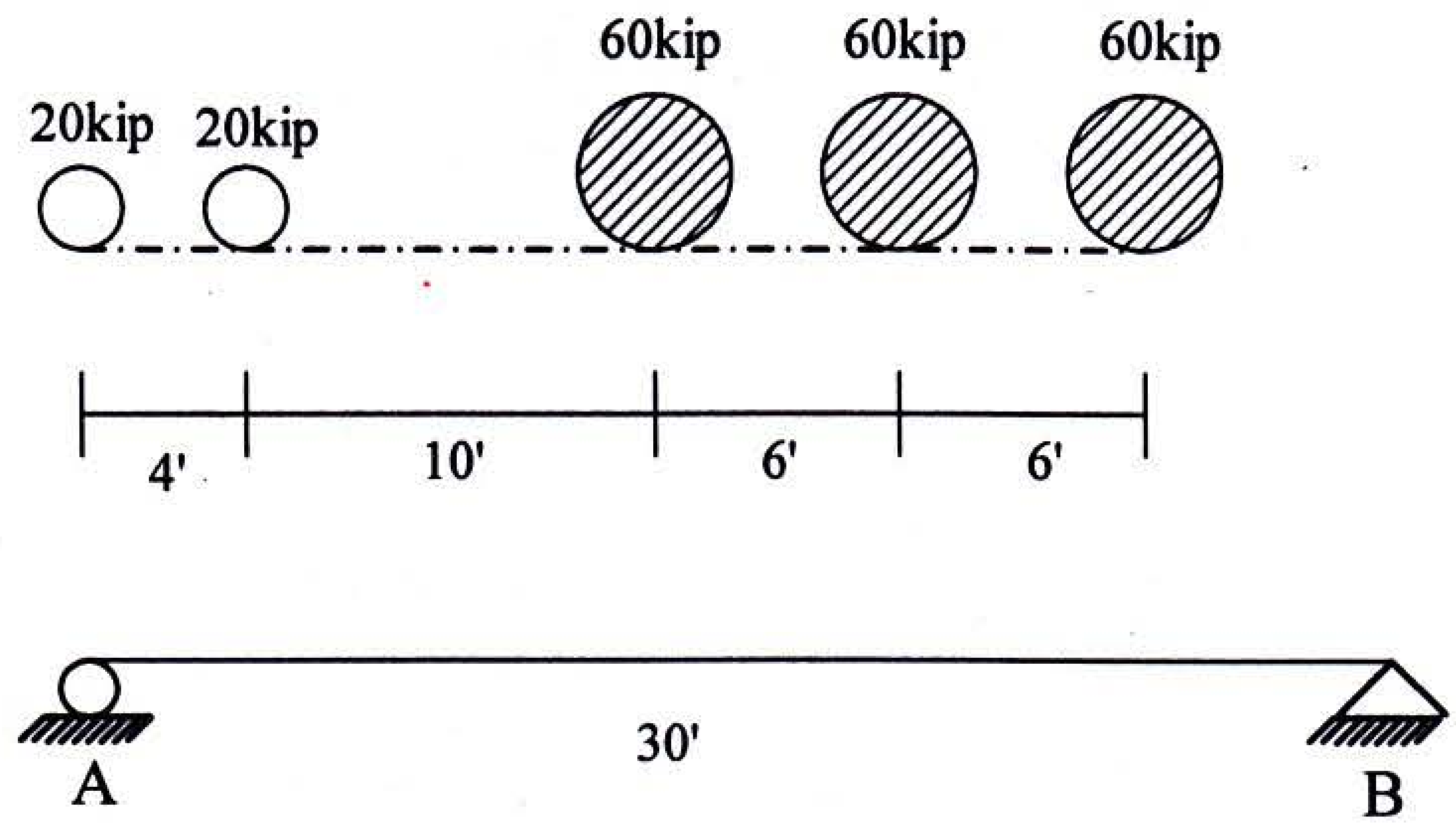
2. For the beam shown below, draw influence line for
   (i) Reaction at B (ii) Shear just left of F (iii) Moment at E (iv) Moment at D



3. Girder AB supports a floor system as shown in the figure below. Draw influence line for
   (i) Support reaction at B
   (ii) Floor beam reaction at panel point 4 and 6
   (iii) Shear in panel 2-3
   (iv) Bending moment at panel point 3

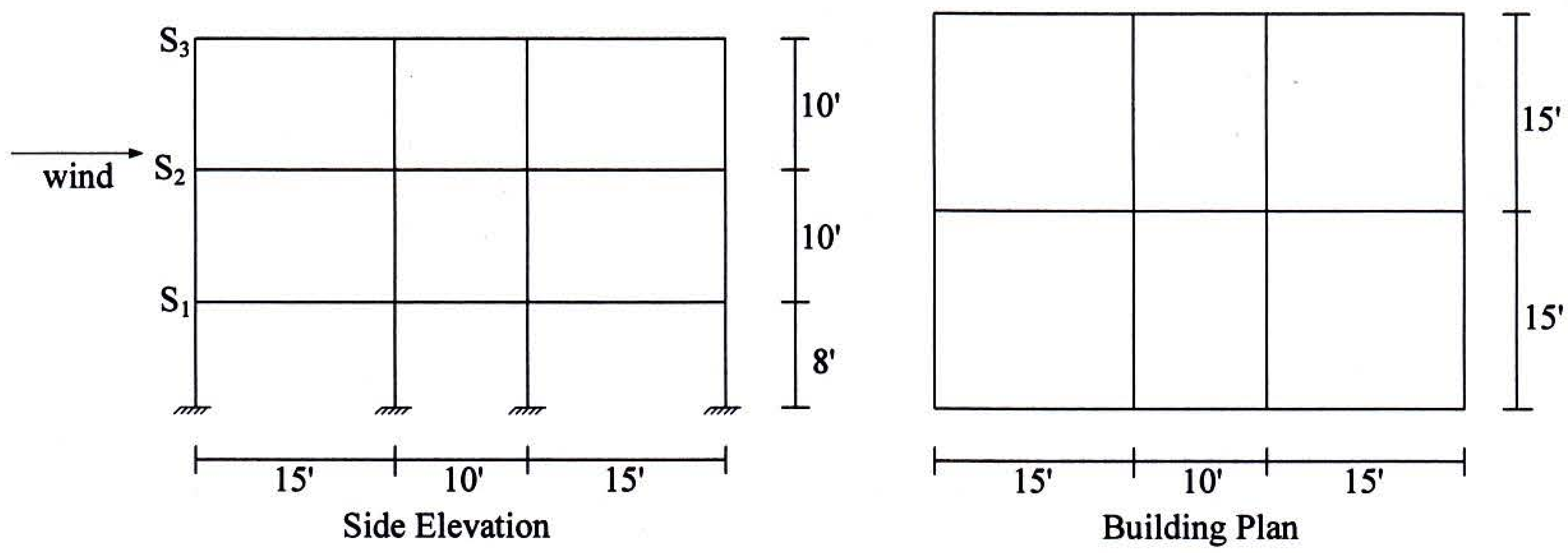


4. Calculate the maximum reaction at support A of the simple supported beam for the wheel load arrangement shown below.

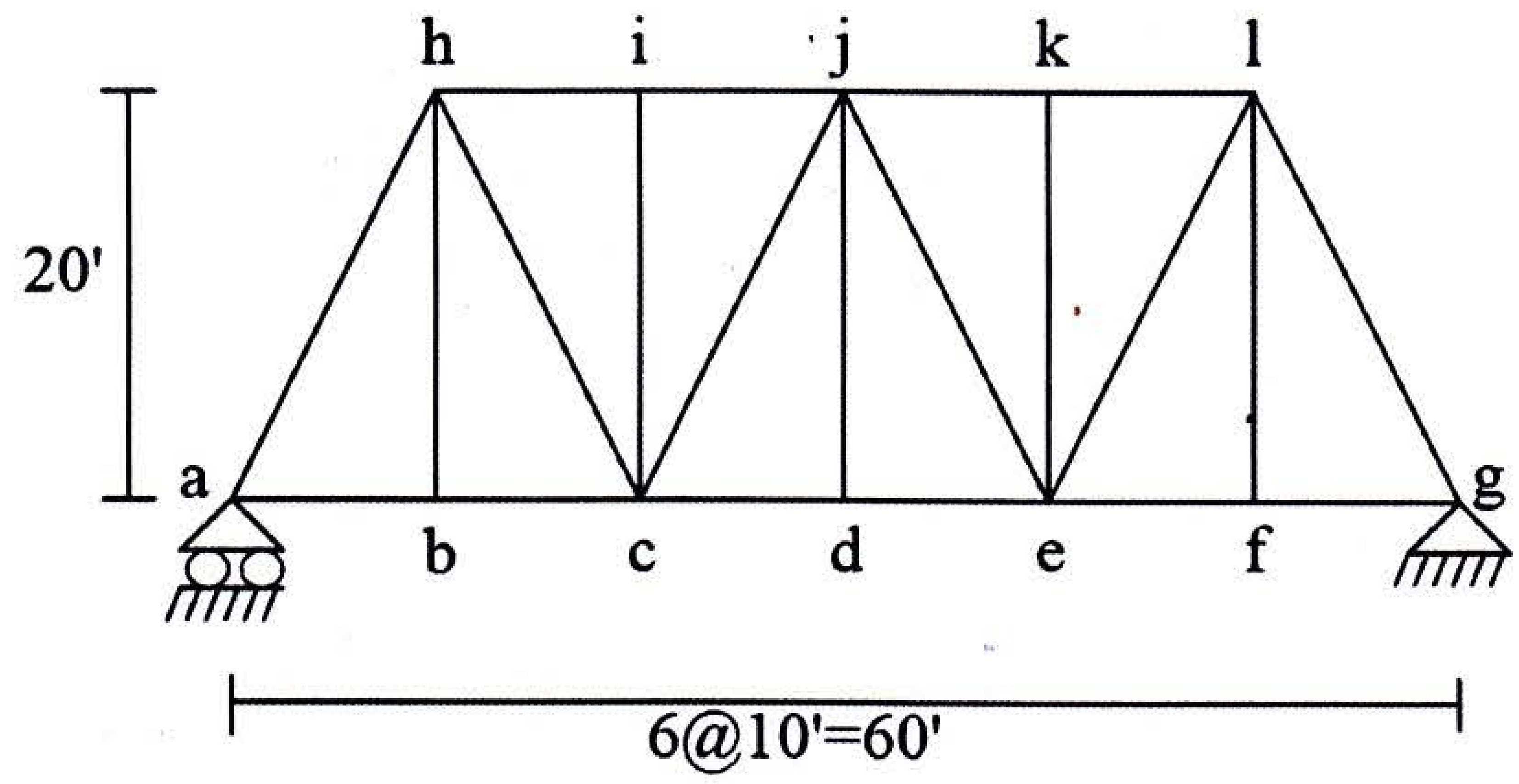


5. Calculate the maximum shear at one-fourth point from the left support of a 20' simple supported beam for the wheel load arrangement shown in question 4.

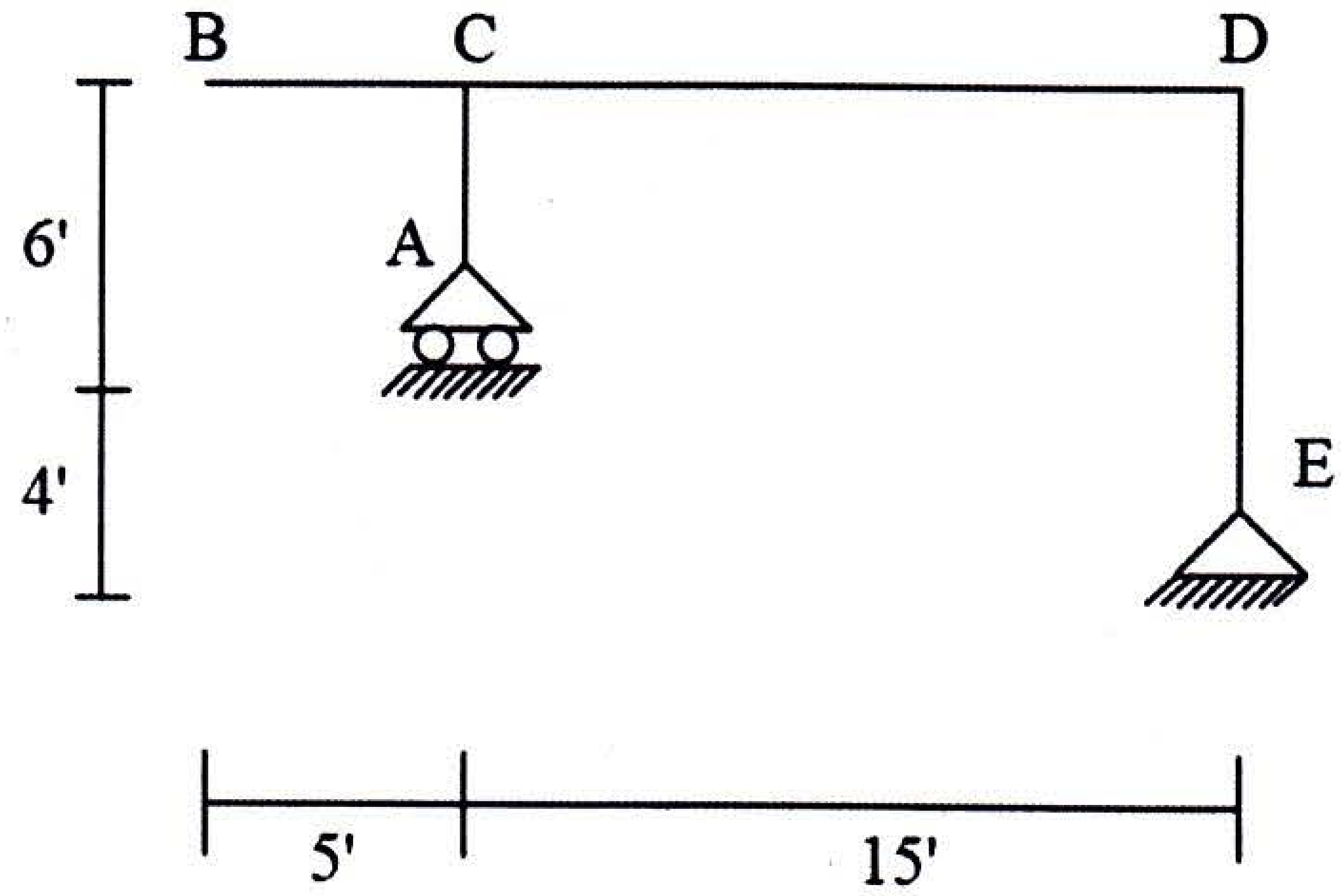
6. Calculate the design wind force at each story of the three-storied residential building located at a hilly terrain (with H=10′, Lu=100′) in Chittagong (Basic wind speed= 160 mph). Assume the structure to be subjected to Exposure B.



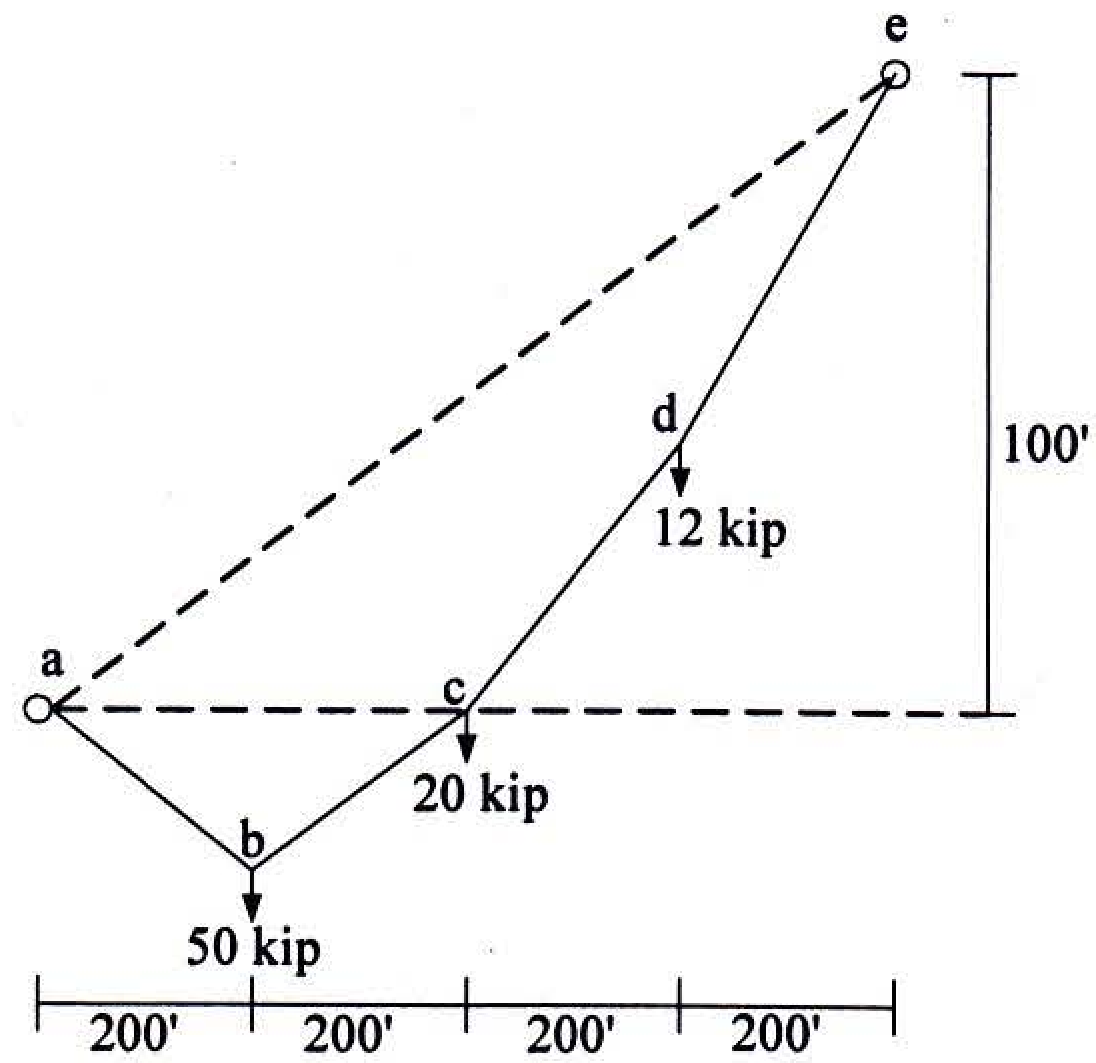
7. For the truss shown below, draw influence lines for F_{hc}, F_{bc} and F_{ic}. Note, each bottom chord joint consists of a cross girder and load moves over the floor beam placed over the girders.



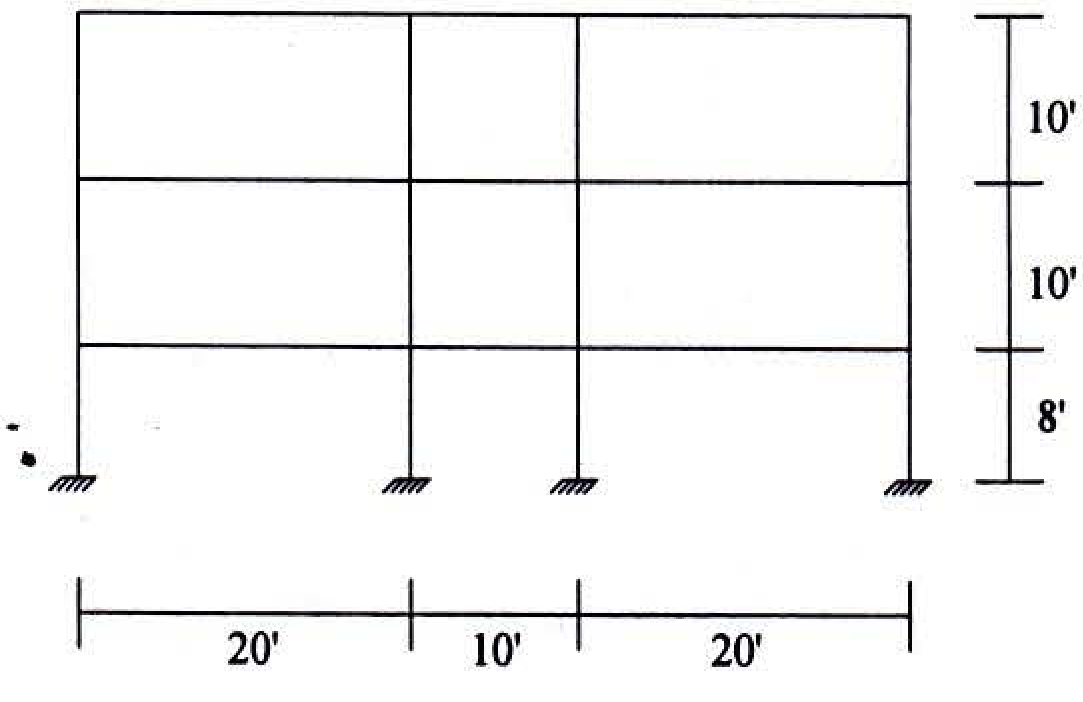
8. For the frame shown below, draw influence lines for
(i) R_A, (ii) R_E, (iii) $V_{c\text{-}right}$ (iv) M_{D}, if the unit load moves over column AC.



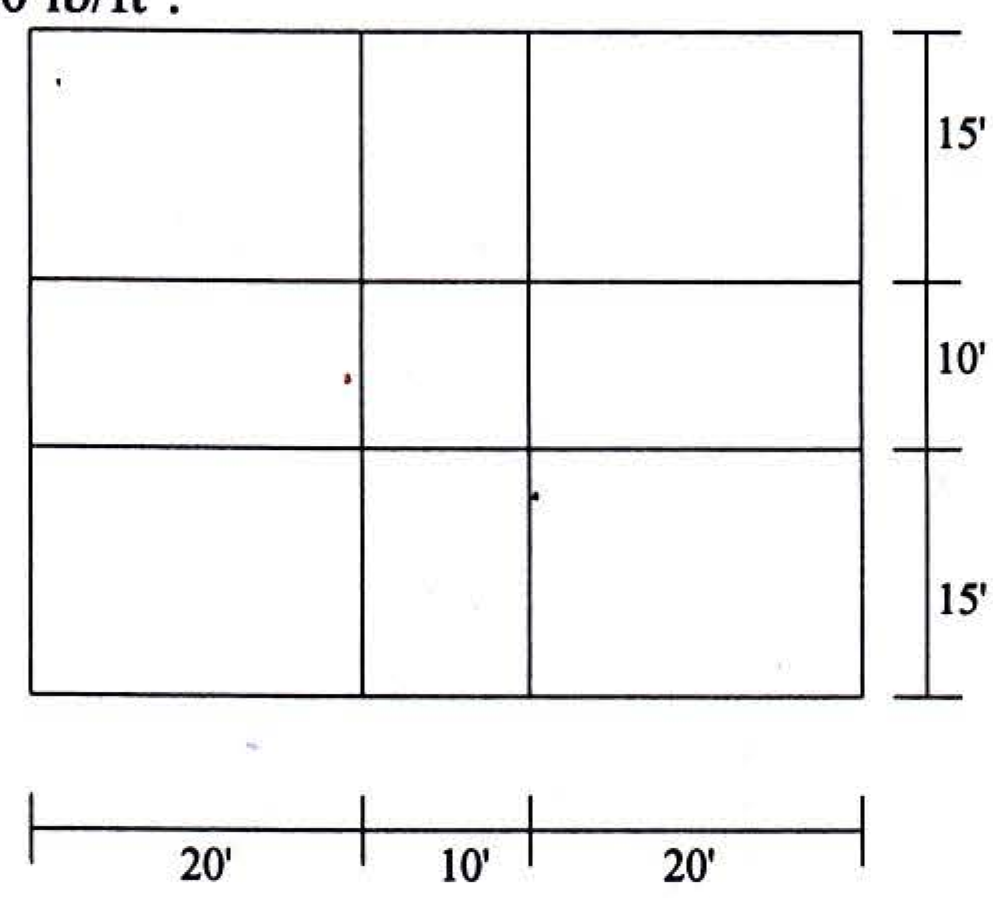
9. For the cable shown in the figure below, calculate the cable length and maximum cable tension.
Given: Maximum sag=50′



10. Calculate the seismic load at each story of frame AB of a three-storied concrete made residential building (shown below) located in Sylhet (Zone 3).
Assume the structure to be a Special Moment Resisting Frame (SMRF) built on soil condition S_2, carrying a Dead Load of 150 lb/ft^{2}and Live load of 40 lb/ft^2.

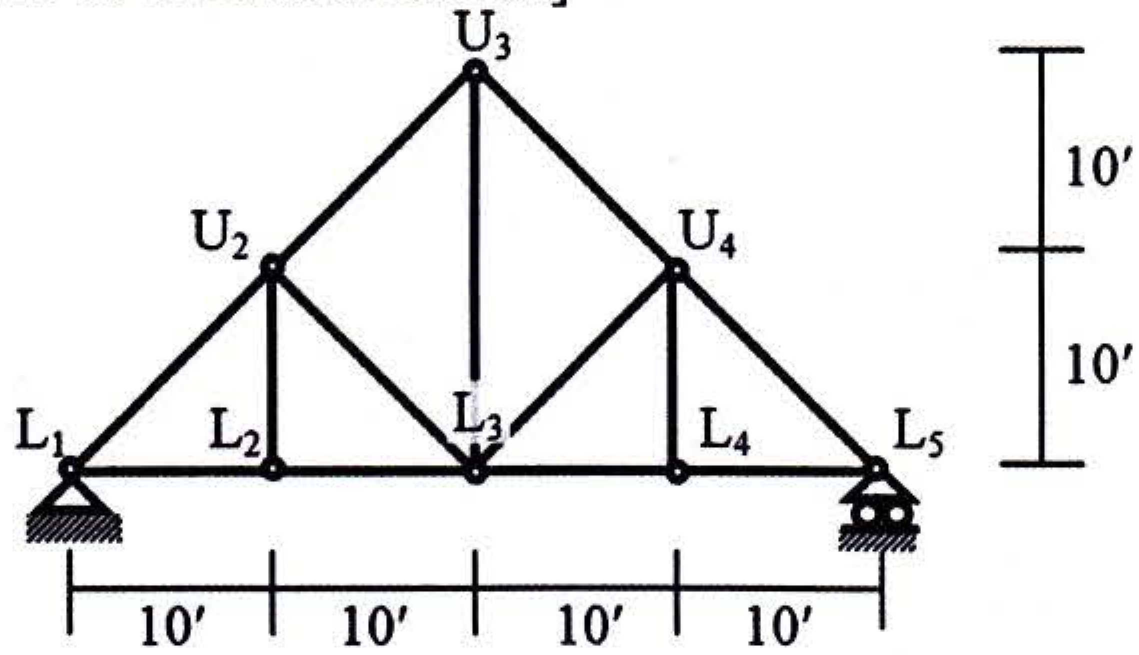


Side Elevation

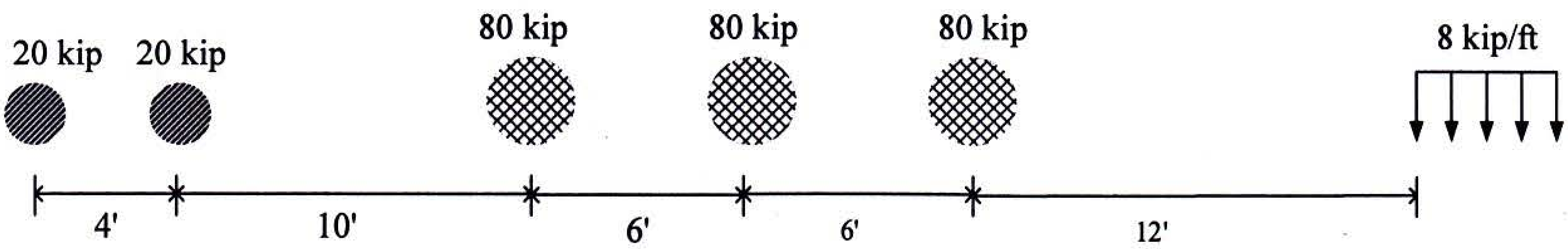


Building Plan

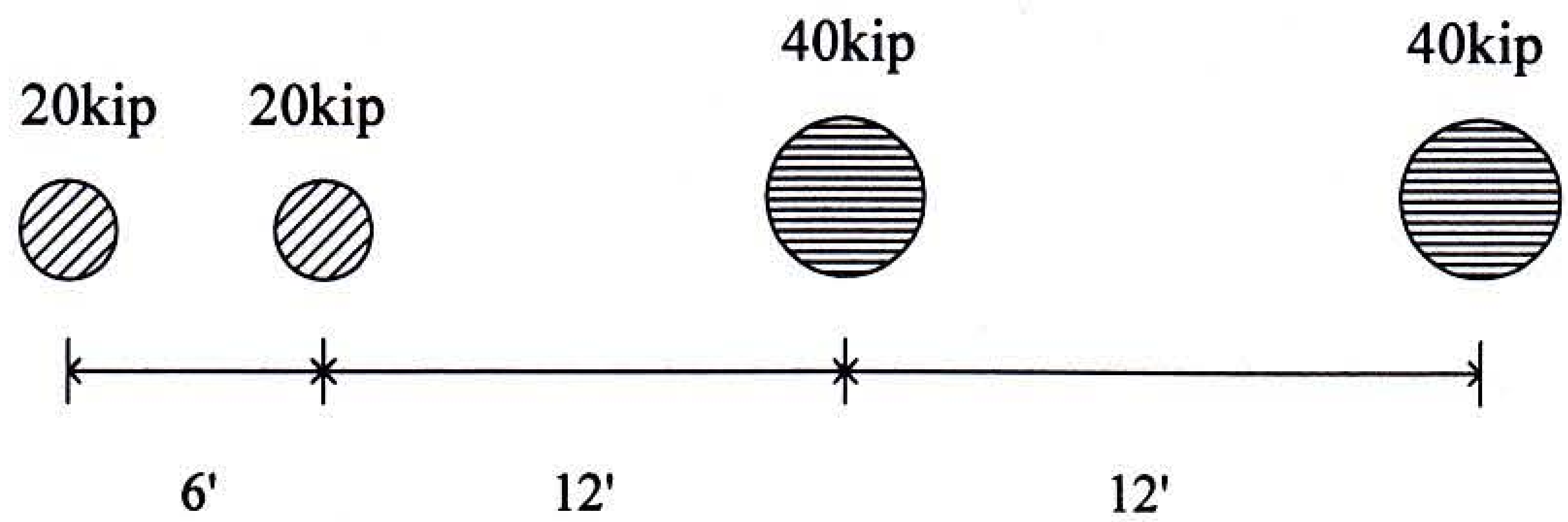
11. For the truss shown below, calculate the maximum axial force in member U_3U_4 for a uniformly distributed dead load of 2 kip/ft and a concentrated live load of 10 kip.
[Note: There are floor beams over bottom chords]



12. Calculate the maximum value of moment at 20' away from the left support of a 60' simple supported beam for the following wheel load arrangement.



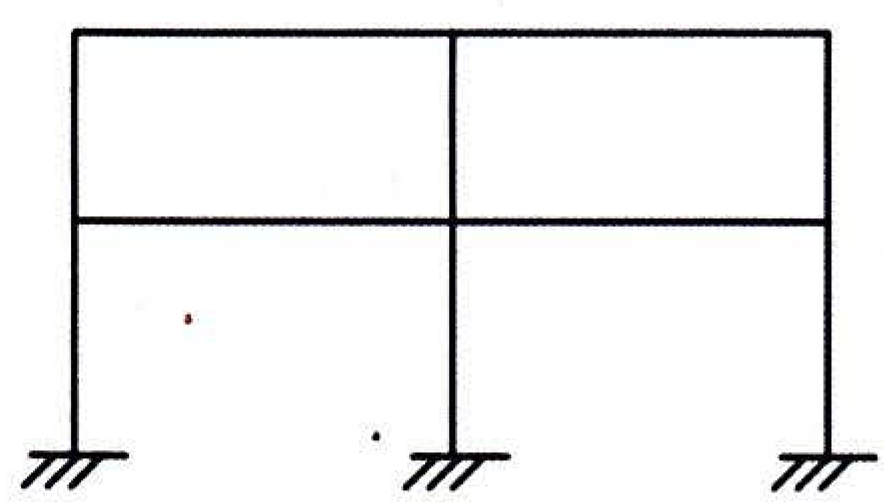
13. Compute the absolute maximum moment in a 30' simple supported beam for the wheel load arrangement shown in the figure below.



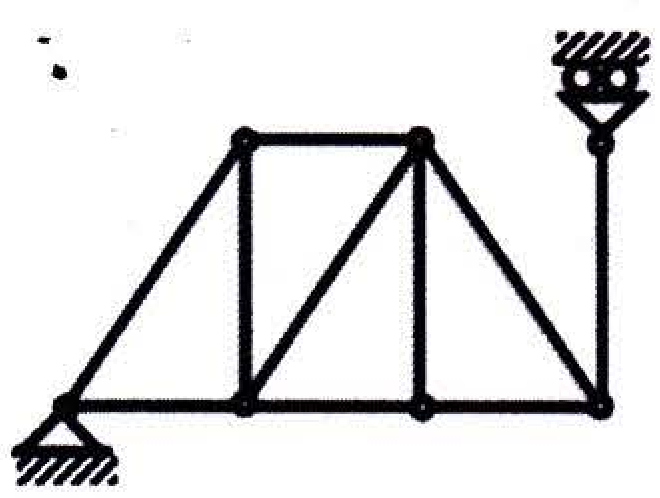
14. Determine whether the structures are statically and geometrically stable or unstable. Also calculate the degree of statical indeterminacy.

i.

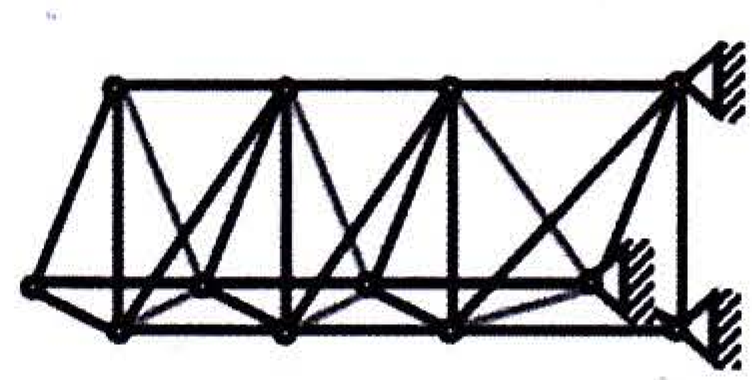
ii.



iii.



iv.



Annexure

Wind load:

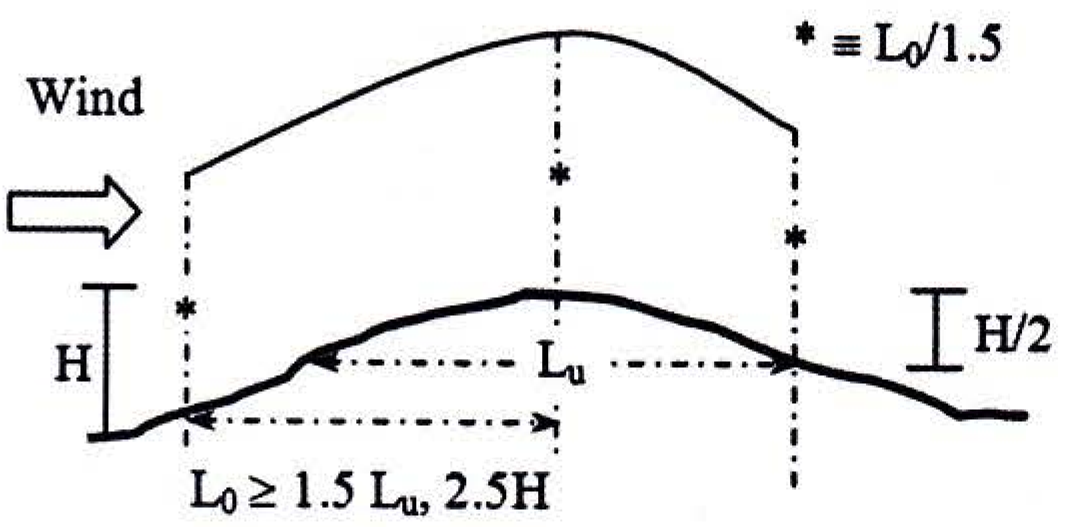
$q_z = 0.00256\, C_I\, C_z\, V_b^2$

$p_z = C_G\, C_t\, C_p\, q_z$

$Fz = B\, heff\, pz$

Category	C_I
Essential facilities	1.25
Hazardous facilities	1.25
Special occupancy	1.00
Standard occupancy	1.00
Low-risk structure	0.80

Height z (ft)	C_z		
	Exp A	Exp B	Exp C
0~15	0.368	0.801	1.196
50	0.624	1.125	1.517
100	0.849	1.371	1.743
150	1.017	1.539	1.890
200	1.155	1.671	2.002
300	1.383	1.876	2.171
400	1.572	2.037	2.299
500	1.736	2.171	2.404
650	1.973	2.357	2.547
1000	2.362	2.595	2.724



$H/2L_u$	C_t
0.05	1.19
0.10	1.39
0.20	1.85
0.30	2.37

Height z (ft)	C_G (for non-slender structures)		
	Exp A	Exp B	Exp C
0~15	1.654	1.321	1.154
50	1.418	1.215	1.097
100	1.309	1.162	1.067
150	1.252	1.133	1.051
200	1.215	1.114	1.039
300	1.166	1.087	1.024
400	1.134	1.070	1.013
500	1.111	1.057	1.005
650	1.082	1.040	1.000
1000	1.045	1.018	1.000

The pressure coefficient C_p for rectangular buildings with flat roofs:

h/B	L/B					
	0.1	0.5	0.65	1.0	2.0	≥ 3.0
≤ 0.5	1.40	1.45	1.55	1.40	1.15	1.10
1.0	1.55	1.85	2.00	1.70	1.30	1.15
2.0	1.80	2.25	2.55	2.00	1.40	1.20
≥ 4.0	1.95	2.50	2.80	2.20	1.60	1.25

Earthquake Load:

$V = (ZIC/R)\ W$

$Z = 0.075$, 0.15 and 0.25 for Seismic Zones 1, 2 and 3 respectively

$C = 1.25\ S/T^{2/3}$, The value of C need not exceed 2.75, The minimum value of the ratio C/R is 0.075

$T = C_t\ (h_n)^{3/4}$

$C_t = 0.083$ for steel moment resisting frames, 0.073 for RCC moment resisting frames, and eccentric braced steel frames, 0.049 for all other structural systems

$V = F_t + \sum F_i$

$F_t = 0.07\ TV \leq 0.25V$ when $T > 0.7$ second, and $= 0$, when $T \leq 0.7$ second

$F_j = (V - F_t)\ [w_j h_j / \sum w_i h_i]$

Category	C_I
Essential facilities	1.25
Hazardous facilities	1.25
Special occupancy	1.00
Standard occupancy	1.00
Low-risk structure	0.80

Site Coefficient, S for Seismic Lateral Forces

Soil Type	**S**
S_1	1
S_2	1.2
S_3	1.5
S_4	2

Response Modification Coefficient, R for Structural Systems

Basic Structural System	Description Of Lateral Force Resisting System	R
Moment Resisting Frame System	Special moment resisting frames (SMRF) (i) Steel (ii) Concrete Intermediate moment resisting frames (IMRF), concrete Ordinary moment resisting frames (OMRF) (i) Steel (ii) Concrete	 12 12 8 6 5

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Course Title: Design of Concrete Structures I — Course Code: CE 315

Time- 3 hours — Full marks: 140

Assume any missing data reasonably.

Answer any Seven (07) of the following Nine (09) questions.

Consider material strengths $f'_c = 4\ ksi$ and $f_y = 60\ ksi$ for all cases.

The stress-strain curves of the materials provided in Appendix.

1. Figure: 01 shows the cross-section of a reinforced concrete column. (20)

(a) For this column determine the
(i) axial load that causes the stress at concrete to be 1300 psi
(ii) load at which the steel starts yielding
(iii) maximum load the column can sustain
(iv) share of total load carried by the reinforcement at these three stages of loading [mentioned in (i)~(iii)].

(b) Compare results with those for f_y = 40 ksi, keeping in mind, in regard to relative economy, that the price per pound for reinforcing steels with 40 and 60 ksi yield strengths is about the same.

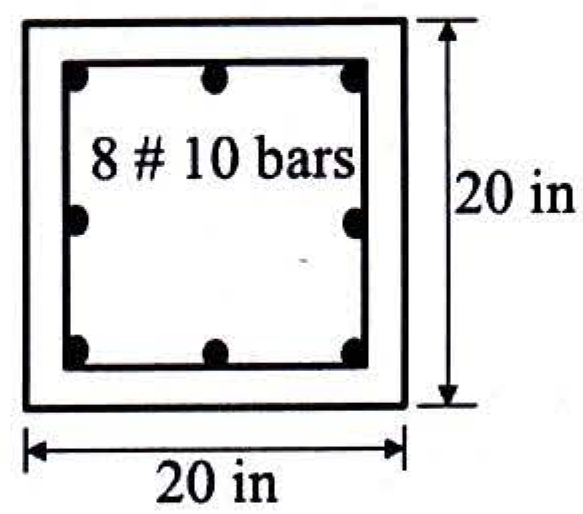


Figure: 01

2. (a) Write the difference between WSD and USD method. (05)

(b) A cross-section of a rectangular beam as shown in Figure: 02. The concrete tensile strength in bending (i.e. its modulus of rupture) is 475 psi. (15)

Determine the stresses caused by a bending moment equal to

(i) 45 kip-ft

(ii) 120 kip-ft

Compare and comment on your answer.

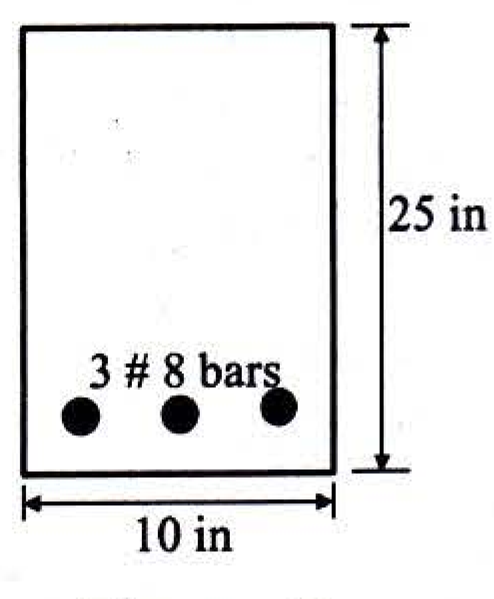


Figure: 02

3. (a) Explain (with neat sketch) the behavior of reinforced concrete beam under different loading conditions. (04)

(b) Architectural considerations specify the section of a beam as shown in Figure: 03. (16)

Calculate the required reinforcements of the beam for the applied Dead load = 0.79 kip/ft, and Live load = 1.65 kip/ft.

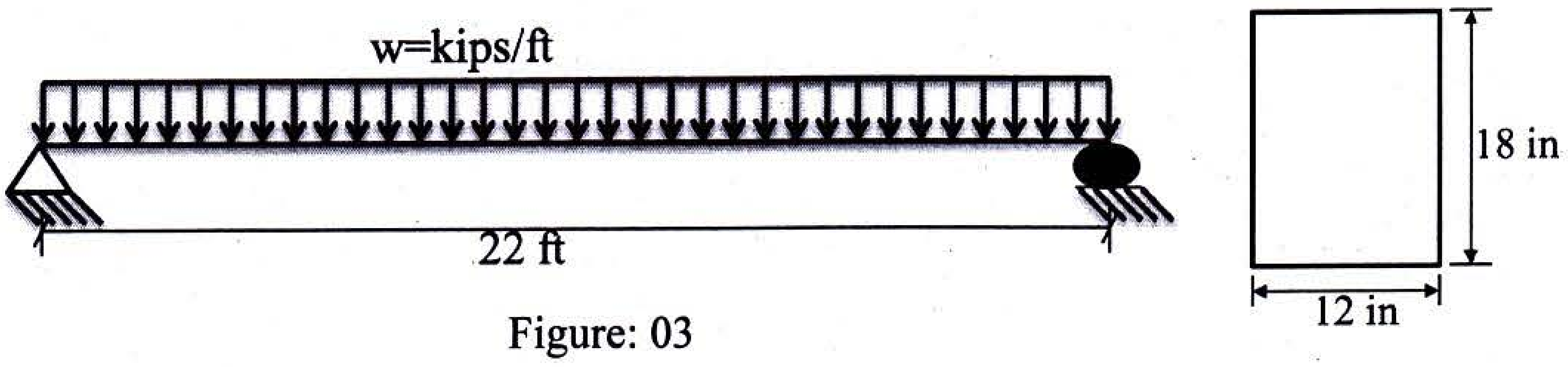


Figure: 03

4. (a) Write down the practical considerations in the design of a reinforced concrete beam. (04)

(b) Write down the fundamental assumptions relating to flexure and flexural shear of a reinforced concrete beam. (06)

(c) Use the **WSD** method to determine the allowable live load w_l (kip/ft) for the beam loaded as shown in Figure: 04, considering beam self-weight as the only dead load. (10)

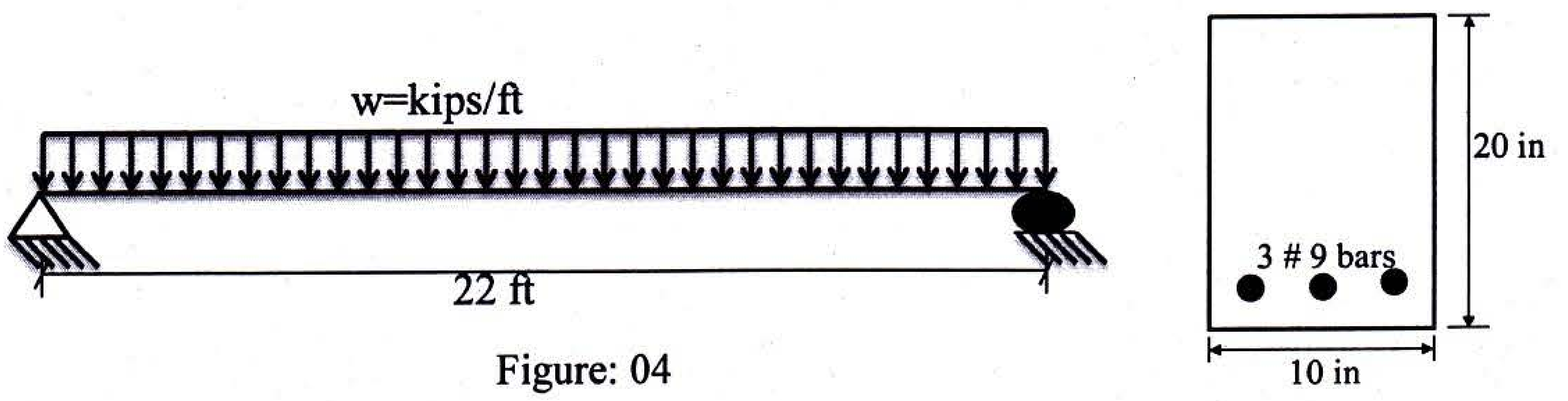


Figure: 04

5. (a) Define reinforced concrete T-beam. (03)
Write the criteria for selecting effective flange width of T-beam.

(b) A floor system, shown in Figure: 05, consists of a 4 *in.* concrete slab supported by continuous T-beams (50 *in.* on centers). Web dimensions, as determined by negative-moment requirements at the supports are $b_w = 10$ *in.* and $d = 18$ *in.* (17)

Calculate the tensile steel area required for the beam [A] to resist factored positive moment of 7000 *kip-in*.

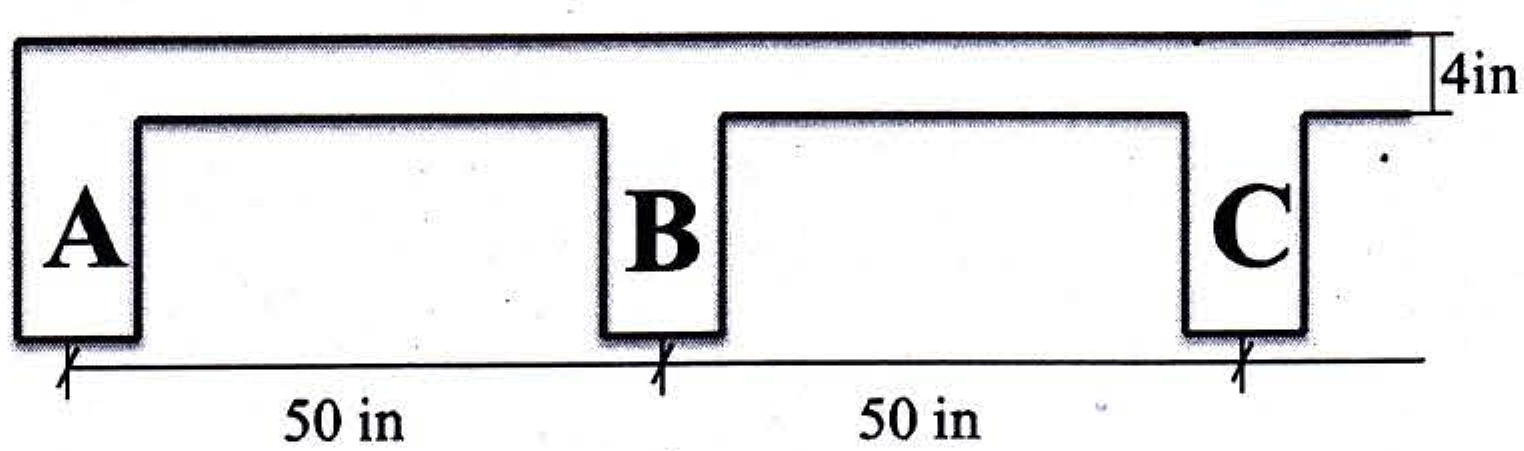


Figure: 05

6. Figure: 06 shows a simply supported rectangular beam with a cross-section having 16 *in.* width and an effective depth of 22 *in.* (20)

It is reinforced with 7.62 in^2 of tensile steel, which continues uninterrupted into the supports.

Design the vertical stirrups for the beam and show details of the stirrups in a sketch.

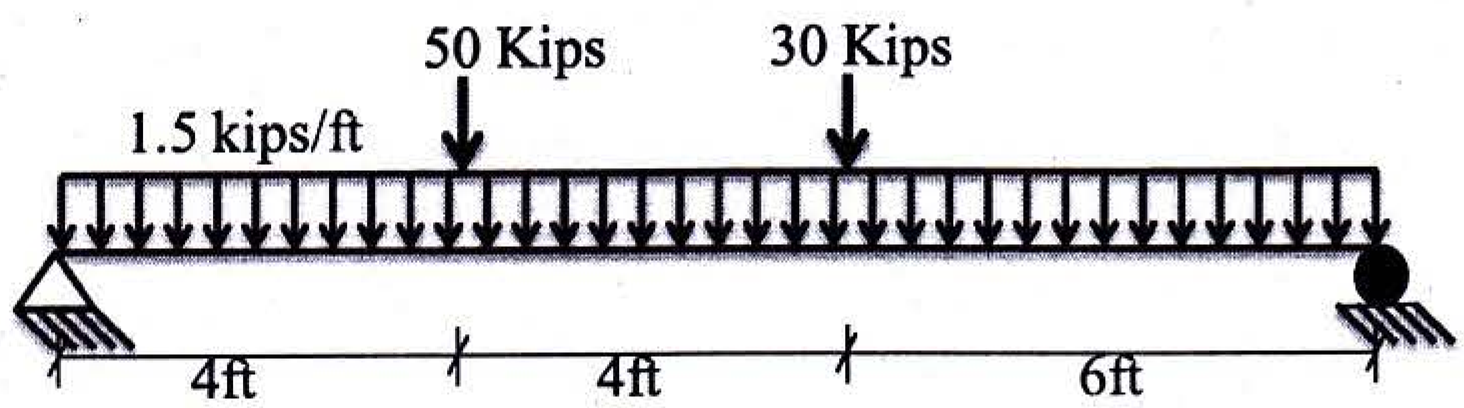


Figure: 06

7. Based on frame analysis, the negative steel required at the end of the beam is 2.25 in^2; two No. 10 bars are used, providing $A_s = 2.54\ in^2$. (20)

Beam dimensions are $b = 11$ *in.* and $h = 21$ *in.*

The design will include No. 3 stirrups spaced four at 3 *in.*, followed by constant 4.5 *in.* spacing in the region of the support, with 1.5 *in.* clear cover.

Determine the minimum distance l_d at which the negative bars can be cut off, based on development of the required steel area at the face of the column, using the simplified and more accurate equations.

Also, calculate l_d considering hook at the bend of bars. Comment on your answers.

8. (a) Sketch the design requirements for hook bars according to BNBC/ACI code for stirrups and main reinforcement. (06)

(b) Write down the factors that influence the development length (l_d) of reinforcing bars. (04)

(c) Calculate the lap-splice length of the column. A tied column with (18 *in.* × 18 *in.*) cross-section has eight no. 09 longitudinal bars and no.3 ties. (10)

Solve for (i) $f_y = 60$ *ksi*, and (ii) $f_y = 80$ *ksi*.

9. Figure: 07 shows a reinforced concrete slab built integrally with its supports. The service live load on the slab is 120 *psf.* (20)

(a) Select the slab panels that fulfill the design criteria of one-way slab.

(b) Design (according to BNBC/ACI Code) a slab-panel among the ones selected in (a).

Also, show the reinforcement details in a cross-section of the slab panel.

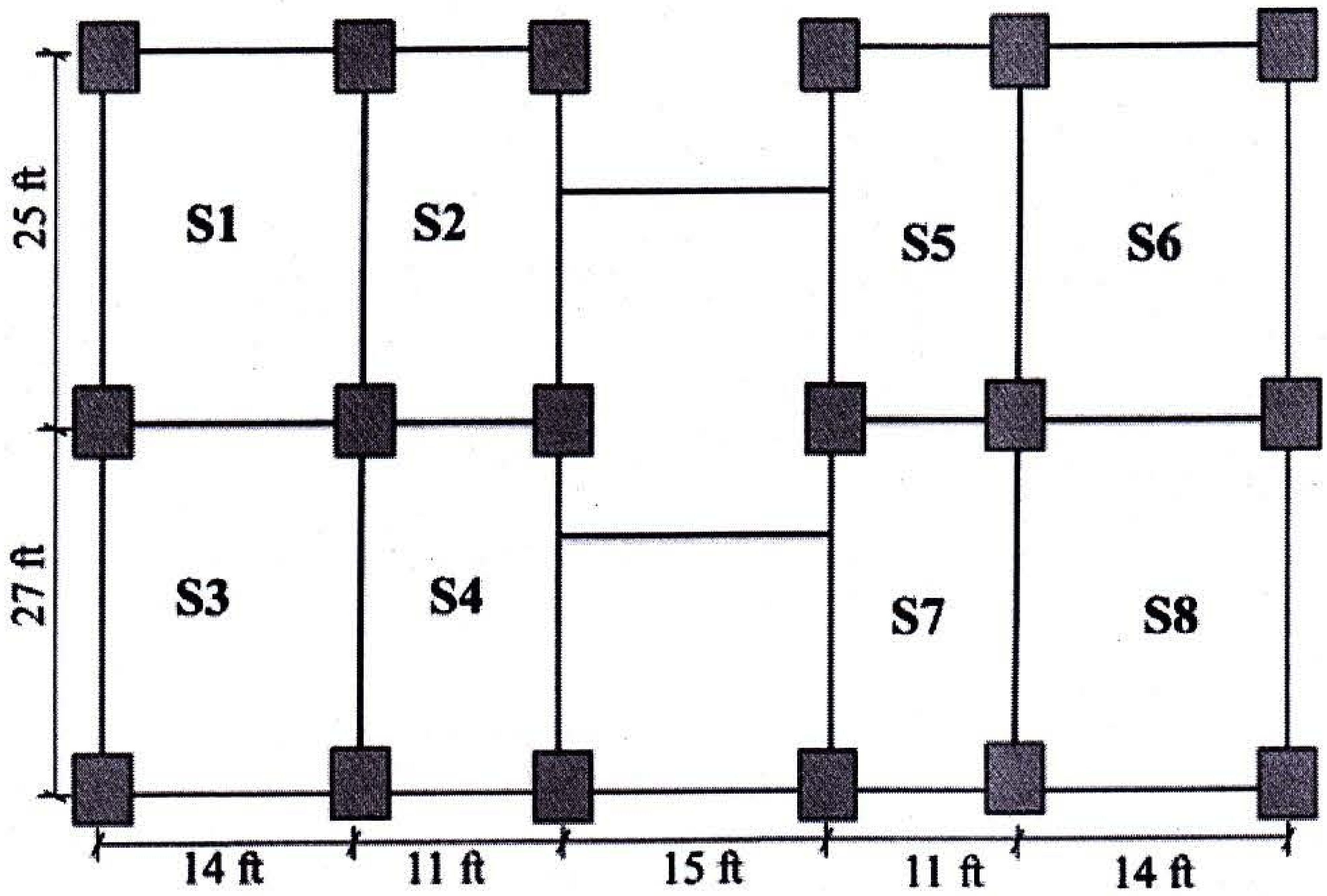


Figure: 07

APPENDIX

1. $P = fc[Ag + (n - 1)Ast]$	11. $As,min = 3\frac{\sqrt{fc'}}{fy} b_w d \geq 200\frac{b_w d}{fy}$
2. $P = fc[Ag + (n - 1)Ast]$	12. $M_{n1} = As' fy(d - d')$
3. $Pn = 0.85\ fc'\ Ac + fyAst$	13. $M_{n2} = (As - As')fy\left(d - \frac{a}{2}\right)$
4. $M = \frac{fc}{2}kjbd^2$; $j = 1 - \frac{k}{3}$	14. $a = \frac{(As - As')fy}{0.85\ fc'b}$
5. $k = \sqrt{(\rho n)^2 + 2\rho n} - \rho n$	15. $M_n = M_{n1} + M_{n2}$
6. $Mn = \rho fybd^2\left(1 - 0.59\frac{\rho fy}{fc'}\right)$	16. $\rho_{0.005} = \rho_{0.005} + \rho'$
7. $fs = \epsilon_u E_s \frac{d - c}{c}$	17. $M_{n1} = A_{sf}\ f_y\left(d - \frac{hf}{2}\right)$
8. $\frac{c = \epsilon_u}{\epsilon_u + \epsilon_y} d$	18. $a = \frac{(As - A_{sf})fy}{0.85\ fc'bw}$
9. $\rho_b = \frac{\alpha fc'}{fy}\frac{\epsilon u}{\epsilon u + \epsilon y}$	19. $M_{n2} = (A_s - A_{sf})f_y\left(d - \frac{a}{2}\right)$
10. $\beta 1 = 0.85 - 0.05\frac{fc' - 4000}{1000}$ for $0.65 \leq \beta 1 \leq 0.85$	20. $Av,min = 0.75\sqrt{fc'}\frac{b_w s}{fyt} \geq \frac{50 b_w s}{fyt}$

APPENDIX

21. $$\rho_{0.005} = \frac{0.85\beta_1 \left(\frac{fc'}{fy}\right) \epsilon_u}{\epsilon_u + 0.005}$$

24. $$s = \frac{\phi A_v f_{yt} d}{Vu - \phi Vc}$$

22. $$Mn = A_s f_y \left(d - \frac{a}{2}\right)$$

25. $$s = \frac{\phi Avfytd\,(\sin\alpha + \cos\alpha)}{Vu - \phi Vc}$$

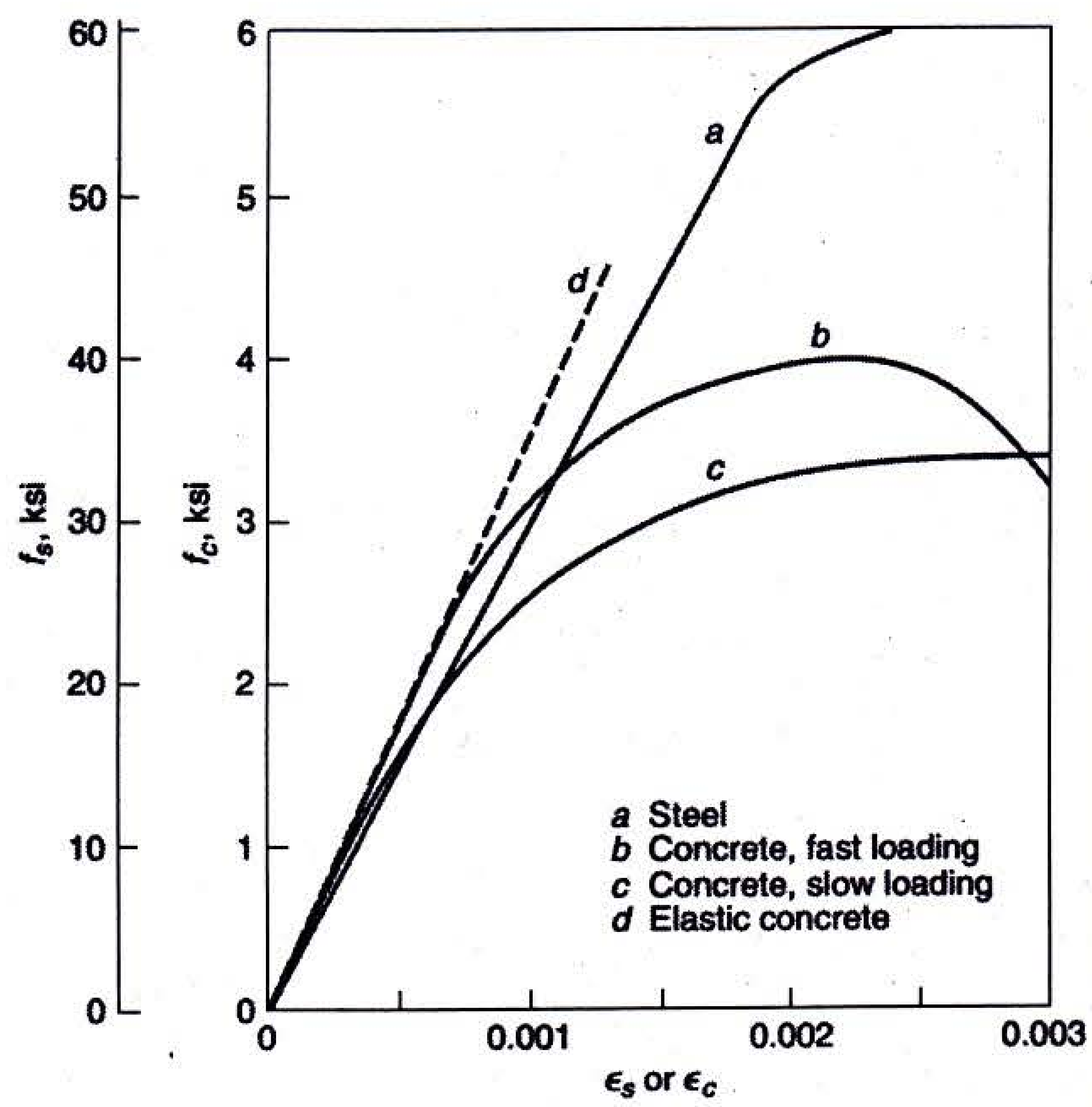
23. $$a = \frac{Asfy}{0.85\, fc'b}$$

26. $$s_{max} = \frac{A_v f_{yt}}{0.75\sqrt{fc'}\, b_w} \leq \frac{A_v f_{yt}}{50\, bw}\ ;\ \frac{d}{2}\ ;\ 24 \text{ in}$$

27. $$\frac{l_d}{d_b} = \left(\frac{3}{40\lambda}\right)\left(\frac{f_y}{\sqrt{f_c'}}\right)\left(\frac{\psi_t\psi_e\psi_s}{(c_b + K_{tr})/d_b}\right)$$

28. $$\frac{l_d}{d_b} = \begin{cases} \dfrac{f_y\psi_t\psi_e}{25\lambda\sqrt{f_c'}} & \text{No.6 and smaller bars} \\ \dfrac{f_y\psi_t\psi_e}{20\lambda\sqrt{f_c'}} & \text{No.7 and larger bars} \\ \dfrac{3f_y\psi_t\psi_e}{50\lambda\sqrt{f_c'}} & \text{No.6 and smaller bars} \\ \dfrac{3f_y\psi_t\psi_e}{40\lambda\sqrt{f_c'}} & \text{No.7 and larger bars} \end{cases}$$

Stress



Strain

Figure: Stress-strain curve

APPENDIX

Symbol	Variable	Value
Ψt	*Horizontal reinforcement, placed>12 in. is below the development length *All other reinforcement	1.3 1.0
Ψe	*Epoxy-coated bars <3db or clear spacing<6db *Other epoxy-coated bars *Uncoated	1.5 1.2 1.0
Ψs	>= #7 bars <= #6 bars	1.0 0.8
λ	*Light Weight concrete *Normal concrete	1.3 1.0

TABLE 11.1
Moment and shear values using ACI coefficient[†]

Positive moment	
End spans	
If discontinuous end is integral with the support	$\frac{1}{14} w_u \ell_n^2$
If discontinuous end is unrestrained	$\frac{1}{11} w_u \ell_n^2$
Interior spans	$\frac{1}{16} w_u \ell_n^2$
Negative moment at interior faces of exterior supports for members built integrally with their supports	
Where the support is a spandrel beam or girder	$\frac{1}{24} w_u \ell_n^2$
Where the support is a column	$\frac{1}{16} w_u \ell_n^2$
Negative moment at exterior face of first interior support	
Two spans	$\frac{1}{9} w_u \ell_n^2$
More than two spans	$\frac{1}{10} w_u \ell_n^2$
Negative moment at other faces of interior supports	$\frac{1}{11} w_u \ell_n^2$
Negative moment at face of all supports for (1) slabs with spans not exceeding 10 ft and (2) beams and girders where ratio of sum of column stiffness to beam stiffness exceeds 8 at each end of the span	$\frac{1}{12} w_u \ell_n^2$
Shear in end members at first interior support	$1.15 \frac{w_u \ell_n}{2}$
Shear at all other supports	$\frac{w_u \ell_n}{2}$

[†] w_u = total factored load per unit length of beam or per unit area of slab.

ℓ_n = clear span for positive moment and shear and the average of the two adjacent clear spans for negative moment.

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2017
Program: B.Sc. Engineering (Civil)

Course Title: Environmental Engineering I — Course No: CE 331
Time: 3.0 hours — Full Marks: 100

There are six (6) questions. Question no. 6 is compulsory. Answer question no. 6 and any four (4) questions (20+20×4=100). Assume any missing data.

1. (a) What is per capita demand? Discuss the factors affecting the water demand of an area. [3+7]

   (b) Draw a figure showing water conveyance in a water supply system and explain the following terms from your figure:
   i) Water delivery ii) Water production iii) Water demand. [5]

   (c) Predict the population in the year 2041 from the following data. Use appropriate method. [5]

Year	1981	1991	2001	2011	2021
Population	7	10	12	13	16

2. (a) With a schematic diagram explain: i) Confined aquifer; and ii) Unconfined aquifer. [5]

   (b) Discuss the advantages and disadvantages of rainwater harvesting system as an alternative water supply option. [5]

   (c) Derive the equation of well discharge for a confined aquifer. A 100mm diameter tube well is sunk to withdraw water from a 10 m thick confined aquifer having K=0.75 lps/m^2. The drawdown is 2m in the tube well while pumping. Calculate the tube well discharge when radius of circle of influence is 30 m. [7+3]

3. (a) Differentiate between potable water and palatable water. What types of impurities are often found in water? Mention the objectives of water treatment. Explain the theories of filtration in water treatment process. [2+2+2+4]

   (b) What is the mechanism of centrifugal pumps? Design a pumping unit to deliver water with a supply rate of 40 gpcd for an area having population of 85000. The ground R.L. at the pump house and the treatment plant are 103 ft and 193 ft respectively. Assume: Pumping time= 10 hours/day; Total length of pipe= 3500 ft; Velocity of water through pipe = 8 fps; Friction factor = 0.0075; Pump efficiency = 70%. [3+7]

4. (a) With a schematic diagram show different types settling of particles in a sedimentation tank. Prove that the efficiency of a sedimentation tank is independent over depth. [3+7]

   (b) Draw a typical chlorination curve and explain the reaction zones. Explain pre-chlorination, post chlorination, re-chlorination, de-chlorination, super chlorination. [5+5]

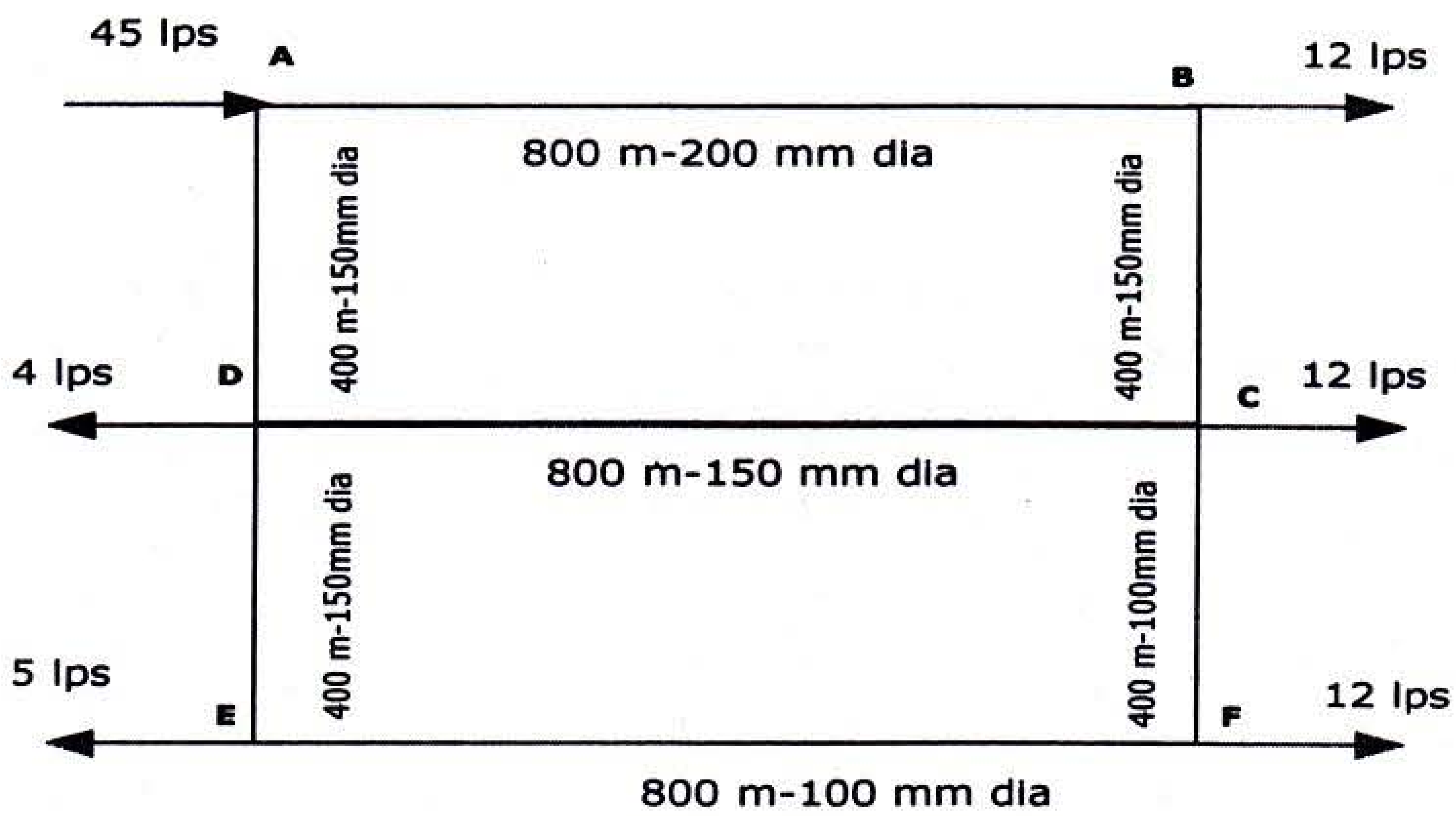
5. (a) With schematic diagrams describe different types of water transmission and

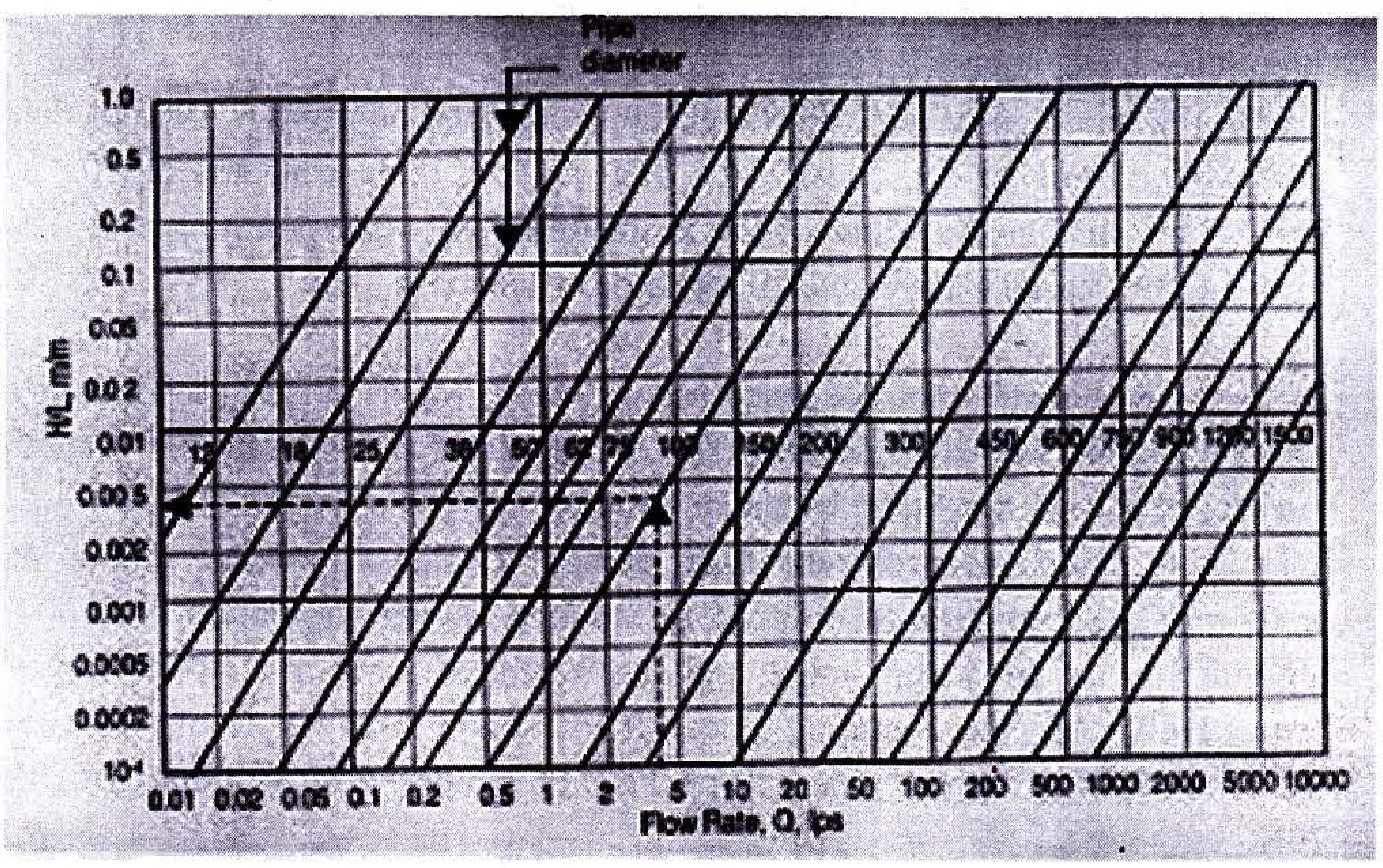
distribution systems. Enlist advantages and disadvantages of such systems. [5+5]

(b) Write short notes on: i) Metering of water; ii) Cost of water. [5+5]

6\. (a) Mention water quality standards according to WHO and BECR guidelines for the following parameters: pH, Hardness, Color, Iron, Arsenic. Enlist commonly used coagulants in coagulation-flocculation process. [3+2]

(b) What assumptions are taken while following Hardy-Cross method to compute water flow? Calculate the corrected flows in the various pipes of a distribution network as shown in the following figure. The diameters and lengths of the pipes used are given against each pipe (two trials are required). Use the following graph if required. [5+10]





University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2017
Program: B.Sc. Engineering (Civil)

Course Title: Geotechnical Engineering I — Course Code: CE 341
Time: 3 hours — Full Marks: 100

Answer the following questions.

1. The results if sieve analysis and Atterberg's limits tests are given in Table 1:

(i) Identify the gradation (poorly graded or well graded) of the soil, according to Unified Soil Classification System (USCS). 6

(ii) Judge that the classification of soil as 'SW-SM' (for the data given in Table 1) is correct according to Unified Soil Classification System (USCS). 2
Provide justification for the format of group symbol and 'M'.

(iii) Identify the minor modification in the given data that can change the group symbol to 'SW'. 2

Table 1 (Question No. 1)

Sieve Analysis	
Particle size (mm)	**% Finer**
6	100
4.75	90
2.36	84
1.3	60
0.6	30
0.2	10
0.075	8
Atterberg's Limits	
Liquid Limit	30%
Plastic Limit	27%

2. The results of compaction tests are given in Fig.1.

(i) Determine $\Upsilon_{d(max)}$ and OMC for both standard and modified Proctor tests. 2

(ii) Convert the field test results (Υ) into $\Upsilon_{d(field)}$. Field Test Results are given in Table 2. 2

(iii) Calculate field relative compaction (i.e., the ratio of $\Upsilon_{d(field)}$ to $\Upsilon_{d(max)}$) using modified Proctor test results. 4

(iv) Compare between the % field compaction (calculated in (iii)) and the required field compaction. 2
According to project specification, the required field compaction is 98% of modified Proctor $\Upsilon_{d(max)}$.

Table 2: Field density test result

Water content (%)	Υ (kN/m^3)
10	16.5
11	16.9

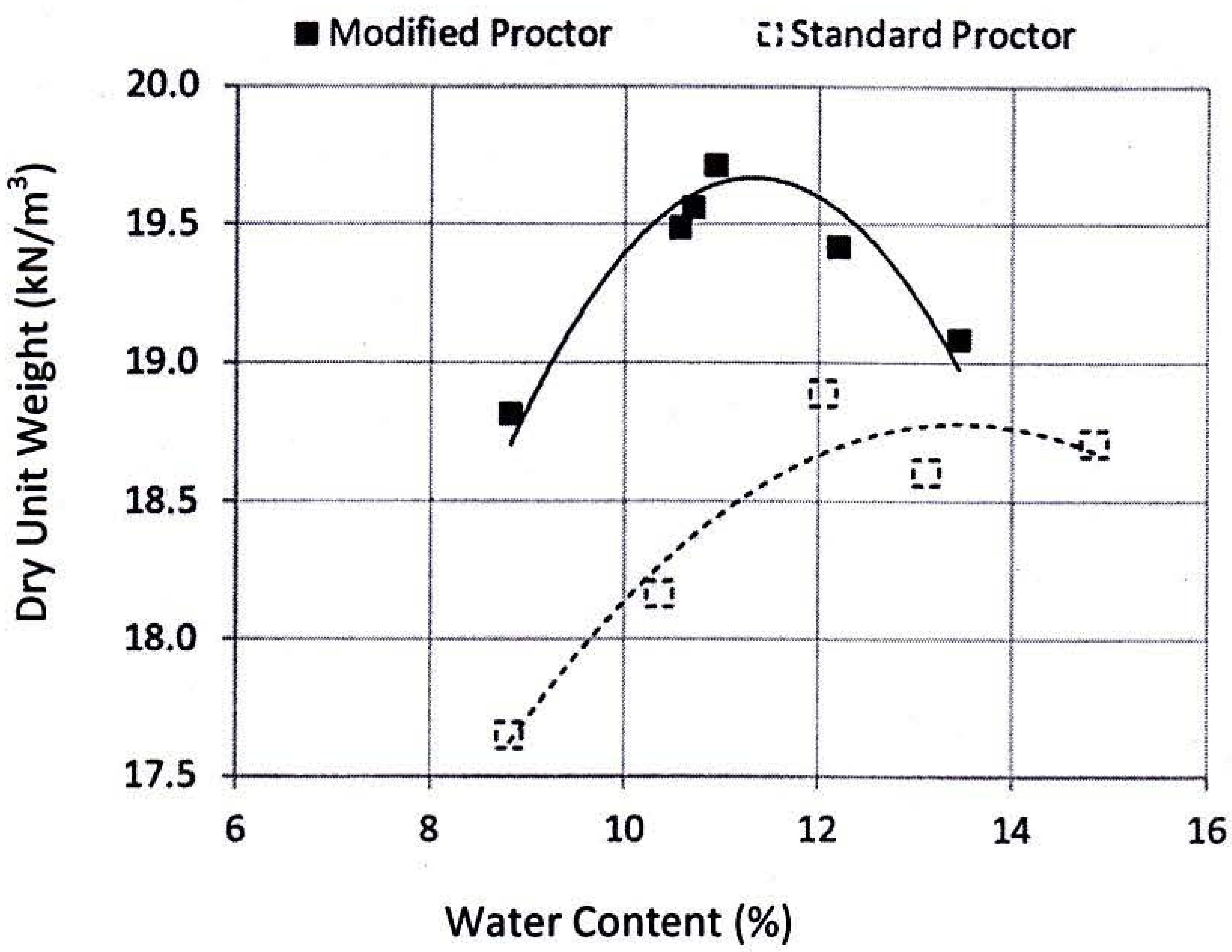


Fig. 1: Compaction Test Results

3. Three consolidated undrained (CU) triaxial tests were performed on identical clay specimens. The diameter and height of the specimens were 38 mm and 76 mm, respectively. The CU triaxial test results are given in Table 3.

(i) Determine the effective shear strength parameters of the soil. 8

(ii) Formulate the Mohr-Coulomb failure envelope for effective stress. 2

(iii) Determine the orientation of the failure plane. 4

(iv) If a CU test is to be performed using cell pressure 152 kPa on an identical specimen, estimate the axial load and pore water pressure at failure for this specimen. 6

Table 3: CU Triaxial test results

Test	Deviator load (N)	Strain (%)	Cell Pressure (kPa)	Pore-water Pressure (kPa)
1	185	5.5	71	29
2	266	6.9	127	38
3	432	6.8	188	39

4. Given that depth of foundation is 2 m for two rectangular footings (Fig.2). The soil profile is given in Fig. 3.
Point 'A' is at a depth of 3 m below the footing base and equally distant from the two rectangular footings.
The chart of influence factor is given.

(i) Evaluate the increase in vertical stress ($\Delta\sigma$) at Point 'A' due to the load transferred by 3 m x 4m rectangular individual footing. 5

(ii) Evaluate the increase in vertical stress ($\Delta\sigma$) at Point 'A' due to the loads transferred by both the individual footings. 5

(iii) Determine the OCR (at the mid-depth of the saturated clay layer) if the smaller footing will be removed. The clay layer was normally consolidated before the construction of both the footings. 5

(iv) Estimate the settlement of the top 1 m clay layer due to the loading from 3 m x 4 m rectangular footing. The smaller footing was not constructed. 5

(v) Estimate the settlement of the top 1 m clay layer if both the footings were constructed at a time. 5

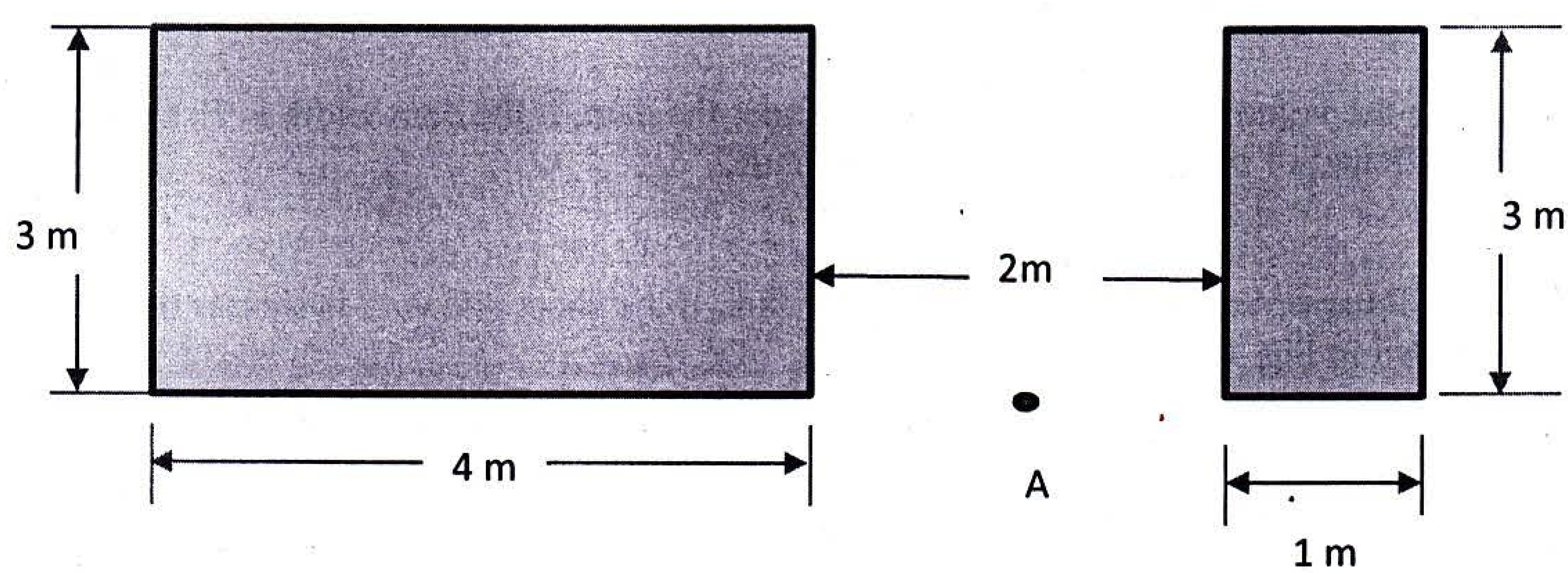


Fig. 2: Rectangular footings (Plan View)

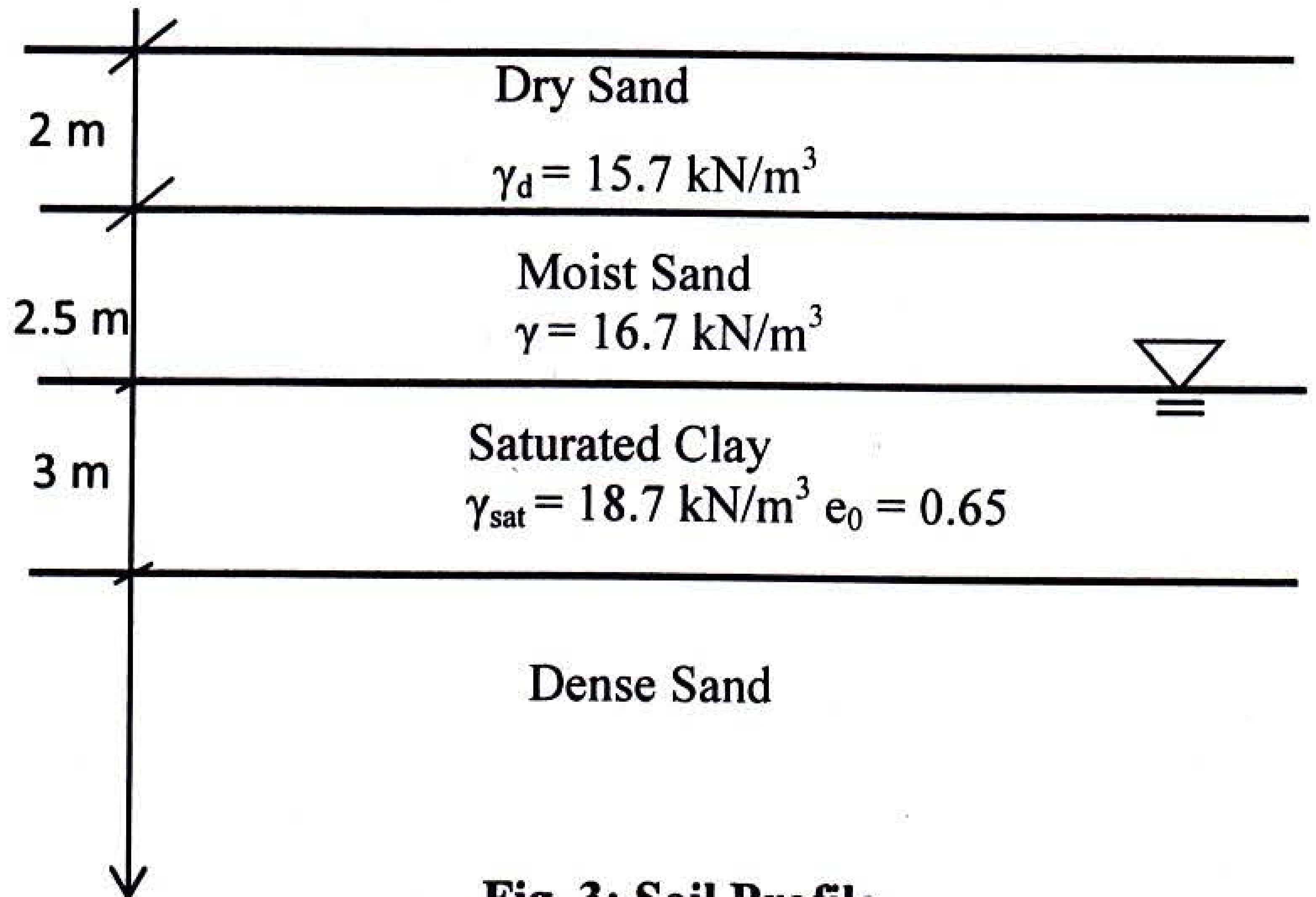


Fig. 3: Soil Profile

5. The flow-net below a concrete dam is drawn (Fig.4).

(i) Create the uplift pressure diagram along the base of the dam by determining the pressures at points A, B, C, D and E. 5

(ii) Compute the head at point F. 2

(iii) Evaluate the hydraulic gradient between points B and C. Assume that the distance between B and D is 30 m. 2

(iv) Evaluate the stability of the dam in terms of Factor of Safety against uplift. Given that
x-sectional area of the dam= 150 m^2 4
Dam width = 75 m
The dam was made of concrete.

(v) Estimate the volumetric flow rate of water under the dam, if the dam width is 75 m and the coefficient of permeability is 3.5 x 10^{-3} cm/s. 4

(vi) What will happen to the flow rate below the dam, if the sheet pile wall is shorter than the one shown in Fig. 4. 3

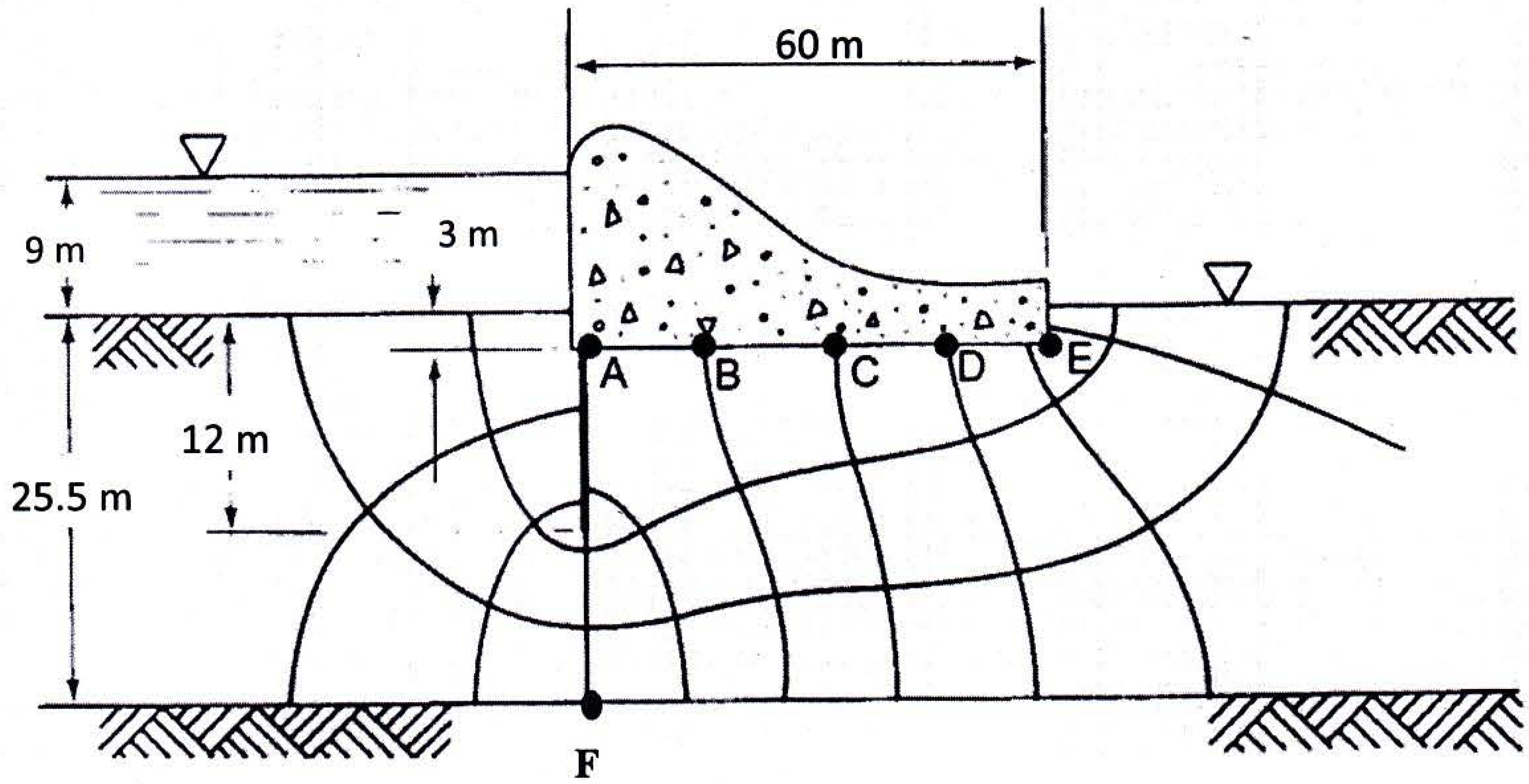


Fig. 4: Flow-net below the dam

6. In Fig.5, the soil profile and $K_0\sigma_v$' diagram are given. Apply Rankine's theory of lateral earth pressure for the following questions:

(i) Create $K_a\sigma_v$' diagram from the $K_0\sigma_v$' diagram. 3

(ii) Compute the magnitude of lateral force (per unit length of the wall) acting on the earth retaining wall (vertical-faced) in active condition, if all the soil layers are cohesion-less. 4

(iii) Evaluate the change in lateral force (active condition) w.r.t. the soil condition given in Fig.1(a), if all the soil layers are cohesion-less. 4

(iv) Compare the active and passive conditions of the retaining wall, in terms of the difference in lateral force due to cohesion only. 4

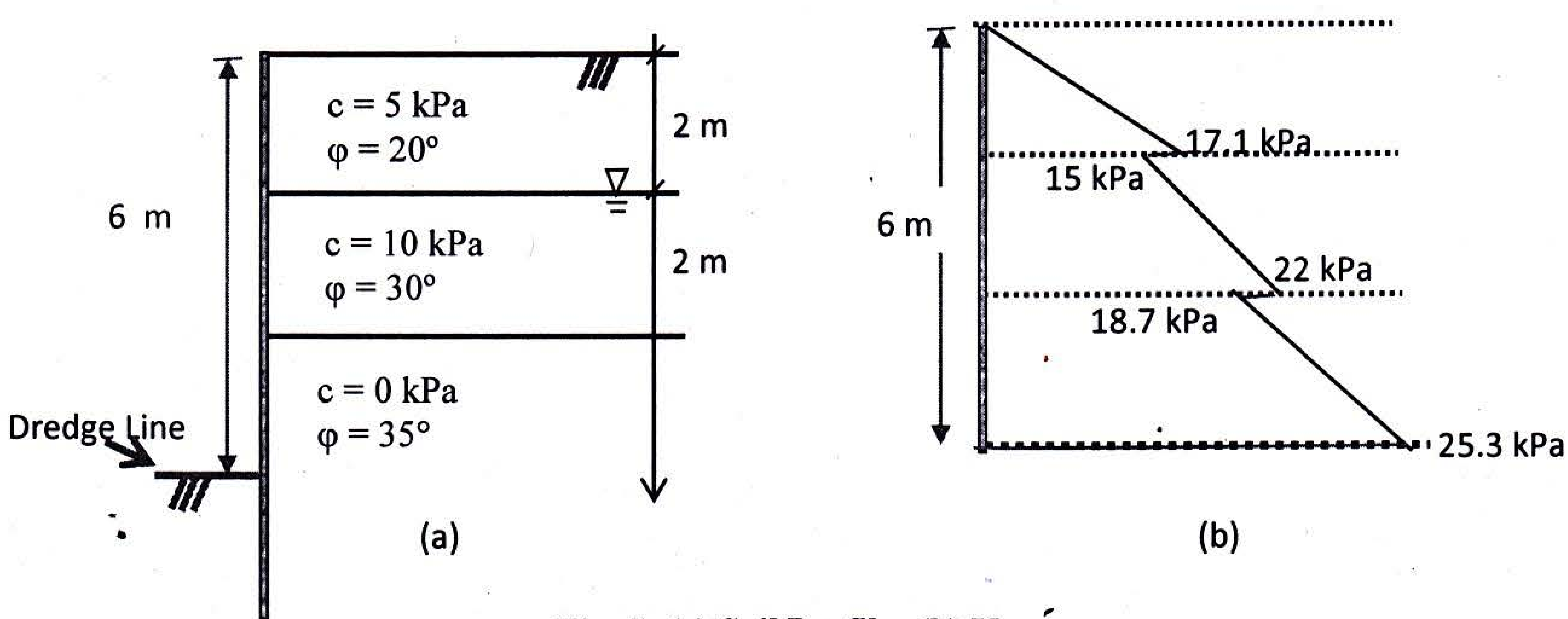


Fig. 5: (a) Soil Profile; (b) $K_0\sigma_v$'

Table: Influence factor chart (For Question No. 3)

n	m								
	0.1	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**1.0**
0.1	0.005	0.00917	0.01324	0.01678	0.01978	0.02223	0.02420	0.2576	0.002794
0.2	0.00917	0.018	0.02585	0.03280	0.03866	0.04348	0.4735	0.05042	0.05471
0.3	0.01323	0.02585	0.03735	0.04742	0.05593	0.06294	0.06859	0.07308	0.07938
0.4	0.01678	0.03280	0.04742	0.06024	0.07111	0.08009	0.08735	0.09314	0.10129
0.6	0.02223	0.04348	0.06294	0.08009	0.09472	0.10688	0.11679	0.12474	0.12018
0.8	0.02576	0.05042	0.07308	0.09314	0.11034	0.12474	0.13653	0.14607	0.15978
0.9	0.02698	0.05283	0.07661	0.09770	0.11584	0.13105	0.14356	0.15370	0.16835
1.0	0.02794	0.05471	0.07938	0.10129	0.12018	0.13605	0.14914	0.15978	0.17522
1.2	0.02926	0.05733	0.08323	0.10631	0.12626	0.14309	0.15703	0.16843	0.18508
1.4	0.03007	0.05894	0.08561	0.10941	0.13003	0.14749	0.16199	0.17389	0.19139
1.6	0.03058	0.05994	0.08709	0.11135	0.13241	0.15027	0.16515	0.17739	0.19546

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2017
Program: B. Sc. Engineering (Civil)

Course Title: Open Channel Flow — Course Code: CE 361
Time: 3 hours — Full marks: 150

Answer all the questions in both of the sections. (25*6= 150)
(Assume reasonable data if necessary)

SECTION – A

1 (a) Derive the expressions for Reynold's number and Froude number as the parameters to assess the effects of viscosity and gravity in open channels respectively. (8)

OR

Derive the expressions for computing the velocity distribution coefficients.

(b) Demonstrate the application of the three governing equations for steady one-dimensional open channel flow with an example case of flow beneath a sluice gate (Figure required). (7)

OR

Derive the Law of Torricelli for the situation if a constant level is maintained in a vessel with atmospheric pressure at the water surface and at the discharge point (Figure required).

(c) The data collected during the stream-gauging operation at a certain river section are given in the following table. Compute the discharge and the mean velocity for the entire section. (10)

Distance from left bank, m	Total Depth, m	Meter depth, m	Velocity, m/s
0	0		
2	1.5	0.6	0.54
6	5.7	4.16	1.35
		1.04	1.6
9	6.8	5.04	1.36
		1.26	1.81
13	2.7	1.32	1.16
0	0		

2 (a) Draw and define "specific energy curve". Verify that "at the critical state of flow, the specific energy is minimum for a given discharge". (3+4)

(b) Explain "Laminar or Viscous Sublayer". Compare the relative locations and usefulness of control sections with respect to subcritical and supercritical states of flow. (3+5)

OR

A rectangular channel is 6 m wide and laid on a slope of 0.25%. The channel is made of concrete (k_s = 2 mm) and carries water at a depth of 0.5 m. Compute the mean velocity of flow.

(c) Water is flowing at a velocity of 2 m/s and a depth of 2.5 m in a 6 m wide rectangular channel. Figure out the contraction in width of the channel for producing critical flow. Also, examine the change in water level produced by the contraction. Neglect energy losses and take $\alpha = 1$. (10)

OR

Water flows at a velocity of 1 m/s and a depth of 1.5 m in a 3 m wide rectangular channel. Figure out the height of a smooth upward step in the channel bed to produce critical flow and the change in water level produced by the step. Neglect energy losses and take $\alpha = 1$.

3(a) Explain how uniform flow readjusts itself. What are the considerations or assumptions in analyzing channels with compound cross sections? (7)

(b) An unlined irrigation canal is trapezoidal in shape with b = 6 m, s = 1, n = 0.025, h = 2m and S_0 = 0.0005. (a) Estimate the discharge carried by the canal under normal flow condition. (b) It is proposed to line the canal with concrete having n = 0.013. Evaluate the discharge that would be carried by the canal when i) only sides are lined, ii) only the bottom is lined [use Horton's Formula: attached]. (13)

OR

A rectangular testing channel is 0.6 m wide and is laid on a slope of 0.1%. When the channel bed and walls were made smooth by neat cement, the measured normal depth of flow was 0.4 m for a discharge of 0.23 m^3/s. The same channel was then roughened by cemented sand grains and the measured normal depth was 0.35 for a discharge of 0.12 m^3/s. Determine the discharge for a normal depth of 0.45 m if the bed is roughened and the walls are made smooth. [Hint: obtain n for each condition, then apply Horton's formula for composite roughness]

(c) What are the advantages of lining a canal? Mention the names of commonly used materials for lining. (5)

SECTION – B

4 (a) Define "Best Hydraulic Section". Explain in terms of cost, material and cross section why Best Hydraulic Section is not the most economic section. (2+5)

OR

Define Alluvial Channels. Explain according to Lacey, when a channel is considered to be in true regime.

(b) An irrigation canal has to carry a discharge of 30 m^3/s through a course non-cohesive material having d_{50} = 2.5 cm, d_{75} = 3 cm and n = 0.025. The angle of repose of the perimeter material is 32°. The canal is to be trapezoidal in shape having s = 2 and laid on a slope of 1 in 1000. Determine section dimensions of the channel by following the step by step approach as detailed in Lane's method. (15)

(c) How is the shape of the cross-section (Triangular/Rectangular/Trapezoidal) determined in designing a channel? (3)

OR

Which kind/state of flow is desirable to maintain in the design of channel (based on Froude number) and why?

5 (a) Generate the possible flow profiles in **ANY TWO** of the following serial arrangements of channels or conditions. The flow is from left to right: (4)

i) mild – milder – steep; ii) critical-steep-mild; iii) steep-mild-milder

(b) A 6 m wide rectangular channel and having n = 0.025 has three reaches arranged serially. The bottom slopes of the reaches are 0.0016, 0.015 and 0.0064, respectively. For a discharge of 20 m^3/s through this channel, identify the resulting flow profiles. (9)

(c) A wide rectangular channel with C = 47 $m^{1/2}/s$ and S_0 = 0.0001 carries a discharge of 1.8 m^2/s. A weir causes the water level to be raised by 0.50 m above the normal depth. Compute the length of the resulting flow profile between the weir site and the location where the depth is 2.8 m by the Bresse method. (drawing required) (12)

OR

A trapezoidal channel with b = 6 m an s = 2 is laid on a slope of 0.0025 and carries a discharge of 30 m^3/s. The depth produced by a dam immediately upstream of it is 2.5 m. Compute the resulting flow profile (**show four steps**). Take α = 1.12 and n = 0.025. [use h_n = 1.6 m and h_c = 1.33 m]

6 (a) Illustrate the types of jumps that occur in sloping channels with figure. (7)

(b) Following the procedure for deriving qualitative flow profiles, show the procedure and draw **ANY TWO** from following the profiles: i) M1 ; ii) M2 ; iii) S1 ; iv) S2 (6)

(c) Water flows at a depth of 1 m in a horizontal trapezoidal channel having a base width of 5 m and side slope 1:1 and Q = 30 m^3/s. If a hydraulic jump occurs in this channel, evaluate the sequent depth and the energy loss involved in the jump. (12)

Given Formulae

	Trapezoidal channel	Circular Channel
$\bar{U} = \frac{\int_0^A u\,dA}{A}$ $\alpha = \frac{\int_0^A u^3\,dA}{\bar{U}^3 A}$ $\beta = \frac{\int_0^A u^2\,dA}{\bar{U}^2 A}$	$A = (b + sh)h$ $P = b + 2h\sqrt{1+s^2}$ $B = b + 2sh$	$h = \frac{d_O}{2}\left[1 - \cos\frac{\omega}{2}\right]$ $\omega = 2\cos^{-1}(1 - \frac{2h}{d_o})$ $A = (\omega - \sin\omega)\frac{d_O^2}{8}$ $B = d_O \sin\frac{\omega}{2}$ $P = \frac{\omega d_O}{2}$ *Note that ω is in radian*

1. **Hydraulically smooth surface:** $\frac{U}{u^*} = 5.75\,log\,(\frac{3.64u^*R}{v})$
2. **Hydraulically rough surface:** $\frac{U}{u^*} = 5.75\,log\,(\frac{12.2R}{k_s})$
3. **Transition regime:** $\frac{U}{u^*} = 5.75\,log\,(\frac{12.2R}{k_s+3.35\frac{v}{u^*}})$

$u^* = \sqrt{(gRS_0)}$;

Bresse function:

$$\emptyset = \frac{1}{6}\ln\frac{u^2+u+1}{(u-1)^2} - \frac{1}{\sqrt{3}}tan^{-1}\frac{\sqrt{3}}{2u+1}$$

Where $u = h/h_n$

$$L = x_2 - x_1 = \frac{h_n}{S_0}[(u_2 - u_1) - (1 - \frac{h_c^3}{h_n^3})(\Phi_2 - \Phi_1)]$$

For wide channel,

$h_c = \sqrt[3]{(\frac{q^2}{g})}$; $h_c = \sqrt[3]{q^2 / C^2 S_0}$; $U = \frac{1}{n}R^{2/3}S_f^{1/2}$

$$\alpha = \frac{\alpha_1 K_1^3/A_1^2 + \alpha_2 K_2^3/A_2^2 + \alpha_3 K_3^3/A_3^2}{K^3/A^2}$$

$$\beta = \frac{\beta_1 K_1^2/A_1 + \beta_2 K_2^2/A_2 + \beta_3 K_3^2/A_3}{K^2/A}$$

$$n = \left(\frac{P_1 n_1^{3/2} + P_2 n_2^{3/2} + P_3 n_3^{3/2}}{P}\right)^{2/3}$$

Lane Method: $\tau_b = 0.40\, d_{75}$

$$K = \frac{\tau_s}{\tau_b} = \sqrt{1 - \frac{\sin^2\phi}{\sin^2\Psi}}$$

Rectangular channel: $h_c = \sqrt[3]{\frac{\alpha Q^2}{g b^2}}$; $S_c = \left(\frac{nQ}{AR^{2/3}}\right)^2$

$Fr = U/\sqrt{(gD)}$; $Q = K\sqrt{S_f}$; $K = AR^{2/3}/n$

$\Delta x = E_2 - E_1/(S_0 - S_f\text{bar})$

$S_f\text{bar} = (S_{f1} + S_{f2})/2$

For Hydraulic Jump:

$$\frac{h_2}{h_1} = \frac{1}{2}\left(\sqrt{1 + 8F_{r1}^2} - 1\right)$$

$$h_L = \frac{(h_2 - h_1)^3}{4 h_1 h_2}$$

$$\frac{E_2}{E_1} = \frac{(1 + 8F_{r1}^2)^{3/2} - 4F_{r1}^2 + 1}{8F_{r1}^2(2 + F_{r1}^2)}$$

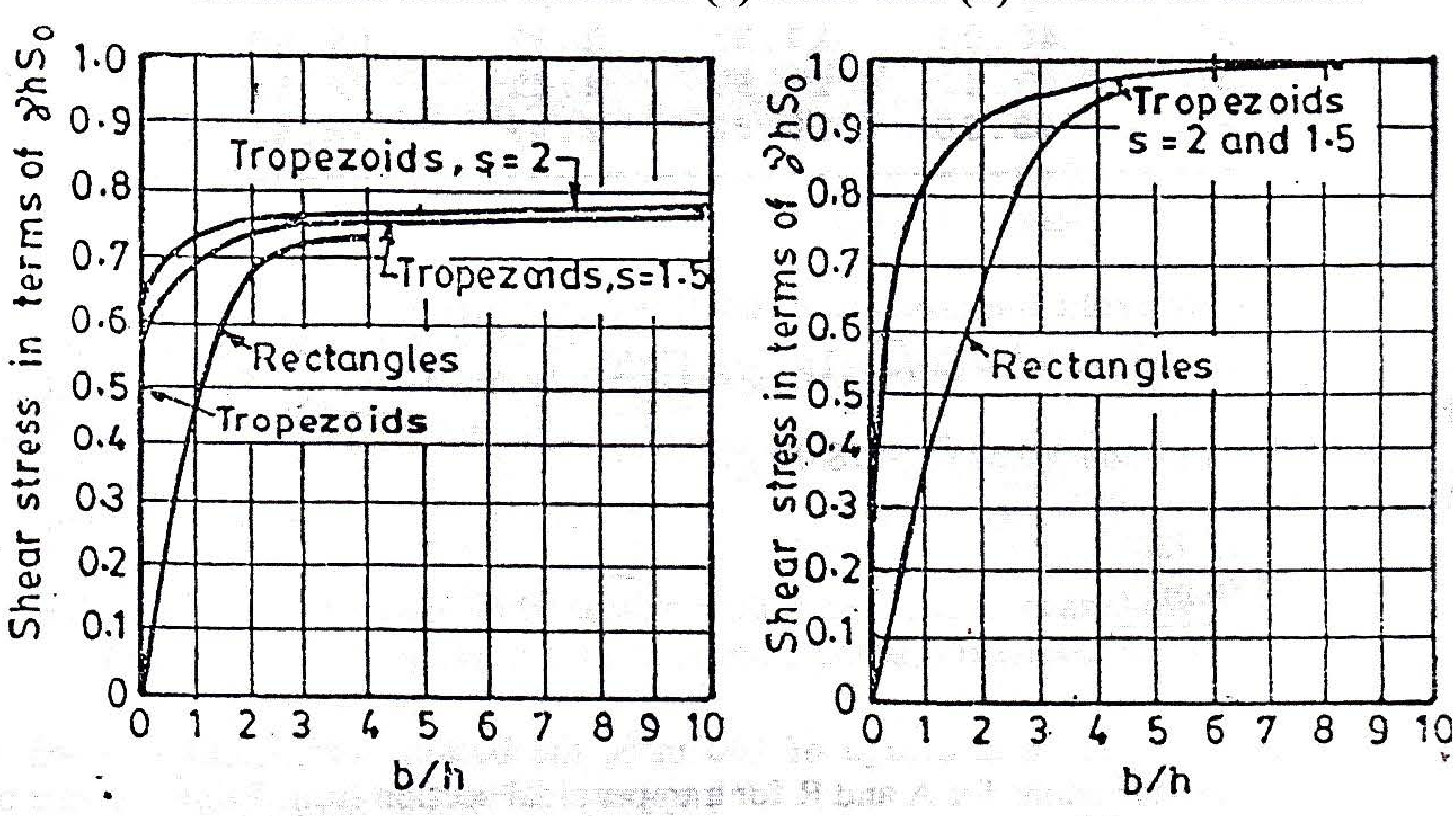
$$\frac{h_j}{E_1} = \frac{\sqrt{1 + 8F_{r1}^2} - 3}{2 + F_{r1}^2}$$

$$L_j = 9.75 h_1 (F_{r1} - 1)^{1.01}$$

$$F_2 = \frac{Q^2}{gA_2} + \bar{z}_2 A_2$$

For trapezoidal channel, $\bar{z} = \frac{h}{6}\left(\frac{3b+2sh}{b+sh}\right)$

Maximum Shear Stress on (a) sides and (b) bottom of channel



(a) (b)