University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2023
Program: B. Sc. Engineering (Civil)

4-1

Course Title: Structural Engineering III | Credit Hours: 3.0 | Course Code: CE 411
Time: 3 hours | Full Marks: 100 (10× 10)

ANSWER ALL THE QUESTIONS. Any missing data can be assumed reasonably.

1. Frame structure ***abcde*** shown in ***Fig.1*** is subjected to a dynamic load, $w = 3t^2$ *(k/ft)*.
   Use *Constant Average Acceleration* (*CAA*) Method to calculate the rotation of joint ***a*** at time $t = 0.10$ sec
   [Given: $EI = 45\times10^4$ *k-ft²*, $\mu = 0.0045$ *k-sec²/ft²*, *Damping ratio of the system = 4.5%*].

2. Calculate Yield Moment and Plastic Moment capacity of the section shown in ***Fig.2*** if the section is made of elastic-fully plastic material
   [Given: $\sigma_y = \sigma_{yp} = 60$ *ksi*].

3. Use Stiffness Method (neglect axial deformations) to calculate rotation of joint ***d*** of the frame ***abcd*** loaded as shown in ***Fig.3***, if the joint ***d*** is a circular foundation of radius 3.5 ft on the surface of subsoil (half-space) with shear wave velocity (v_s) equals to 1200 ft/sec
   [Given: $EI = 45\times10^3$ *k-ft²*, $\gamma_{soil} = 120$ *pcf*, Poisson's ratio of soil, $\nu = 0.25$].

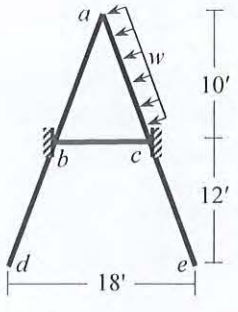


Fig.1

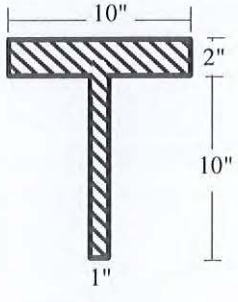


Fig.2

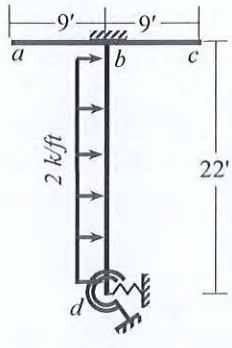


Fig.3

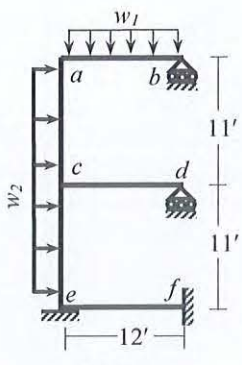


Fig.4

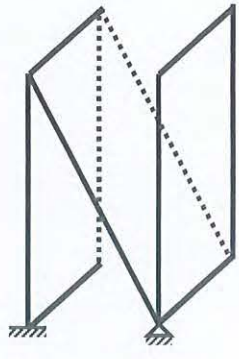


Fig.5

4. Use the Energy Method to calculate the load (i) w_1 needed to form beam mechanism, (ii) w_2 needed to form the sidesway mechanism in the frame ***abcdef*** loaded as shown in ***Fig.4***
   [Given: $M_{P\,(beam)} = 250$ *k-ft*, $M_{P\,(column)} = 280$ *k-ft*].

5. Determine the degree of kinematic indeterminacy (**doki**) and show the corresponding deflections and rotations of the 2D frames (***Fig.4***) and 3D frame (***Fig.5***) for the following cases
   i) Not considering boundary conditions
   ii) Considering boundary conditions
   iii) Neglecting axial deformations

6. Identify zero-force members of the 2D truss ***abcdef*** loaded as shown in ***Fig.6***. Determine the displacements of joint *c*. Also calculate member forces
   [Given: $EA/L = 1200$ *k/ft*].

7. Calculate 1st natural frequency of the frame ***abcde*** shown in ***Fig.7*** using consistent mass matrices (Considering rotations at ***b*** and ***d*** only)
[Given: $EI = 45 \times 10^3$ k-ft², $\mu = 0.0045$ k-sec²/ft²].

8. Use Stiffness Method considering flexural deformations only to calculate the unknown rotation at ***a*** and ***d*** of the frame ***abcd*** loaded as shown in ***Fig.8***
[Given: $EI = 45 \times 10^4$ k-ft²]

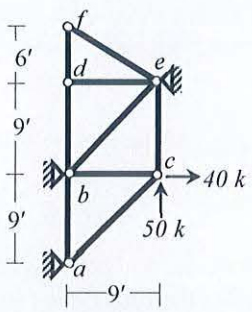


Fig.6

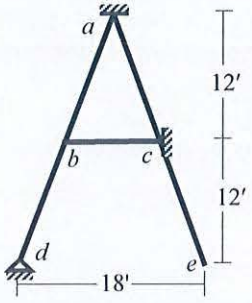


Fig.7

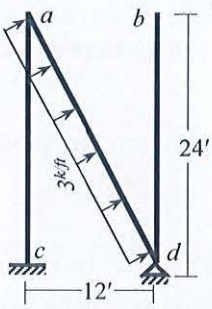


Fig.8

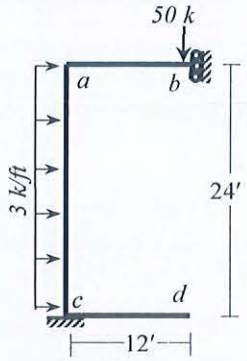


Fig.9

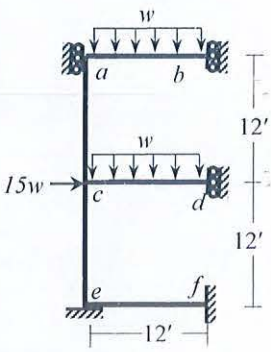


Fig.10

9. Use Stiffness Method considering geometric nonlinearity and flexural deformations only to calculate the unknown deflection at ***b*** and rotation at ***a*** of the frame ***abcd*** loaded as shown in ***Fig.9***
[Given: $EI = 45 \times 10^3$ k-ft²].

10. Use Stiffness Method (neglect axial deformations) considering geometric nonlinearity to calculate w required for buckling of the frame ***abcdef*** loaded as shown in ***Fig.10***
[Given: $EI = 45 \times 10^3$ k-ft²].

List of Useful Formulae for CE 411

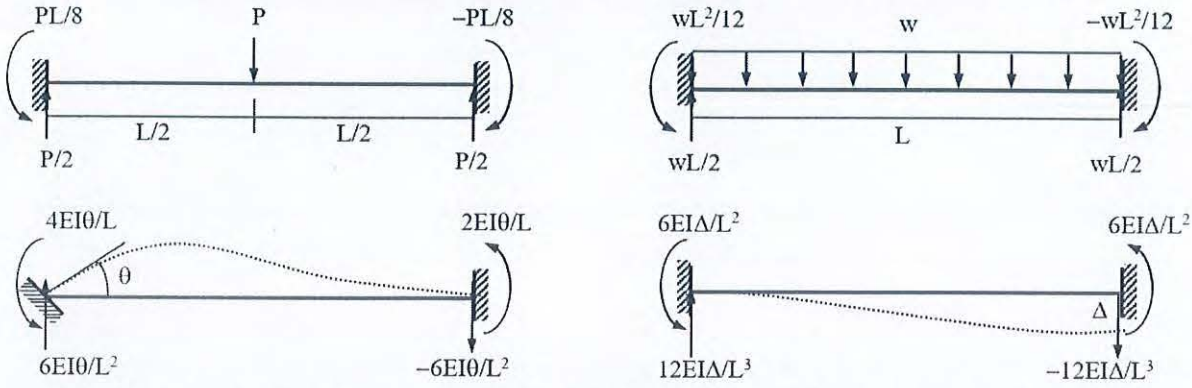
* The stiffness matrix $\mathbf{K_m}^G$ of a 2D truss member in the global axis system is given by

$$\mathbf{K_m}^G = S_x \begin{pmatrix} C^2 & CS & -C^2 & -CS \\ CS & S^2 & -CS & -S^2 \\ -C^2 & -CS & C^2 & CS \\ -CS & -S^2 & CS & S^2 \end{pmatrix}$$

and Truss member force, $P_{AB} = S_x [(u_B - u_A) C + (v_B - v_A) S]$

[where $C = \cos\theta$, $S = \sin\theta$]

Fixed End Reactions for One-dimensional Prismatic Members under Typical Loadings



* The stiffness matrix of a 3D truss member in the global axes system [using $C_x = \cos\alpha$, $C_y = \cos\beta$, $C_z = \cos\gamma$] is

$$\mathbf{K_m}^G = S_x \begin{pmatrix} C_x^2 & C_xC_y & C_xC_z & -C_x^2 & -C_xC_y & -C_xC_z \\ C_yC_x & C_y^2 & C_yC_z & -C_yC_x & -C_y^2 & -C_yC_z \\ C_zC_x & C_zC_y & C_z^2 & -C_zC_x & -C_zC_y & -C_z^2 \\ -C_x^2 & -C_xC_y & -C_xC_z & C_x^2 & C_xC_y & C_xC_z \\ -C_yC_x & -C_y^2 & -C_yC_z & C_yC_x & C_y^2 & C_yC_z \\ -C_zC_x & -C_zC_y & -C_z^2 & C_zC_x & C_zC_y & C_z^2 \end{pmatrix}$$

$C_x = L_x/L$, $C_y = L_y/L$, $C_z = L_z/L$
where $L = \sqrt{[L_x^2 + L_y^2 + L_z^2]}$

* Member force $P_{AB} = S_x [(u_B - u_A) C_x + (v_B - v_A) C_y + (w_B - w_A) C_z]$
* Torsional stiffness $T_1 = GJ/L$

* Ignoring axial deformations, the matrices $\mathbf{K_m}^L$ and $\mathbf{G_m}^L$ of a frame member in the local axis system are

$$\mathbf{K_m}^L = \begin{pmatrix} S_1 & S_2 & -S_1 & S_2 \\ S_2 & S_3 & -S_2 & S_4 \\ -S_1 & -S_2 & S_1 & -S_2 \\ S_2 & S_4 & -S_2 & S_3 \end{pmatrix} \qquad \mathbf{G_m}^L = (P/30L) \begin{pmatrix} 36 & 3L & -36 & 3L \\ 3L & 4L^2 & -3L & -L^2 \\ -36 & -3L & 36 & -3L \\ 3L & -L^2 & -3L & 4L^2 \end{pmatrix}$$

where $S_1 = 12EI/L^3$, $S_2 = 6EI/L^2$, $S_3 = 4EI/L$, $S_4 = 2EI/L$

* $\mathbf{K_{total}} = \mathbf{K} + \mathbf{G}$, buckling occurs (i.e., $P = P_{cr}$) when $|\mathbf{K_{total}}| = 0$

* For sections of Elastic-Fully-Plastic material, $A_t = A_c = A/2$, and $M_p = A_c\ \bar{y}_c + A_t\ \bar{y}_t$
* For RC sections, $M_p = A_s f_y (d - a/2)$, where $a = A_s f_y/(0.85 f_c' b)$
* Virtual work done by external forces (δW_E) = Virtual work done by internal forces (δW_I)
* For simply supported beams under (i) concentrated midspan load $P_u = 4 M_p/L$, and (ii) UDL $w_u = 8 M_p/L^2$
* For fixed-ended beams under (i) concentrated midspan load $P_u = 8 M_p/L$, and (ii) UDL $w_u = 16 M_p/L^2$
* For hinged-fixed ended beams under UDL $w_u = 11.66 M_p/L^2$

* Using CAA Method, $(m + c\Delta t/2 + k\Delta t^2/4)a_{i+1} = f_{i+1} - ku_i - (c + k\Delta t)v_i - (c\Delta t/2 + k\Delta t^2/4)a_i$
[m = Total mass, c = Damping = $2\xi\sqrt{(km)}$, where ξ = Damping Ratio]
Also $v_{i+1} = v_i + (a_i + a_{i+1})\Delta t/2$, and $u_{i+1} = u_i + v_i \Delta t + (a_i + a_{i+1})\Delta t^2/4$, starting with $a_0 = (f_0 - cv_0 - ku_0)/m$

* Lumped- and Consistent-Mass matrix for axial rod

$$\mathbf{M_m} = (\mu L/2)\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \qquad \mathbf{M_m} = (\mu L/3)\begin{pmatrix} 1 & 0.5 \\ 0.5 & 1 \end{pmatrix}$$

Consistent-Mass matrix for beam [μ = Mass per unit length]

$$\mathbf{M_m} = (\mu L/420)\begin{pmatrix} 156 & 22L & 54 & -13L \\ 22L & 4L^2 & 13L & -3L^2 \\ 54 & 13L & 156 & -22L \\ -13L & -3L^2 & -22L & 4L^2 \end{pmatrix}$$

* At natural frequency (i.e., $\omega = \omega_n$), $|\mathbf{K} - \omega_n^2 \mathbf{M}| = 0$
* Stiffness of Circular Surface Foundations on Half-Space

Motion	Horizontal	Vertical	Rotational	Torsional
$K_{Halfspace}$	$8G_sR/(2-\nu)$	$4G_sR/(1-\nu)$	$8G_sR^3/(3-3\nu)$	$16G_sR^3/3$

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2023
Program: B. Sc. Engineering (Civil)

Course Title: Geotechnical Engineering II | Course Code: CE 441
Time: 3 Hours | Credit Hours: 3.0 | Full Marks: 120

Answer all the questions

1. (a) What is subsurface exploration in terms of geotechnical engineering? Mention three major purposes of geotechnical subsurface exploration. 2 + 3 = 5

(b) Mention the names of four drilling/boring techniques used for making exploratory boreholes. Also mention the one, most frequently used in Bangladesh. Mention its reason. 3

(c) Write down the names of any five (5) in-situ testing performed in the field under the field investigation phase of a sub-surface exploration program. Which one is most commonly used? 2

(d) Mention the preliminary information that should be available to conduct a subsurface exploration program for a building project. 2

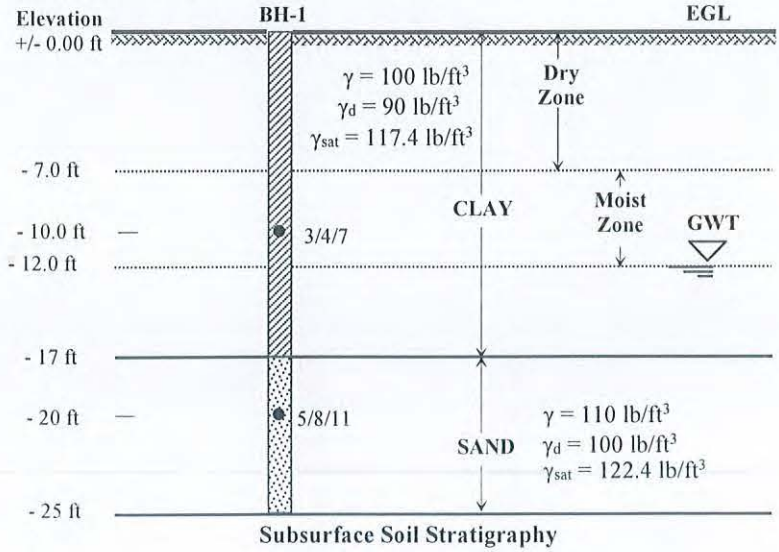
(e) Write short note on any one of the following: 4

(i) Site reconnaissance (ii) Vane shear test

(f) The outside and inside diameters of a split spoon sampler are 2 inches and 1-3/8 inches, respectively. The degree of disturbance (DOD) of a Shelby tube sampler is one-twelfth of the DOD of the split spoon sampler. If the inside diameter of the Selby tube sampler is 73 mm, determine its outside diameter. 4

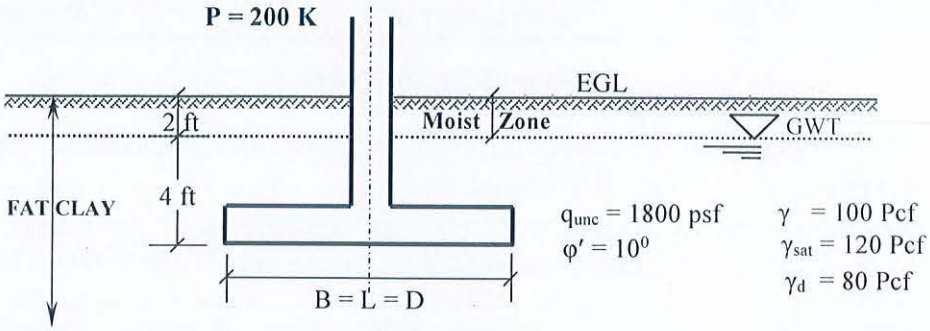
(g) A six-inch diameter borehole (**BH-1**) was advanced at a site under the scope of a **preliminary** geotechnical sub-surface exploration program. Determine the Field SPT-N values at elevations -10 ft and -20 ft. Apply necessary corrections, as required, and determine the corrected SPT values (Use Appendix as necessary). Also estimate the shear strength parameters as necessary at corresponding depths. 10

Notes: - Wash Boring method was used; Hammer efficiency = 40%.
- Standard sampler was used during sampling.

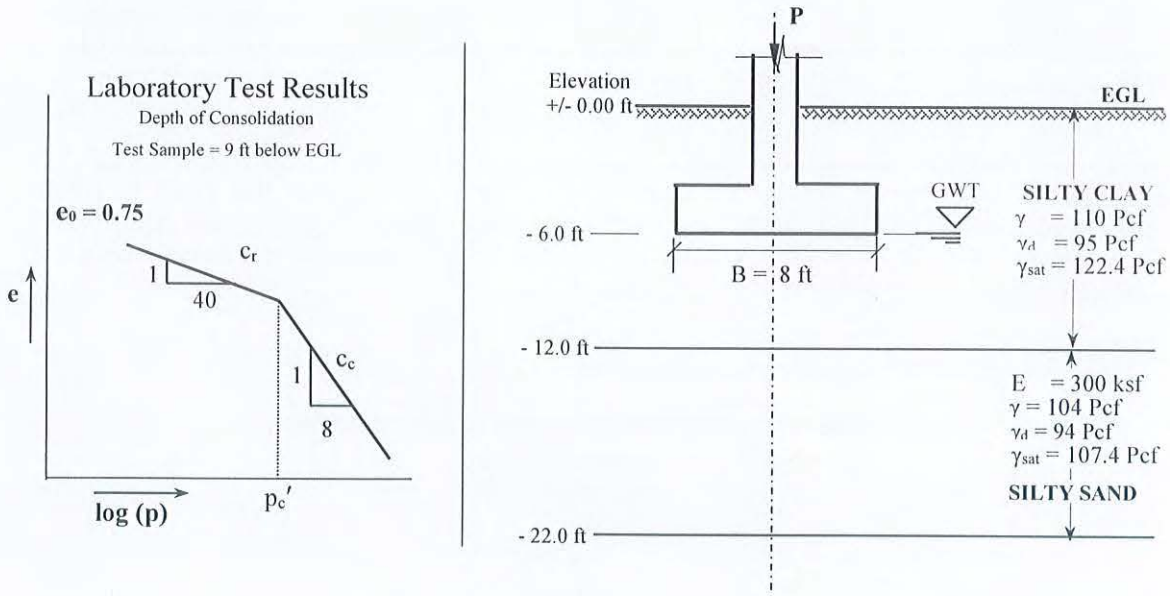


Subsurface Soil Stratigraphy

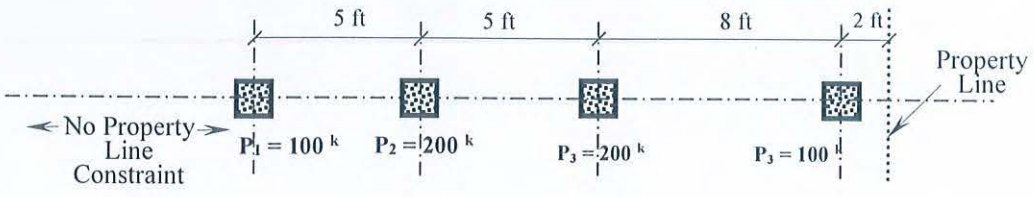
2. Using General Bearing Capacity Equation (GBCE), design the size of the circular footing for the conditions as shown in the figure below. Use $D_f/B <$ or $= 1$. 15



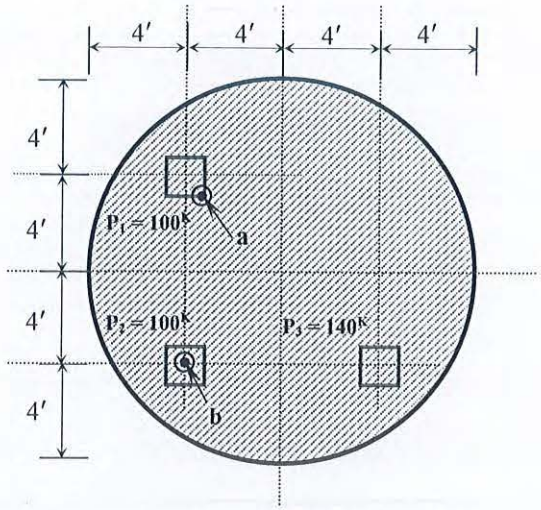
3. A rectangular footing (8 ft x 12 ft), designed as per allowable bearing capacity based on shearing failure, is shown in the following figure. Over-consolidation ratio (OCR) of the cohesive deposit is 3.0. Estimate settlements for both sand and clay layers. Use $q_a = p = 5.0$ ksf. 15



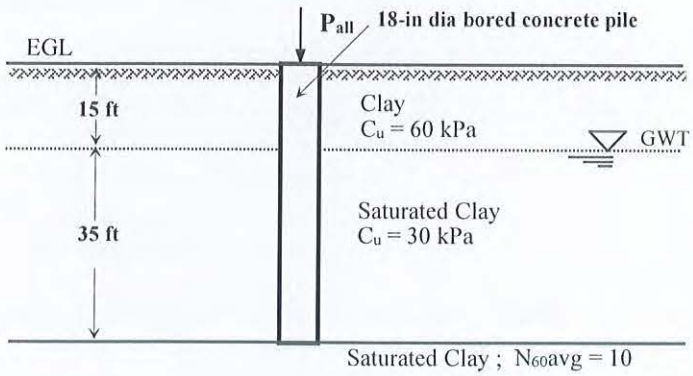
4. (a) Design the size of a rectangular combined footing incorporating all the columns for the conditions shown below. Consider $q_a = 2.0$ tsf. 5



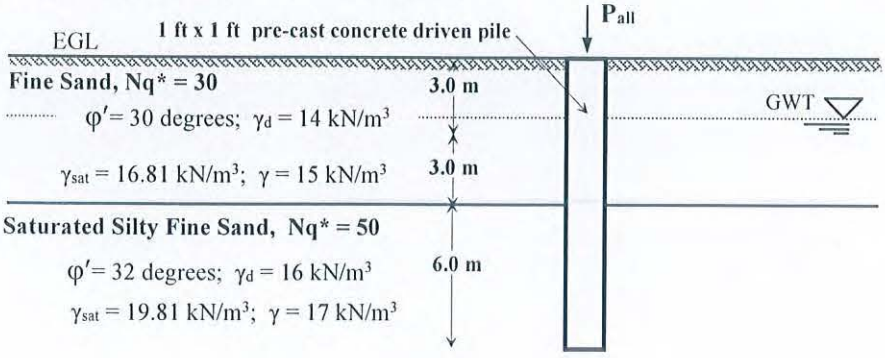
(b) The plan of a mat foundation with column loads and dimensions is shown in the following figure. Calculate the soil pressures at points a, b and at the geometric centroid of the foundation All the columns are 12 by 12 inches in size and symbols carry their usual meanings. 13



5. (a) For the following condition, calculate the allowable capacity of a single pile. Assume reasonable factor of safeties for end bearing and skin resistance. Also calculate the capacity considering group effect of pile group consisting of six piles forming a block. Use spacing of piles = 2.5 times the diameter of the piles. Finally estimate the design capacity. 15



(b) For the following condition, calculate the allowable capacity of a single pile. Assume reasonable factor of safeties for end bearing and skin resistance. 12



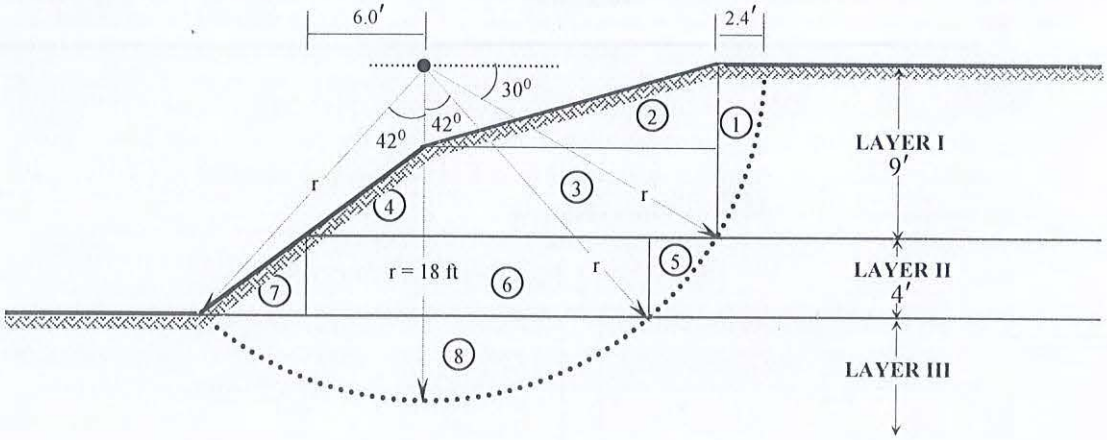
6. Determine the factor of safety (stability) against the possible failure arc through the slope as shown below. 15

LAYER I:
Sandy Clay
Average SPT Blow Count, $N_{60} = 4$
Unit Weight = 110 pcf

LAYER II:
Clay
Average SPT Blow Count, $N_{60} = 3$

LAYER III:
Clay
Average SPT Blow Count, $N_{60} = 4$

Segment No.	Area (ft^2)	Arm (ft)	Magnitude of Induced Moment (k-ft)
1	10.80	16.39	19.47
2	31.18	10.39	35.64
3	---	---	---
4	---	---	3.3
5	---	---	---
6	72.16	3.02	21.79
7	12.08	8.01	9.68
8	---	---	---



University of Asia Pacific
Department of Civil Engineering
Final Examination – Spring 2023
Program: B.Sc. Engineering (Civil)

Course Title: Transportation Engineering II | Course Code: CE 451
Time: 3 hours | Credit Hour: 3:00 | Full Marks: 120

1. a) What are the basic specifications for setting an ideal permanent way? (5)

   b) Discuss the significance of - i) Check rail, ii) Coning of rail, and iii) Tilting of rail. (15)

   c) What should be the equilibrium cant on a B.G. curve of 8 degrees for an average speed of 100 km/h? Also, find out the maximum permissible speed after allowing the maximum cant deficiency. (10)

   d) A locomotive shown in Figure 1 is required to haul a train at 313 kmph. The axle load of the driving wheels of the engine is 600 tonnes. The train is to run on a 5-degree M.G. curved track. Calculate the maximum permissible train load that the engine can pull. If the train climbs a gradient of 1 in 175 and the track has a three-degree curvature, then how much of the speed should be reduced? (15)

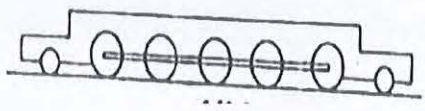


Figure 1

2. The pavement that needs to be constructed is a six-lane divided highway. The average two-way traffic per day on the existing highway counted in 2012 was 15,000 commercial vehicles and it is expected to grow at 6.7% per annum. It is also expected that the construction of pavement will be completed 12 years after the traffic count taken in 2012. The AADT (both directions) in the year 2012 was 25,000 vehicles. The pavement has a terminal serviceability index (pt) of 2.5 and SN of 4. Predict the cumulative traffic for the design period and also calculate the design ESAL for the peak direction if the design life is 25 years, and the vehicle mix is as follows: (20)

   Passenger cars (1000 lb/axle) = 5%,
   2-axle single-unit trucks (6000 lb/axle) = 20% (growth rate 5%)
   3-axle single-unit trucks (13000 lb/axle) = 10% (growth rate 4.5%)
   3-axle tandem-unit trucks (8000 lb/axle) = 40% (growth rate 2%)
   4-axle tandem-unit trucks (15000 lb/axle) = 25% (growth rate 6%)

3. Design a suitable pavement of an asphalt mixture surface within a limited budget with an elastic modulus of 150,000 lb/in^2, a base layer with a structural coefficient of 0.08 on a subgrade having a resilient modulus of elasticity of 1000 lb/in^2. It takes about 1 week for the base course and 1 month for the sub-base course to drain out the water with a saturation of 4%. Use a reliability level of 70%. Consider the value of design ESAL as calculated in question no 2 (Q2). The CBR value of the sub-base is 20. The resilient modulus of the base course and sub-base course is 30000 lb/in^2 and 17000 lb/in^2 respectively. (20)

4. Design a concrete pavement for a four-lane urban expressway using the AASHTO method where a 12-inch layer of untreated granular material is used as a sub-base layer. The monthly value of the resilient modulus of roadbed soil and sub-base is given in Table 5. If the rock depth is located 8.5 ft below the subgrade surface and the projected slab thickness is 10 in, (15+10)

i) Estimate the effective modulus of the subgrade reaction. And

ii) Check whether the projected slab thickness is sufficient for such kind of pavement or not for the design period of 30 years if the effective modulus of subgrade reaction, K = 500 lb/in^3.

[Consider design ESAL as 0.2X10^6, the working stress of the concrete is 650 lb/in^2 and the modulus of elasticity is 4.5X10^6 lb/in^2. The overall standard deviation is 0.35, the load transfer coefficient is 3.0, the drainage coefficient is 0.70, the loss of serviceability is 1, the traffic growth rate is 5%, and the reliability is 75%.]

Table 1: Soil Characteristics

Month	Roadbed Modulus (lb/in^2)	Sub-base Modulus (lb/in^2)
July	10,000	600,000
August	20,000	15,000
September	5,000	200,000
October	12,000	50,000
November	4,000	1,000,000
December	7,000	75,000

5. The gradation required for a typical mix is given in Table 1 in columns 1 and 2. The gradation of available aggregates A, B, and C are given in columns 3, 4, and 5. Determine the proportions of A, B, and C if mixed will get the required gradation in column 2. (10)

Table 2: Sieve Analysis Report

Sieve Size (retained) (mm) (1)	Required Gradation Range (2)	Filler (A) (3)	Fine Aggregate (B) (4)	Coarse Aggregate (C) (5)
25	100	100	100	100
19	90 - 100	100	100	94.0
12.5	60 - 80	100	100	54.0
4.75	40 - 75	100	66.4	31.3
0.425	20 – 35	100	26.0	22.8
0.180	12 – 22	73.6	17.6	9.0
0.075	5 -10	40.1	5.0	3.1

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2023
Program: B.Sc. Engineering (Civil)

Course title: Irrigation and Flood Control | Course code: CE 461
Time: 3 Hours | Full marks: 50

There are FIVE (5) questions. Answer all questions. Assume any missing data.

1. a) In between furrow irrigation method and sprinkler irrigation method, which irrigation method is most appropriate for Bangladesh. Justify your answer. 4

   b) An irrigation project located in Kurigram district of Bangladesh divert surface water from Dharala river through a canal for irrigating an area of 3950 hectares, Based on the data and information provided in the **figure 1** and **table 1** below, calculate the following for the period from January to March: 6
   - Consumptive Water Use (C_U);
   - Consumptive Irrigation Requirement (C.I.R.);
   - Net Irrigation Requirement (N.I.R.);
   - Field Irrigation Requirement (F.I.R.);
   - Gross Irrigation Requirement (G.I.R.);
   - Volume of water required to be diverted from the head works.

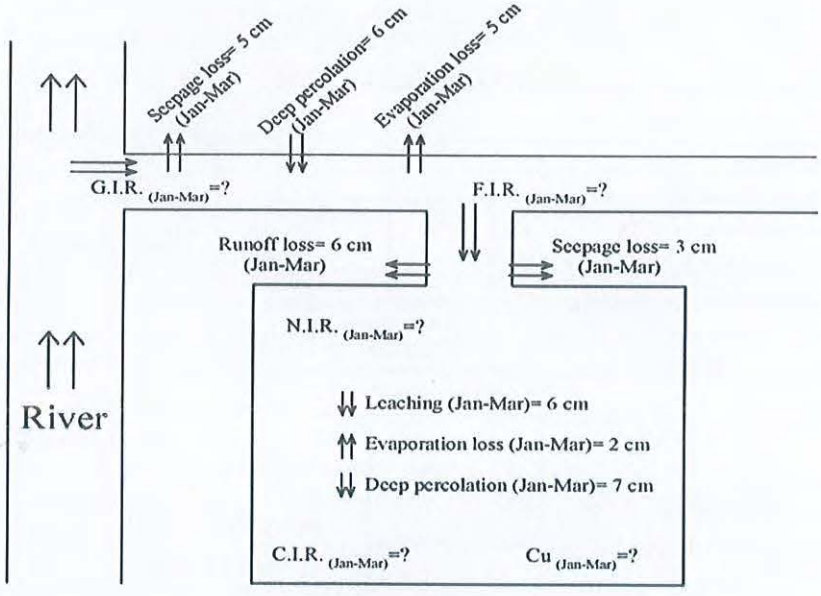


Figure 1

Table 1

Month	Monthly temperature (°C) averaged over the last 5 years	Monthly percent of day time hour of the year computed from the Sun-shine	Useful rainfall in cm averaged over the last 5 years	Crop factor
January	18.0	6.90	1.76	0.8
February	20.1	7.10	1.43	0.76
March	23.4	7.80	2	0.79

c) Find out the following by analyzing the data and information provided in **figure 2** below: 6

- Discharge required at the potato field (Q_1);
- Discharge required at the wheat field (Q_2);
- Discharge required at rice field (Q_3);
- Actual discharge required at the head of the distributary canal (Q);
- Design discharge required at the head if time factor is 0.85;
- Average discharge required at the head of the distributary canal if capacity factor is 0.72.

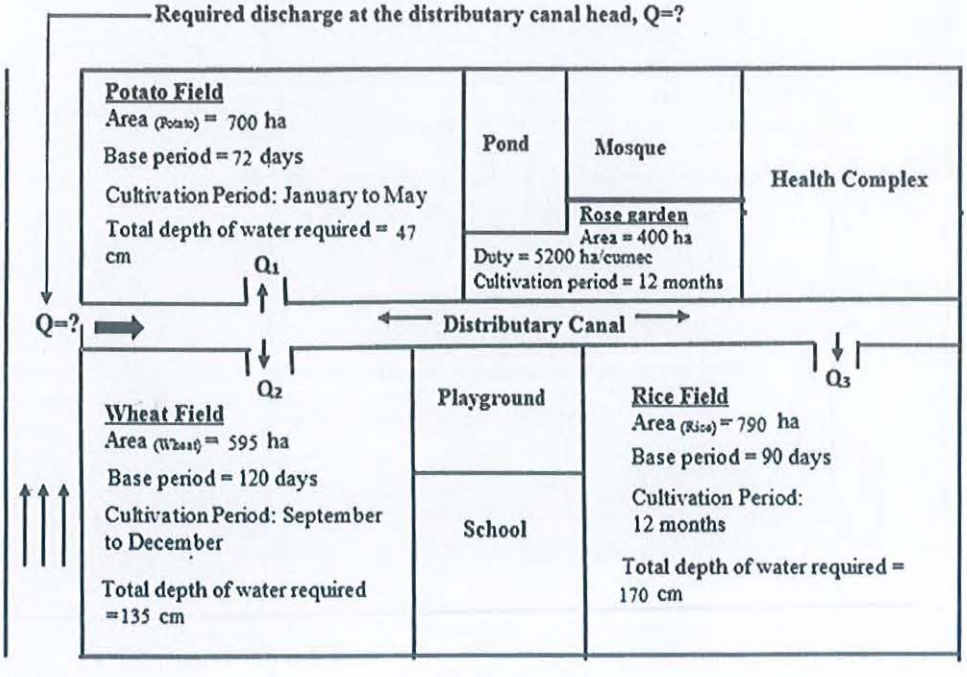


Figure 2

2. a) Explain the following i) Spoil Banks; ii) Borrow pit; iii) Critical velocity ratio; 3
b) An irrigation project is located in an area formed by alluvial soil. The responsible engineering department is planning to construct a new irrigation canal to provide sufficient water in the agricultural plots located in the project area. To decrease the cost and keep the options open for possible future changes in the cropping pattern and water distribution requirement in the project area, the engineering department decided to construct an unlined canal. 8

As a newly recruited engineer in the local engineering department, design that canal having the following data (**TWO TRIALS ARE COMPULSORY**):
Full supply discharge = 6 m^3/s
Rugosity coefficient (n) = 0.0224
C.V.R (m) = 1
Side slope = 1:1
Bed slope = 1 in 5150
Assume other reasonable data for the design

3. a) Explain different types of spurs with neat sketch. 3
b) After how many days will you supply water to soil in order to ensure sufficient irrigation of the given crop, if, 8
   - Available moisture= 18%
   - Unavailable moisture= 15%
   - Optimum moisture content = 16%
   - Dry density of soil = 1.3 gm/cc
   - Effective depth of root zone = 59 cm
   - Daily consumptive use of water for the given crop = 13 mm
   - If the crop period is 60 days, find out the base period of this particular crop.
   - Find out the delta and duty of the crop.

4. Explain delta formation process and how delta formation process relates to flood. 4

5. a) During monsoon period, the farmers of Bangladesh are facing flood due to the excessive flow in the major rivers that flow from upstream India to Bangladesh. Bangladesh also claims that due to excessive extraction of water through construction of barrages and dams in upstream India during non-monsoon period, the water availability in downstream Bangladesh is reduced substantially. Bangladesh and India formed a joint rivers commission to solve this conflict related to too little water during non-monsoon period and too much water during monsoon period in Bangladesh. You are representing Bangladesh in the joint rivers commission. 4

Select three international water resources management principles based on which you can negotiate/cooperate with India to solve this water conflict. Justify why you have selected those three principles.

b) Explain different components of flood risk management. 4

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2023
Program: B. Sc. in Civil Engineering

Course Title: Environmental Engineering III — Course Code: CE 431
Time: 2.00 Hours — Credit Hour: 2.00 — Full Mark: 100

Answer all the questions.

1. (a) Identify the factors to be considered for selecting landfill sites for hazardous waste. (6)

   (b) Explain the concept of 'cradle to grave' in life cycle inventory of industrial waste. (5)

   (c) Demonstrate the differences between the followings: (5+5)
   (i) Putrescible and Non-putrescible waste
   (ii) Primary and secondary collection

2. (a) Use your judgement to decide which collection and transfer system should be adopted based on the following information. (12)

Transportation Costs	Stationary-container system using an 25 m^3 compactor	3000 BDT/hr
	Tractor-trailer transport unit with a capacity of 120 m^3	4000 BDT/hr
Other Costs	Transfer station operating cost	50 BDT/m^3
	Extra cost for unloading facilities for tractor-trailer transport unit	5 BDT/ m^3
Other Data	Density of wastes in compactor	415 kg/ m^3
	Density of waste in transport units	170 kg/m^3

   (b) Choose among various waste collection systems for your community and justify your answer. (5)

   (c) Determine the number of storage containers required in your area based on the following data: (5)

   Storage container dimension: 3 m × 3 m ×1.3 m
   Population served in your area: 12,000
   Average rate of waste generation: 0.75 kg/cap/day
   Wastes are collected 6 days per week
   Density of waste: 120 kg/m^3
   Capacity margin: 66%

3. (a) Summarize the benefits of transfer station. (6)

(b) Explain your understandings on environmental cost. (6)

(c) Assess the risks in recycling and reuse. (5)

4. (a) Show the hierarchy of priorities in hazardous waste management with a figure. (5)

(b) Interpret how these factors influence anaerobic digestion: (4+4)

(i) Loading Rate

(ii) Inoculation

(c) Identify the environmental factors that affect composting. (5)

5. (a) The following 4 soil layers are lying between the base of a landfill and the underlying aquifer: (5+3)

	Depth (m)	Porosity (%)	Permeability (cm/s)
Soil A	3.4	45	3.4×10^{-6}
Soil B	4.1	30	2.2×10^{-7}
Soil C	3.7	55	5.4×10^{-5}
Soil D	5.4	27	3.4×10^{-9}

(i) Estimate how long it will take for leachate to percolate to aquifer.

(ii) Assess the amount of leachate flowing down per year in a 125,000 m^2 landfill.

(b) Explain briefly the treatment options of leachate and its applicability. (6)

(c) Categorize the major stages of waste degradation in landfills. (8)

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2023
Program: B.Sc. Engineering (Civil)

Course Title: Professional Practices and Communication | Course Code: CE 403
Time: 2 Hours | Credit Hours: 2.00 | Full Marks: 100

Answer all the questions.

1. Presume that you are a member of the Tender Evaluation Committee (TEC) for a bridge construction project. Prepare a list of all aspects/issues for which you will conduct preliminary and detailed examinations to find out the best tenderer. **[10]**

2. Suppose that you are the Managing Director of "ABC Construction Company Ltd.". Recently your Human Resources Manager has made a complaint against Assistant Engineer Mr. "X". The written complaint states that Mr. "X" is always late to work. Moreover, he had been absent from office for 12 working days without any notice/application. Which legal actions will you apply against Mr. "X"? Your action should conform to the Bangladesh Labour Law (BLL). **[10]**

3. Assume that you are an Executive Engineer and the Project Director of a Government owned construction project. You have come to know that the contractor of the project has not paid the salary to the workers for the past two months. As a Project Director how will you solve the issue (make arrangements to pay the salary to the workers) in accordance with the Bangladesh Labour Law (BLL). **[10]**

4. (i) Provide some examples of occupational crimes with their brief descriptions. **[15]**

   (ii) How will you prepare yourself to be an effective engineer in ensuring a safe and clean environment? **[10]**

5. A client came to a structural designer and asked to design a multistoried building. The soil type of the proposed site was found not suitable for that type of structure. The structural designer hesitated to design the building. The client said that he actually was not going to build that structure. He wanted to collect money from outside sources showing that design as a proposal for his venture and wanted to utilize that money in other businesses.

   Investigate the above situation and explain the role of the structural designer in the perspective of professional ethics. **[20]**

6. You are an Environmental Engineer for one of the many local plants. That plant discharges effluents into a lake in a flourishing tourist area. Although all the plants are marginally profitable, they compete for the same customers. Your responsibilities are to monitor the water and air discharges at your plant and the periodic reporting to the Department of Environment (DoE). You have just prepared a report that indicates that the level of pollution in the Plant's water discharges slightly exceeds the legal limits. Your supervisor says that you should regard the excess as a mere 'technicality', and he asks you to 'adjust' the data so that the data appears to be in compliance. He says that slight excess is not going to endanger human or fish life any more than if the plant were actually in compliance. However, he says, solving the problem would require a very heavy investment. He explains, "We cannot afford new equipment. It might cost even a few jobs. It will set us behind our competitors. Besides, many of the competitors are doing the same and the bad publicity we would get might scare off some of the tourist industry, making it worse for everybody."

Apply Code of Ethics to answer the following questions:

(i) What are the ethical issues in this case? **[15]**

(ii) How should you respond to your supervisor's requests? **[10]**

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University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2023
Program: B.Sc. Engineering (Civil)

Course Title: Structural Engineering V (Prestressed Concrete) Credit Hour: 2 Course Code: CE 415
Time: 2 hours Full Marks: 100

Answer all five questions. Assume reasonable value for any missing data

1. Determine the ultimate resisting moment for the given I-shaped beam section in **Fig.1** following the ACI Code. The beam is prestressed with a prestressing steel area of 4 in^2 with 150 ksi effective steel stress. Material properties are: f_{pu}= **270 ksi**; **f'c= 7000 psi**.
[20]

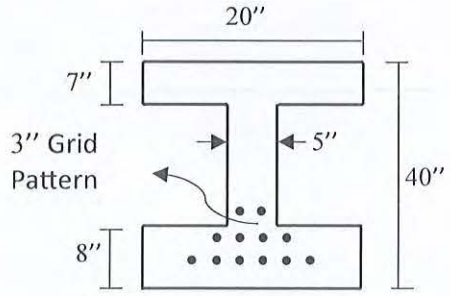


Fig.1

2. a) Design a preliminary I-section for a prestressed-concrete beam, with M_G = **60 k-ft**, M_T = **350 k-ft**, f_{se} = **130,000 psi**, f_c = **- 1800 psi**. The depth of the beam 'h' in inches can be approximated by an empirical formula $h = 50\sqrt{(M_T/1000)}$, where M_T is in k-ft. An I-section is preferred for this solution. Your sketch should clearly show the dimensions of the flange and web, where the width of the flange would be four times the width of the web, and the thickness of the flange not exceeding 4". [15]

b) Briefly explain why an I -section is preferred for this problem. Suggest another shape that will be more cost-effective. [05]

c) Modify the design in 2.a), allowing and considering tension in concrete. Sketch the revised section.

(No trial needed) [05]

Given, f_o = **150 ksi**, f_t' = **0.30 ksi**, f_b' = **0.24 ksi**, f_t = **-1.6 ksi**, f_b = **- 1.8 ksi**.

3. A rectangular beam with a cross-section of 20 in (width) x 30 in (depth) is initially post-tensioned with a force of 450 k. At service load after losses, the prestress in the tendon reduces to 350 k. Design the bearing plate area required for a tendon of 7-wire strands to transmit the force to the concrete. Assume, f_{ci}' = **4.5 ksi**, and f_c' = **6 ksi**. Take the diameter of the circular hole in the plate (for passing the tendon) to be of 6 in diameter. [15]

4. The beam shown below is post-tensioned with 1.5 in^2 of high tensile steel to an initial prestress of 150 ksi immediately after prestressing. Determine the initial deflection at midspan due to prestress and the beam's self-weight, assuming $\mathbf{E_c = 5000\ ksi}$. Also estimate the center deflection after 1 month due to a 20k concentrated load applied at midspan, assuming the modulus of elasticity for concrete has reduced to 4000 ksi with an effective prestress of 130 ksi remaining at that time. A creep coefficient of 1.6 is also applicable. Given: Unit weight of concrete 120 lb/ ft^3. [20]

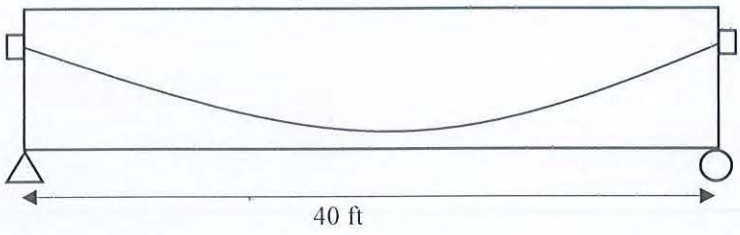


Fig.2(i)

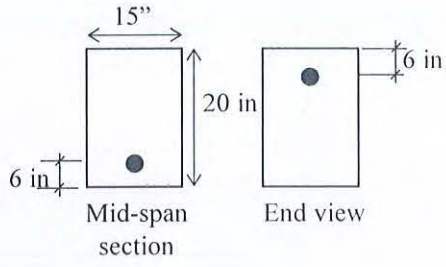


Fig.2(ii)

5.(a) Assess the shear strength of a simply supported beam at a section that is h/2 from the support. The asymmetric I-shaped noncomposite section spans 40ft, $\mathbf{A_{ps} = 3\ in^2}$ and the c.g.s. is 4'' from the bottom fiber all throughout the beam. The longitudinal and cross-section of the beam is shown below. Also determine the shear force that is carried by the stirrups.

Given, $\mathbf{f_{se} = 125\ ksi}$, $\mathbf{f_c' = 5000\ psi}$, $\mathbf{w_D = 6.5 kN/m}$ (beam weight), 6 strands draped, $\mathbf{F_e = 75k}$. [15]

(b) What is cracking moment? Describe Frictional loss. [05]

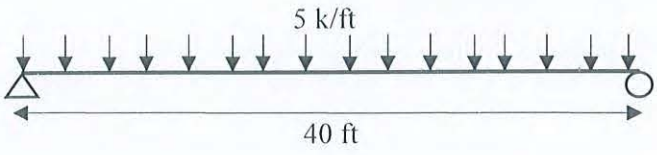
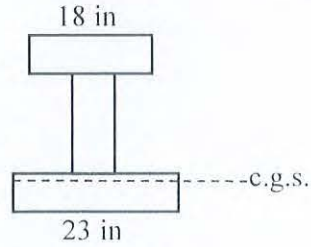


Fig.3(i)



$\mathbf{b_w = 5\ in}$, $\mathbf{t_f = 5\ in}$,
$\mathbf{h = 36\ in}$

Fig.3(ii)

Formula Sheet:

- $M_G/M_T \leq 25\%, F = \frac{M_L}{0.5h}$
- $M_G/M_T \geq 25\%, F = \frac{M_T}{0.65h}$
- $A_c = A_{ps} f_{se} / 0.5 f_c$
- **Elastic design, allowing tension:**

  $$e_1 + e_2 = \frac{M_G + f_t' A k_b}{F_O}, F = \frac{M_T - f_b' A k_t}{k_t + e}$$

  $$A_c = \frac{F_O h}{f_b c_t - f_t' c_b} \text{ (at transfer)}, A_c = \frac{Fh}{f_t c_b - f_b' c_t} \text{ (under working load)}$$

  [where f_b & f_t are absolute values]
- $v_{cw} = 3.5\sqrt{f_c'} + 0.3 f_{pc} + \frac{V_p}{b_w d}$
- $V_{cw} = (3.5\sqrt{f_c'} + 0.3 f_{pc})\, b_w d + V_p$
- $v_u = \frac{V_u}{\Phi b_w d}, \Phi = 0.85$
- $M_{cr} = \frac{I}{y_t}\left(0.5\sqrt{f_c'} + f_{pe}\right)$
- $V_{ci} = 0.05 b_w d \sqrt{f_c'} + \frac{V_i M_{cr}}{M_{max}}$
- $f_{pc} = \frac{F_{se}}{A}$
- Average bearing stress on concrete

  At service load: $f_{cp} = 0.6 f_c \sqrt{\left(\frac{A_b'}{A_b}\right)}$, not greater than f_c'

  At transfer load: $f_{cp} = 0.8 f_{ci}' \sqrt{\left(\frac{A_b'}{A_b}\right) - 0.2}$, not greater than $1.25 f_{ci}'$
- **Deflection at midspan of a simply supported beam due to uniform load,** $\Delta = \frac{5wL^4}{384EI}$
- **Deflection at midspan of a simply supported beam due to end moments,** $\Delta = \frac{ML^2}{8EI}$
- **Deflection at midspan of a simply supported beam due to concentrated load,** $\Delta = \frac{PL^3}{48EI}$
- $w = \frac{8Fh}{L^2}$
- $p_p = \frac{A_{ps}}{bd}$
- $T' = A_{ps} f_{ps}$
- $f_{ps} = f_{pu}\left(1 - .5 p_p \frac{f_{pu}}{f_c'}\right)$
- $w_p = p_p f_{ps} / f_c' < 0.30$
- $A_{pf} = 0.85 f_c'(b - b_w) h_f / f_{ps}$
- $A_{pw} = A_{ps} - A_{pf}$
- $M_u = \Phi[A_{pw} f_{ps}(d - a/2) + 0.85 f_c'(b - b_w) h_f(d - h_f/2)]$