

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

Course Title: Structural Engineering V (Prestressed Concrete) Credit Hour: 2 Course Code: CE 415
 Time: 1 hour Full Marks: 60

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

1. A prestressed concrete I beam is indicated in Fig. 1 below. It has a simple span of 30 ft. It is loaded by a uniform load of 5k/ft including its own weight and two concentrated live loads of 30 kips placed at one-third of the span from each end as shown in the figure. The beam has a prestress of 350 kips in the steel immediately after prestressing, which eventually reduces to 300 kips due to losses. For simplification purposes, the layout of the tendon is assumed to be linear with maximum sag at midspan. Compute the extreme fiber stresses at the cross-section A-A which is located 10 ft from the left end support.

- (a) Under the initial condition with full prestress and no live load [10]
 (b) Under the final condition, after losses have taken place, and with full live load. [10]

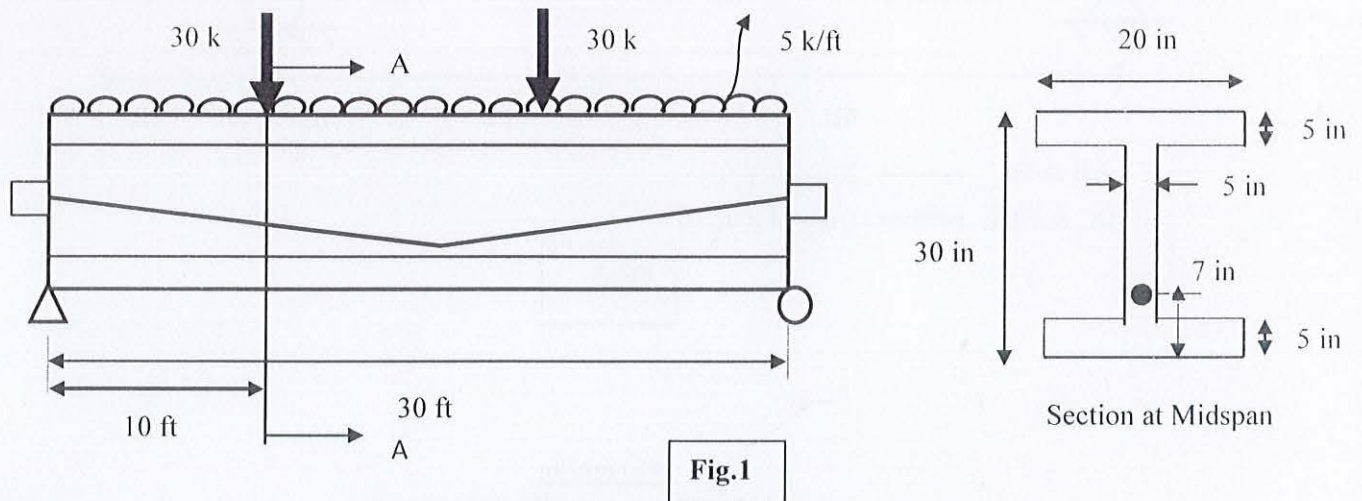


Fig.1

2. (a) The cross-section of a posttensioned simple beam on a span of 25 ft is shown in Fig. 2. The concrete used is lightweight concrete with a unit weight of 120 lb/ft³ in the beam. It also carries a uniform load of 635 lb/ft on top of its own weight. The initial prestress in the steel is 1,35,000 psi, reducing to 1,20,000 psi after deducing all losses and assuming no bending of the beam. The parabolic cable has an area of 2.5 sq in., $n=6$. Compute the stress in the steel at midspan, assuming: i) the steel is bonded by grouting ii) the steel is unbonded and entirely free to slip. [8+8]

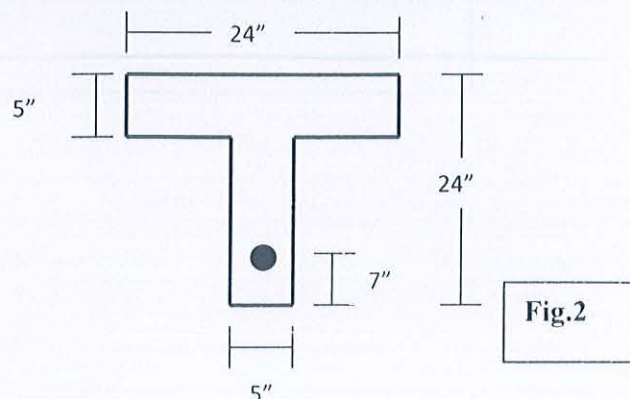


Fig.2

(b) What are the purposes of grouting? Explain the behavior of a prestressed member before, during and after the transfer of prestress. [4]

3. (a) Name the factors influencing the shrinkage loss of prestressed concrete members. Explain loss of prestress due to shortening in a posttensioned member for multiple successive tendons. [6]

(b) An overhanging beam as shown in Fig. 3 is to be posttensioned from the end 'A' with a force 350 kips. Compute the percentage loss of prestress due to friction from support 'A' to the free end. Solve using the exact friction formula. Given, the co-efficient of friction (μ)= 0.40 and wobble effect (k) = 0.0008/ft. [14]

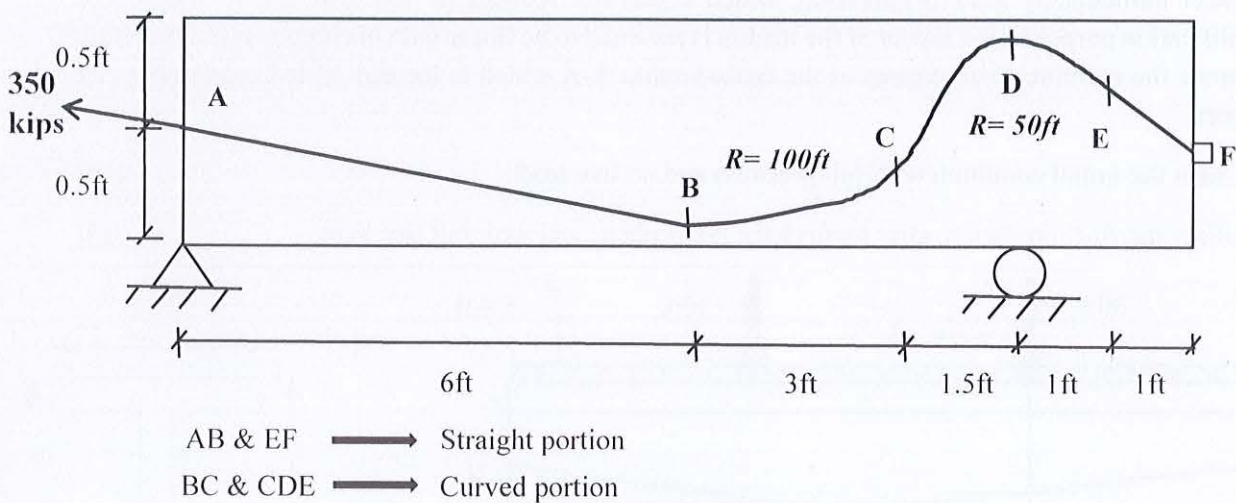


Fig.3

Formulae

$$f_{ps} = f_{pu} \{1 - 0.5 \rho_p (f_{pu} / f_c)\}$$

$$\rho_p = A_{ps} / bd$$

$$F = - \mu \alpha \text{ (due to curvature effect)}$$

$$F = - KL \text{ (due to wobble effect)}$$

$$F_2 = F_1 e^{-\mu \alpha - kL}$$

$$\alpha = L/R$$

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Course Title: Structural Engineering VI
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QUESTION 1

From the following table, select the lightest 12-ft-long angle section of A36 ($F_u = 60$ ksi) steel to resist a tensile service dead load of 90 kips and a service live load of 55 kips. The short leg of the tension member is connected to a gusset plate using 5 nos. 5/8-in bolts with standard holes as shown in **Figure 1**. Assume the gusset plate has adequate strength in tension, and $U = 0.85$ for preliminary calculation (revise this value after selecting the section). Neglect block shear failure mode, and follow AISC-ASD method. [14]

Shape	A_g (in ²)	\bar{x} (in)	\bar{y} (in)	r_x (in)	r_y (in)	r_z (in)
L6x4x7/8	8.0	1.12	2.12	1.86	1.10	0.854
L6x4x3/4	6.94	1.07	2.07	1.88	1.12	0.856
L5x5x3/4	6.98	1.52	1.52	1.50	1.50	0.972
L8x6x1/2	6.80	1.46	2.46	2.55	1.79	1.30

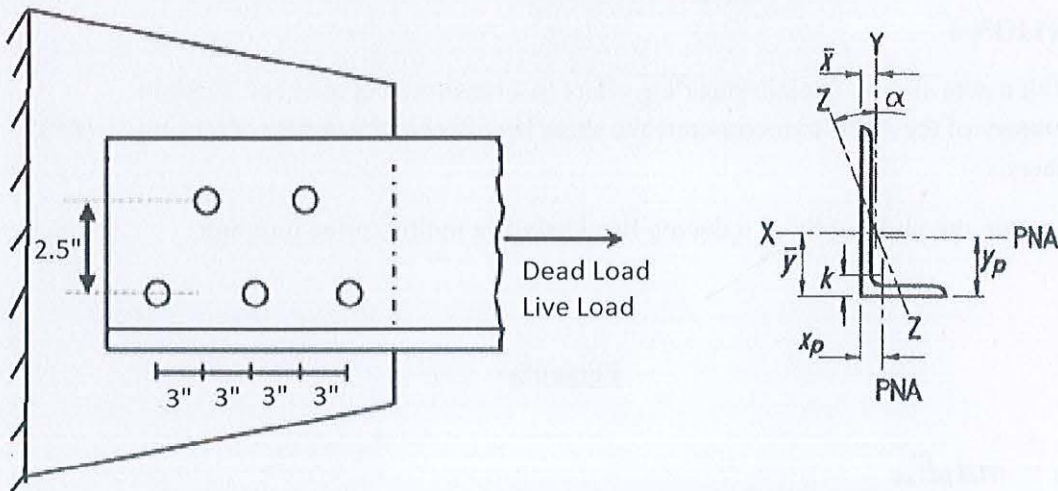


Figure 1

QUESTION 2

Figure 2 shows an eccentrically loaded bolt group where 5/8-inch-diameter A449 ($F_{by} = 90$ ksi, $F_{bu} = 120$ ksi) bolts are used. Calculate the shear forces on the bolts by using [14]

elastic method, and check whether the bolts are adequate to resist the maximum shear. Assume single shear plane for the calculation, and follow **AISC-LRFD** approach.

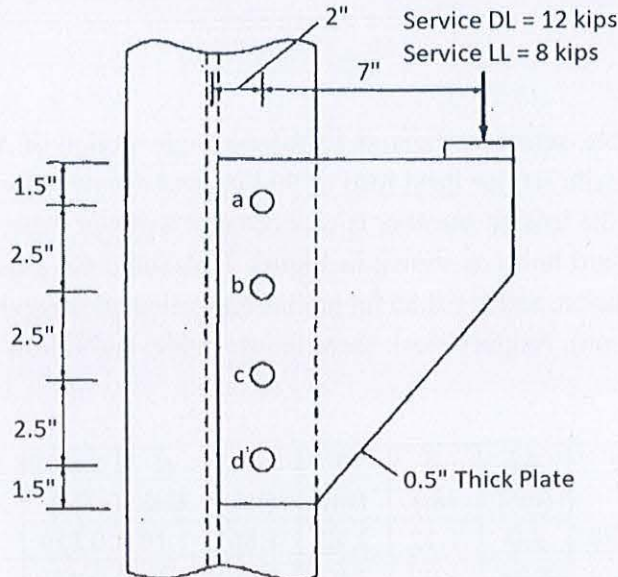


Figure 2

QUESTION 3

(i) With a neat sketch, explain shear lag effect in a tension steel member. Explain the strategy of the AISC to incorporate the shear lag effect in the design of tension members. **[5+3]**

(ii) Explain the philosophy of reducing live loads in a multi-storied building. **[4]**

Formula

1. $R_n = mA_bF_{nv}$
2. $R_n = 0.6F_yA_{gv} + U_{bs}F_uA_{nt}$
3. $R_n = 0.6F_uA_{nv} + U_{bs}F_uA_{nt}$
4. $R_n = 1.5L_{ct}F_u \leq 3.0dtF_u$
5. $R_n = 1.2L_{ct}F_u \leq 2.4dtF_u$
6. $R_n = 1.0L_{ct}F_u \leq 2.0dtF_u$
7. $R_x = \frac{My}{\Sigma d^2}$ and $R_y = \frac{Mx}{\Sigma d^2}$

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Course Title: Structural Engineering VII

Course Code: CE 419

Time: 1 hour

Credit Hour: 2.00

Full Marks: 40

Answer the following questions.

1. Express the fundamental invariants of a symmetric second order tensor using eigen values. [2]
2. Define body force and surface force. Express the traction vectors for the co-ordinate planes in terms of their stress components. [4]
3. Describe the elasticity field equations for a linear elastic solid in a cartesian co-ordinate system. [6]
4. How to solve the elasticity field equations? What type of solution can be obtained using finite element method (FEM)? Describe FEM method briefly. [6]
5. Determine the strain and rotation tensor of the following displacement fields:

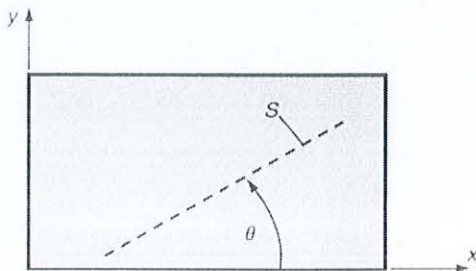
(i) $u = Ax^2y, v = Bxz, w = c(x^2 + y^2)$

(ii) $u = Ayz^3, v = Bxy^2, w = c(x^2 + z^2)$ [10]

6. The state of stress in a rectangular plate under uniform biaxial loading, as shown in the following figure, is found to be

$$\sigma_{ij} = \begin{bmatrix} x & 0 & 0 \\ 0 & y & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

Determine the traction vector, the normal and shearing stresses on the oblique plane S . [12]



Note:

$$Q_{ij} = \begin{bmatrix} l_1 & m_1 & n_1 \\ l_2 & m_2 & n_2 \\ l_3 & m_3 & n_3 \end{bmatrix}$$

$$\sigma'_x = \sigma_x l_1^2 + \sigma_y m_1^2 + \sigma_z n_1^2 + 2(\tau_{xy} l_1 m_1 + \tau_{yz} m_1 n_1 + \tau_{zx} n_1 l_1)$$

$$\sigma'_y = \sigma_x l_2^2 + \sigma_y m_2^2 + \sigma_z n_2^2 + 2(\tau_{xy} l_2 m_2 + \tau_{yz} m_2 n_2 + \tau_{zx} n_2 l_2)$$

$$\tau'_{xy} = \sigma_x l_1 l_2 + \sigma_y m_1 m_2 + \sigma_z n_1 n_2 + \tau_{xy}(l_1 m_2 + m_1 l_2) + \tau_{yz}(m_1 n_2 + n_1 m_2) + \tau_{zx}(n_1 l_2 + l_1 n_2)$$

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

Course Title: Structural Engineering X
Time: 1 hour

Credit Hour: 2

Course Code: CE 425
Full Marks: 40

QUESTION 1

Some pier caps need to be constructed to support a bridge superstructure located on a national highway. The river over which the bridge will be constructed is connected to a nearby sea. The length, width and thickness of the pier caps are 15 ft, 20 ft and 10 ft, respectively. Three types of cement (A, B and C) have been chosen and technical data sheets are collected to pre-investigate the performance of cement in order to find suitable concrete for that construction. Chemical compositions of the cements are determined by X-ray fluorescence and presented in Table 1.

Table 1: Chemical constituent of cement (A, B and C)

Bulk Oxide Content	CaO	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MgO	SO ₃	K ₂ O	Na ₂ O	LOI
A	66	19.6	8	4.0	0.5	0.3	0.3	0.3	1.0
B	64	20.0	11	1.4	1.1	0.1	0.1	0.4	1.9
C	59	23.6	8	4.0	1.0	0.3	0.5	0.6	3.0

(i) Identify the cements that may provide higher strength of concrete and higher heat of hydration. [10]

(ii) Based on silica ratio, alumina modulus and Bogue analysis, select a suitable cement for the pier caps considering sustainability and durability of concrete, and justify your selection. [8]

QUESTION 2

“A very high dose of superplasticizer can slow down the construction process of concrete structures.” Explain this with the help of a neat sketch. [8]

QUESTION 3

With the help of a neat sketch, describe the mechanism of concrete pumping. Explain the factors which are considered for selecting suitable pump for pumping concrete. [4+4]

QUESTION 4

“Incorporation of silica fume in concrete can improve the resistance of the concrete against chemical attack.” Justify this statement with chemical reactions and proper comments. [6]

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

Course Title: Environmental Engineering IV
 Time: 1 hour

Credit Hour: 2.0

Course Code: CE 433
 Full Marks: 40

(Answer all the questions. All questions are of equal value. Figures in the right margin indicate marks)

1. a) Define Ryznar Stability Index. Categorize the types of water based on Ryznar Stability Index [5]
- b) State the limitations of Streeter-Phelps Dissolved Oxygen model. [5]
2. a) Explain why treatment standards vary from country to country/province to province. [5]
- b) Discuss the nitrification process with figure. [5]
3. a) The BOD rate constant of a wastewater sample is 0.18 d^{-1} . The temperature of the wastewater is 30°C . What will be the rate constant at 15°C ? [5]
- b) 15 ml of sewage has been mixed with dilution water to fill a 300 ml BOD bottle. The initial DO and DO after 5 days of the sewage mixed with dilution water are 8.8 mg/L and 2.9 mg/L, respectively. The initial DO and DO after 5 days of diluted mix are 8.7 mg/L and 7.7 mg/L, respectively. Calculate BOD of the sewage. [5]
4. You are assigned to judge the water quality of a river based on the Dissolved Oxygen (DO) level where wastewater is discharged at a certain point. The details are given below. [10]

River	Wastewater
Q = 8.2 m ³ /s	Q = 0.7 m ³ /s
DO = 10.2 mg/L	DO = 1.5 mg/L
BOD ₅ = 2.50 mg/L	BOD ₅ = 170 mg/L
T = 28 °C	T = 35 °C

The reaeration rate and the deoxygenation rate are 0.52 d^{-1} and 0.48 d^{-1} at 20°C , respectively. The guideline value for minimum DO necessary in the rivers and streams is 4.0 mg/L (ppm) for the survival of fishes and aquatic animals. What will you suggest?

Equations:

$$t_c = \frac{1}{k_r - k_d} \ln \left[\frac{k_r}{k_d} \left(1 - D_a \frac{k_r - k_d}{k_d L_a} \right) \right] \quad D_c = \frac{k_d L_a}{k_r - k_d} (e^{-k_d t_c} - e^{-k_r t_c}) + D_a e^{-k_r t_c}$$

$$\text{DO}_{\text{sat}} = 14.62 - 0.394T + 0.007714T^2 - 0.0000646T^3;$$

$$D_t = \frac{k_d L_o}{k_r - k_d} (e^{-k_d t} - e^{-k_r t}) + D_a (e^{-k_r t})$$

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Course Title: Environmental Engineering III

Course Code: CE 431

Time: 1 hour

Credit Hour: 2.0

Full Marks: 40

Answer all the questions.

- 1) Summarize the factors that influence the composition of solid waste. (5)
- 2) Interpret the term "reduce" in solid waste management system. (4)
- 3) Summarize the functional steps to be followed for an effective solid waste management system. (6)
- 4) Explain why bulk density of solid waste is higher in low-income countries than in industrialized countries. (3)
- 5) Estimate the energy content of a typical 100 kg sample of wet municipal solid waste. (8)

Type	Wet Mass (kg)	Moisture Content
Food Waste	65	70%
Paper	15	6%
Wood	20	20%
Total	100	

Given:

Table: Typical data on ultimate analysis of combustible materials found in solid waste

Type	% by weight (dry basis)					
	C	H	O	N	S	Ash
Food Waste	73	11.5	14.8	0.4	0.1	0.2
Paper	43.3	5.8	44.3	0.3	0.2	6
Wood	49.5	6	42.7	0.2	0.1	1.5

$$\text{Energy Content (KJ/kg)} = 337 C + 1428 [H - (O/8)] + 9 S$$

Where C = carbon %, H = hydrogen %, O = oxygen % and S = sulfur %

6) Explain how you can promote source reduction and on-site processing. (4)

7) (i) Differentiate between Heuristic and Deterministic approaches to design the collection routes of vehicles. (2)

(ii) Suppose the annualized cost of purchasing, fueling and maintaining a compactor truck is given by the following expression:

$$\text{Annualized Cost (tk /yr)} = 100,000 + 400,000 V$$

Where V is the truck volume in m^3 . Suppose, these trucks require 2 person crews, with labor charged at 5500 tk/week each.

Perform an economic analysis of the collection system in which a 16 m^3 truck collects refuse from 250 households each day. Each household generates 25 kg of refuse per week. The trucks and crew work 5 days per week and curb-side pickup is provided once a week for each house.

What is the annual cost per ton of refuse collected and what is the annual cost per household? (8)

[1000 kg = 1 ton, 1 yr = 52 week]