University of Asia Pacific
Department of Civil Engineering
Mid-Term Examination, Fall 2024
Program: B.Sc. in Civil Engineering
4th Year 1st Semester

Course Title: Structural Engineering X | Course Code: CE 425
Time: 1 hour | Credit Hour: 2.0 | Full Marks: 40

QUESTION 1 [8 MARKS] [8]

Explain the hydration of four main compounds of cement and their effects on strength development of concrete.

QUESTION 2: [8 MARKS] [8]

Discuss the effects of Superplasticizer on fresh and hardened concrete.

QUESTION 3: [8 MARKS] [8]

Ready mix concrete (RMC) is preferably used in large projects – Do you agree? Justify your answer with advantages and disadvantages of RMC.

QUESTION 4 [16 MARKS]

a. A cement with a Silica ratio of 1.50, Alumina ratio of 1.55, Hydraulic modulus of 2.0 and Lime saturation factor of 1.02 is selected. Determine the missing oxide percentages [8]

b. Comment of the properties of cement in terms of strength, heat of hydration, setting time. [8]

Oxides	Content (%)
Cao	?
SiO_2	?
Al_2O_3	7.50
Fe_2O_3	?
SO_3	?

University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination Fall 2024
Program: B. Sc. Engineering (Civil)

Course Title: Environmental Engineering III — Course Code: CE 431
Time- 1 hour — Full marks: 40

Answer all the questions (*15 +25 = 40*). [Assume reasonable data if any]

1. (a) Discuss which properties (Physical/Chemical/Biological) of the following waste (individually) are important to know to plan management of those wastes: (8)

i) Alcohol, ii) Garden trimming, iii) Kitchen waste, iv) medical waste

(b) Calculate the energy content of the waste using Dulong's formula mentioned below: (7)

Dulong's Formula:

Energy Content (KJ/Kg) = 338.2C+1430 (H-O/8) + 95.4S

Component	Moisture	Carbon	Hydrogen	Oxygen	Nitrogen	Sulfur	Ash
Mass (kg)	25	50	6	40.00	0.5	0.3	5
Molar Mass (kg/mol)	-	12.00	1.00	16.00	14.00	32.00	-

2. (a) Explain the beneficial consequences of climate change with respect to source reduction. Evaluate what kind of on-site processing of waste you can dattempt at home for decreased burden in disposal and increased collection efficiency. (4+4)

(b) Explain your understanding of Primary and Secondary recycling. (5)

(c) A stationary system uses a compactor with a volume of 50 m^3 that incurs cost @BDT 4000/hour with density of waste in the compactor @500 kg/m^3. On the other hand, a transfer/transport system uses a unit with a capacity of 150 m^3 that incurs cost @BDT 5000/hour with density of waste in the unit @200 kg/m^3. The transfer system has an additional operating and unloading cost of BDT 150/ m^3. Evaluate the breakeven time beyond which the economic benefit switches from one system to the other with time. (12)

University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination, Fall 2024
Program: B.Sc. in Civil Engineering
4th Year 1st Semester

Course Title: Irrigation and Flood Control | Course Code: CE 461
Time: 1 hour | Credit Hour: 3.00 | Full Marks: 40

Answer all the questions

QUESTION 1 [10 MARKS]

a. State two considerations for ground water as a source of irrigation water [2]

b. i) Classify the irrigation water having the following characteristics: Concentration of Na, Ca and Mg are 250, 18 and 6 milligram per litre and the electric conductivity is 450 micro mhos per cm at 25°C. [4+2+2]

Given are:
Atomic weight of sodium= 23
Atomic weight of calcium= 40
Atomic weight of magnesium= 24.3

ii) Identify two problems that may arise from using this water on fine textured soils.
iii) Provide remedies to overcome these troubles.

QUESTION 2 [10 MARKS]

a. Compute the net irrigation requirement the given information. [10]
T_{max}= 32.5 °C, T_{min} = 14.2 °C, Relative humidity = 30 %, Wind speed U_2= 18.5 km/day, Net radiation in equivalent evaporation = 5.5 mm/day, c = 1.0, w = 0.75, Crop coefficient = 1.2, Effective rainfall = 1.6 mm/day, Percolation = 5 mm/day, Increase in soil moisture over a day = 0.6 %, Apparent specific gravity of soil = 1.20, and, Root zone = 30 cm.
[Hint: Use FAO Penman equation to calculate reference crop evapotranspiration
FAO Penman equation: $E_{t0} = c[wR_{ne} + (1-w)f(u)(e_s - e_a)]$,
Equation for calculating vapor pressure: $e(T)$= 0.611 exp $[\frac{17.27T}{T+237.3}]$, kpa]

QUESTION 3 [10 MARKS]

a. Demonstrate the forces by which water is held in the soil. [2]

b. Explain the importance of measuring soil moisture for irrigation and identify an accurate method to measure it. [3]

c. Calculate the depth and frequency of irrigation required for a certain crop with data given below: [5]
Root zone depth = 100 cm
Field capacity = 22 %
Wilting point = 12 %
Apparent specific gravity of soil = 1.50
Consumptive use = 2.5 cm/day
Assume 50 % depletion on available moisture before application of irrigation water at field capacity.

QUESTION 4 [10 MARKS]

a. 800 m^3 of water is applied to a farmer's rice field of 0.6 hectares. Prior to irrigation, the moisture content was reduced by 60 % of the available water between field capacity of 36 % and permanent wilting point of 15 %. Determine the water application efficiency. The root zone depth of rice is 60 cm and dry unit weight of the soil is 10.8 kN/m^3. Assume any other data not given. [6]

b. The water depths along the length of a border strip at points 30 meters apart were probed after irrigation. Their observed values are 2.0, 1.9, 1.8, 1.65 and 1.4. Compute the water distribution efficiency. [4]

University of Asia Pacific
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4th Year 1st Semester

Course Title: Transportation Engineering II | Course Code: CE 451
Time: 1 hour | Credit Hour: 3.00 | Full Marks: 60

Answer all the questions

PART A

QUESTION 1 [12 MARKS]

a. Differentiate between the load distribution pattern of flexible and rigid pavement with neat sketch of different layers. [5]
b. Briefly explain tie bars and dowel bars. [4]
c. Suppose you need to construct a cement concrete pavement on a low volume highway. Discuss the type of pavement need to be selected and justify your answer [3]

QUESTION 2 [8 MARKS]

The following results were obtained by a sieve analysis. Classify the soil according to the AASHTO classification system and calculate the group index. Discuss whether this material is suitable in its natural state for use as a subbase material. [8]

Table 1: Mechanical Analysis

Sieve No.	Percent Finer	Plasticity Test
10	92	Liquid Limit = 40
40	90	Plastic Limit = 31
100	85	
200	80	

PART B

QUESTION 3 [10 MARKS]

a. Explain the process of obtaining bitumen as a short residue from petroleum crude oil? [7]
b. Describe the significance of conducting Aggregate Crushing Value test in roadway construction. [3]

QUESTION 4 [30 MARKS]

a. Determine the optimal asphalt content for a pavement designed to facilitate local travel from the village to the Sadars. The ESAL for the road is 2×10^3. Table 2 shows data obtained from the Marshall test. The total thickness of the mix is 67 mm. Compare the stability, flow and percent voids in total mix of the paving mixture containing the optimum asphalt content with the requirements for Marshall mix design of the pavement specified in Table 3. [25]

Table 2: Marshall Method

Asphalt %	Weight of the specimen in Air (gm)	Weight of specimen in Water (gm)	Stability (lb)	Flow (in)	Maximum Specific Gravity
3.0	782	625	1000	10	6.50
3.5	1050	875	800	12	7.50
4.0	860	740	945	20	8.44

b. Evaluate the suitability of your design by determining whether the parameters meet the specified limits outlined in Table 2. [5]

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4th Year 1st Semester

Course Title: Professional Practices and Communication | Course Code: CE 403
Time: 1 hour | Credit Hour: 2.00 | Full Marks: 40

Answer all the questions

QUESTION 1 [10 MARKS]

Describe the strategies you would apply to ensure deliverables consistently meet quality standards and achieve client approval during the Implementation phase of the project. Also, explain how you would apply a comprehensive lessons-learned analysis during project closure to optimize future project outcomes. [06+04]

QUESTION 2 [10 MARKS]

The 'Town Center Road Project' is a multi-phase civil construction project aimed at improving traffic flow in the town center. The project's initial phase, 'Road Widening Phase 1', focused on expanding a key arterial road. This phase, funded by a substantial initial grant, has seen progress, with groundwork completed and initial paving laid. However, unforeseen utility line issues caused delays and increased material costs, leading to a budget shortfall.

The project team now needs to secure funding for the second phase, 'Road Widening Phase 2', which involves completing the road surfacing, installing sidewalks, and adding street lighting. The initial grant was intended to cover the entire road widening, but the unforeseen issues have created a funding gap.

Given the project's ongoing nature and the need to secure additional funding for the completion of the 'Town Center Road Project,' determine the most appropriate type of project proposal and provide justification for your answer by explaining the key characteristics of this proposal type and how they align with the project's current status and funding needs. [04+06]

QUESTION 3 [10 MARKS]

Your civil engineering firm has been selected to design and oversee the 'Downtown Redevelopment Project,' a complex urban renewal initiative. During the contract negotiation phase, the client, a city municipality, expresses concerns about several standard terms and conditions. While the budget is generally agreed upon, disagreements arise regarding the

scope of services, the allocation of risk for potential site contamination, and the municipality's desire for specific performance guarantees not included in your firm's standard contract.

The client is particularly concerned about the potential discovery of hazardous materials during excavation, which could lead to significant project delays and cost overruns. They propose shifting the majority of this risk to your firm. Additionally, they want to modify the general conditions related to project change orders and dispute resolution.

Considering the complexity of the 'Downtown Redevelopment Project' and the client's specific concerns, which *type* of contract format (e.g., Conventional, Negotiated Terms and Conditions, Multiple Contracts, Special Contracts, Client - Developed Contract) would be most applicable? Back up your answer by proper justification. **[03+07]**

QUESTION 4 [10 MARKS]

The infrastructure development company has been awarded the 'Waterline Expansion Project', a contract to extend the town's water supply to a newly developed residential area. The contract is structured as a **Unit Price** agreement, with pricing based on linear feet of installed water pipe. However, the project involves various complexities, including excavation in diverse soil conditions, installation of specialized pipe fittings, and coordination with multiple utility companies.

During the initial phase, discrepancies arose regarding the interpretation of unit prices. The client questioned whether the linear foot price included all necessary components, such as excavation, backfill, and pipe fittings. Additionally, unexpected soil conditions required the use of specialized excavation techniques, leading to increased labor costs. Furthermore, permit delays resulted in the need for overtime work to meet the project deadline.

Based on the 'Waterline Expansion Project' case study, thoroughly investigate and document the advantages and disadvantages of employing a **Unit Price** contract for this type of civil engineering project. **[10]**

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University of Asia Pacific
Department of Civil Engineering
Mid-Term Examination, Fall 2024

Course # CE 441 — Course Title: Geotechnical Engineering II
Full Marks: 40 — Time: 1 hour

Answer to all questions

1. (a) Mention three major purposes of geotechnical sub-surface exploration. Also mention the names of any four in-situ tests. 4

   (b) Mention the preliminary information that should be available to conduct a subsurface exploration program for (i) a building project, and (ii) a bridge project. 3

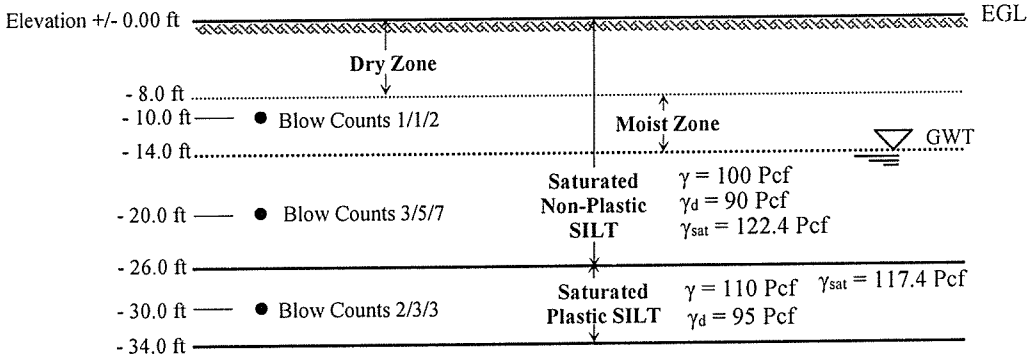
   (c) Summarize your understanding regarding disturbed and undisturbed sampling in terms of disturbances. 6

2. Consider the following scenario for an existing three-storied building: 7

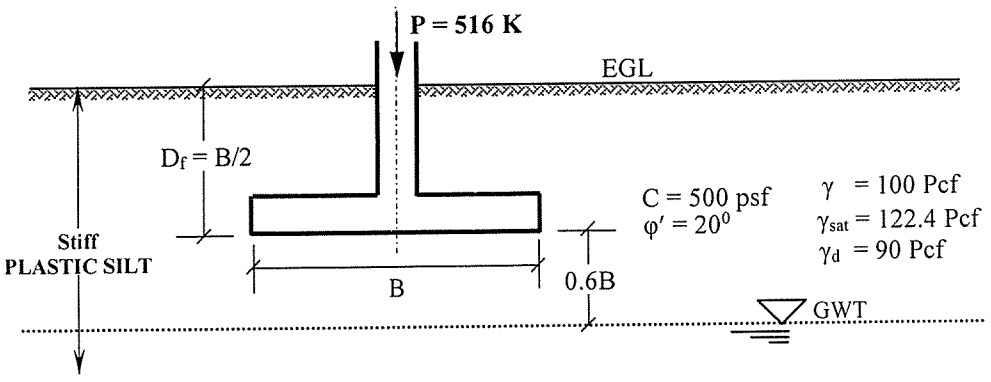
   - *An existing footing is found to have dimension of 8 ft x 8 ft*
   - *Estimated column load on this footing for existing condition, P_{app} = 400 kips*
   - *Analyzed ultimate bearing capacity as determined from geotechnical analysis performed for this site, (q_u) = 12,500 psf.*

   Assess the actual factor of safety of the existing footing and comment on your result. Also estimate the revised size of the footing required to maintain required factor of safety of 2.5

3. Information regarding a geotechnical site investigation conducted using a hammer with efficiency of 55% at a site is provided below. Estimate the Field SPT values for all depths. Apply necessary corrections (for 60% energy and overburden) and calculate the corrected SPT values as required (Use Appendix, as necessary) at depths of *10 feet and 15 feet* below EGL. Also determine the angle of internal friction and cohesion, as applicable at corresponding depths. Consider use of liner. 8



4. Using Terzaghi's Bearing Capacity Equation (TBCE), as appropriate, determine the size of the square footing for long term (drained) condition as shown in the figure below. Also calculate the allowable bearing capacity in this case. 12



University of Asia Pacific
Department of Civil Engineering
Mid Semester Examination, Fall 2024
Program: B.Sc. in Civil Engineering
4th Year 1st Semester

Course Title: Structural Engineering V | Course Code: CE 415
Time: 1 hour | Credit Hour: 2.00 | Full Marks: 60

Answer all the questions

QUESTION 1 [20 MARKS]

A prestressed concrete rectangular beam 500 mm by 800 mm has a simple span of 6.5 m and is loaded by a uniform load of 45 kN/m including its own weight, as shown in **Figure 1**. The prestressing tendon is parabolic and produces an effective prestress of 1620 kN. Compute the extreme fiber stresses in the concrete at the midspan section using the **Flexural Stress Method** (1st Concept).

[15]

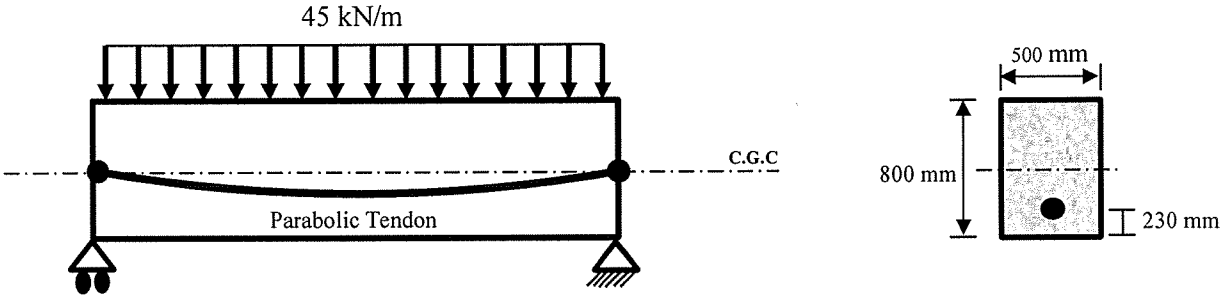


Figure 1: Simply Supported beam with parabolic tendon

QUESTION 2 [10 MARKS]

Describe briefly about the following topics:

i. Nature of Concrete-Steel Interface
ii. Stages of Loading
iii. Advantages of Prestressed Concrete

[10]

QUESTION 3 [15 MARKS]

a. A straight pretensioned concrete member of 15 m long, with a cross section of 400 mm by 400 mm, is concentrically prestressed with 800 mm^2 of steel wires which are anchored to the bulkheads with a stress of 1050 MPa. If E_c = 35000 MPa and E_s = 200000 MPa, compare (i) the **Exact loss** of prestress, and (ii) the **Approximate loss** of prestress due to the elastic shortening of concrete at the transfer of prestress.

[8]

b. A straight cable 20 m long is to be tensioned from one end to an initial prestress of 1035 MPa immediately after transfer. The shrinkage of concrete is 0.0005 and the average compression of concrete is 6 MPa per unit length of the tendon. If E_c = 30000 MPa and E_s = 200000 MPa, determine the **length of the shims** required, neglecting elastic shortening and friction of tendon.

[7]

QUESTION 4 [15 MARKS]

A posttensioned bonded concrete beam, as shown in **Figure 2**, has a prestress of 1580 kN in the steel immediately after prestressing, which eventually reduces to 1300 kN due to losses. The beam carries three live loads of 50 kN each in addition with its self-weight of 5 kN/m. The cross section of the midspan, as shown in **Figure 3**, has 500 mm width and 800 mm depth. Determine the extreme fiber stresses in midspan under the **Final condition** after the losses have been taken place, and with full live load using the **Internal Couple Resisting Method** (2nd Concept).

[20]

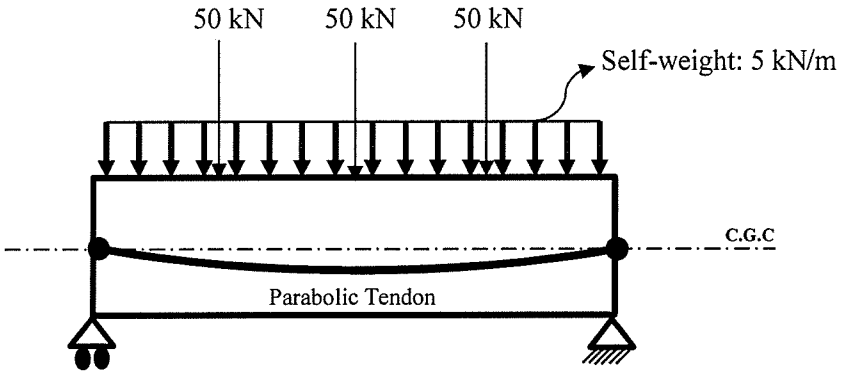


Figure 2: Beam Elevation

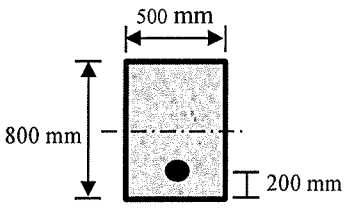


Figure 3: Midspan Section

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Program: B.Sc. Engineering (Civil)

Course Title: Structural Engineering III | Course Code: CE 411
Time: 1 hour | Credit Hour: 3.0 | Full Marks: 40 (= 4 × 10)

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

1. Use stiffness method to calculate rotations of joint ***d*** of the grid system ***abcdef*** loaded as shown in ***Fig.1***
   [Given: EI = 50×10^3 k-ft^2 and GJ = 5×10^3 k-ft^2].

2. Ignore zero-force members of the space truss ***abcdefgh*** shown in ***Fig.2*** and apply boundary conditions to formulate stiffness matrix and load vector.
   [Given: S_x = 1000 k/ft, Nodal Coordinates (*ft*) are *a*(0,12,0), *b*(0,12,-5), *c*(6,12,-5), *d*(6,12,0), *e*(0,0,0), *f*(0,0,-5), *g*(6,0,-5) and *h*(6,0,0)].

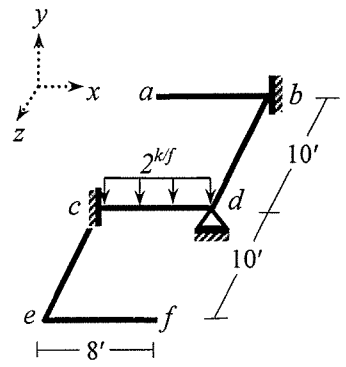


Fig.1

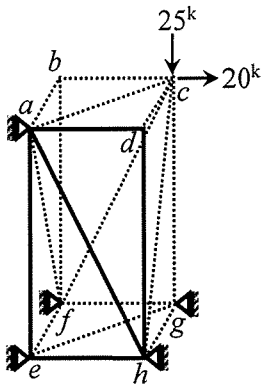


Fig.2

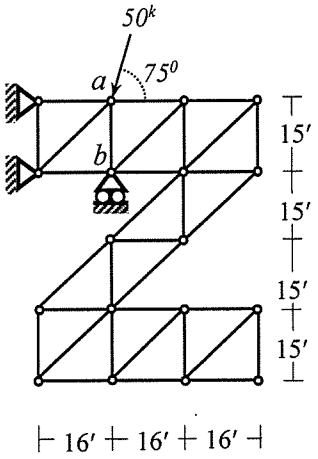


Fig.3

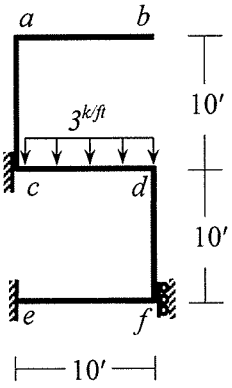


Fig.4

3. Identify zero-force members of the truss loaded as shown in ***Fig.3***. Determine the displacements of joints ***a*** and ***b***.
   [Given: EA/L =1000 k/ft].

4. Use stiffness method (neglecting axial deformations) to calculate deflection of joint ***f*** and rotation of joint ***d*** of the frame ***abcdef*** loaded as shown in ***Fig.4***
   [Given: EI = 50×10^3 k-ft^2]

List of Useful Formulae for CE 411

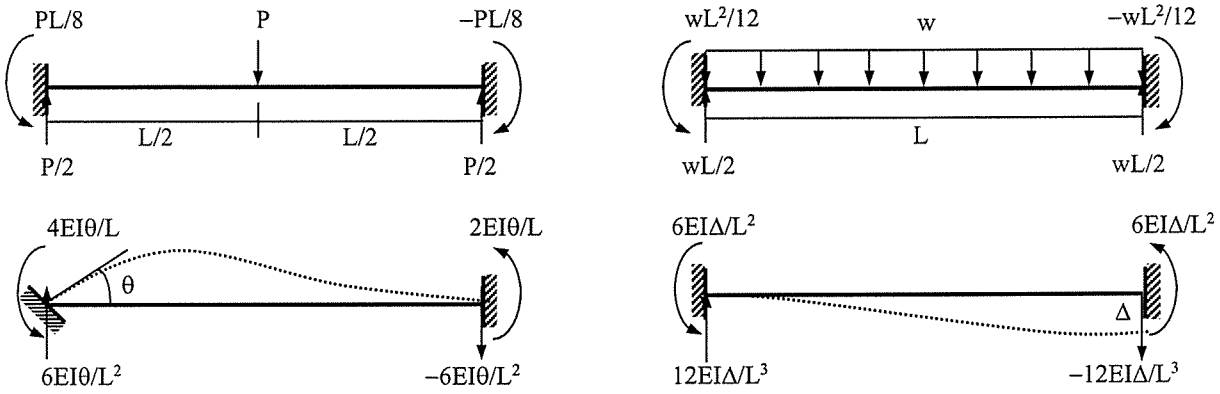
* The stiffness matrix $\mathbf{K_m}^G$ of a 2D truss member in the global axis system is given by

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

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
$K_{Halfspace}$	$8G_sR/(2-\nu)$	$4G_sR/(1-\nu)$	$8G_sR^3/(3-3\nu)$	$16G_sR^3/3$