B. Sc. Engg. (CEE)/5th Semester — 15th December 2023/Afternoon

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Final Examination — **Winter Semester: 2022–2023**
Course Number: CEE 4513 — **Full Marks: 200**
Course Title: Structural Analysis and Design I — **Time: 3 Hours**

There are **5 (five)** questions. Answer **all of them.** The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in brackets. Assume any reasonable value if required.

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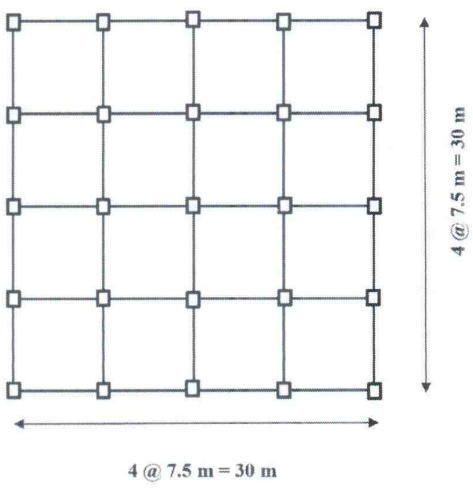
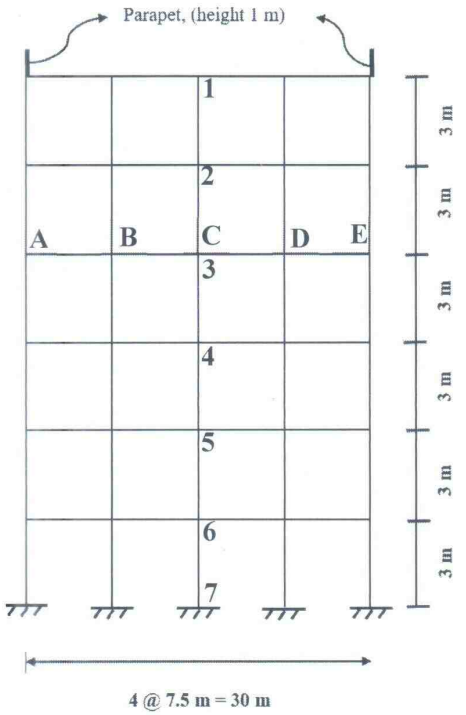
1. A typical 6-storied residential RC building is situated at a flat terrain of Cox's Bazar. The dimension of the building plan is 30 m × 30 m, height of each storey is 3 m and overall height of the building excluding parapet is 18 m. Parapet height is 1 m. Plan and the elevations of the building are shown in ***Fig. 1***. Occupancy category is II, exposure category is C, and the importance factor is 1.0. Basic wind speed of Cox's Bazar is 80 m/s. Gust effect (G) is 0.85. External pressure coefficient (C_p) is 0.8 for windward wall and -0.5 for leeward wall. The combined net pressure coefficient for windward parapet is 1.5 and for leeward parapet is -1.0.



(a) Plan of the building



(b) Elevation (both direction) of a typical interior frame

Fig. 1 for Question 1

Answer the following questions:

(a) Assuming that the building is classified as **OPEN**, calculate the wind load distribution (both windward and leeward direction) for a typical interior frame for Wind towards X direction using analytical procedure. Follow BNBC 2020 for your calculation. The following formula can be used for calculating velocity pressure exposure coefficient (K_z). CO2, PO2: [25]

$K_z = 2.01\ (z/z_g)^{2/\alpha}$ for $4.57\ m \le z \le z_g$, where $z_g = 213.36$ m and $\alpha = 11.5$
$K_z = 2.01\ (4.57/z_g)^{2/\alpha}$ for $z \le 4.57$ m

(b) Calculate the floor-wise shear force distribution and storey shears at each level of the building. Given, structural system is IMF, each storey height is 3 m, site class is SC, seismic zone coefficient (Z) = 0.28, Importance factor (I) = 1.0, Response modification factor (R) = 5 and Damping correction factor (η) = 1.2. Follow BNBC 2020 for your calculation. Use the following loads for calculating the building weight. CO2, PO2: [25]

I. Dead load and partition wall load = 12 kN/m^2 for all floors.
II. Live load for typical floor is 2.0 kN/m^2 including ground floor.
III. Live load in the roof is 1 kN/m^2.
IV. Self-weight of all pedestals is 120 kN.

$$C_S = S\left(1 + \frac{T}{T_B}(2.5\eta - 1)\right) \quad \text{for} \quad 0 \le T \le T_B$$

$$C_S = 2.5S\eta \quad \text{for} \quad T_B \le T \le T_C$$

$$C_S = 2.5S\eta\left(\frac{T_C}{T}\right) \quad \text{for} \quad T_C \le T \le T_D$$

$$C_S = 2.5S\eta\left(\frac{T_C T_D}{T^2}\right) \quad \text{for} \quad T_D \le T \le 4\ sec$$

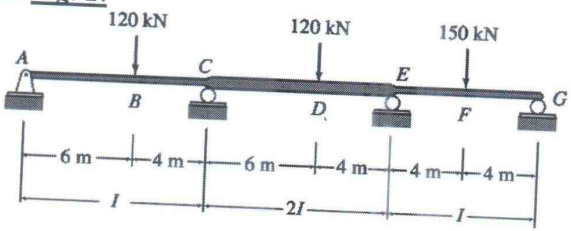
Table 6.2.16: Site Dependent Soil Factor and Other Parameters Defining Elastic Response Spectrum

Soil type	S	T_B(s)	T_C(s)	T_D(s)
SA	1.0	0.15	0.40	2.0
SB	1.2	0.15	0.50	2.0
SC	1.15	0.20	0.60	2.0
SD	1.35	0.20	0.80	2.0
SE	1.4	0.15	0.50	2.0

(c) For the wind load distribution obtained for windward direction in ***Question 1 (a)***, draw SFD and BMD of **"A-B-C-D-E"** beam shown in ***Fig. 1(b)***. Assume that all columns have the same cross-sectional area. Use **cantilever method** for your analysis. CO3, PO2: [25]

(d) For the vertical loads given in ***Question 1(b)***, draw (a) shear force and and (b) bending moment diagram of the column **"1-2-3-4-5-6-7"** shown in ***Fig. 1(b)***. CO3, PO2: [25]

2. Determine the reactions and draw the shear and bending moment diagrams for the structures shown in ***Fig. 2***. CO3, PO2: [25]



or

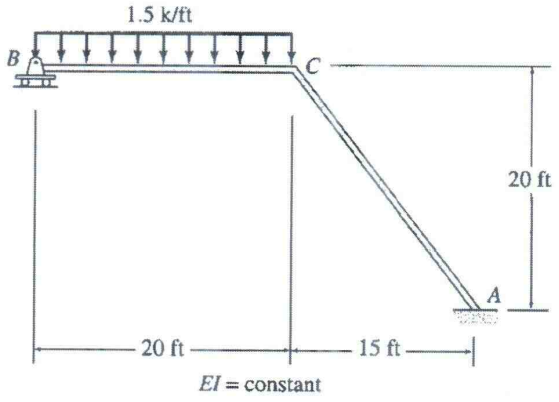


Fig. 2 for Question 2

3. Determine the reactions and the force in each member of the truss shown in ***Fig. 3*** due to a temperature drop of 25°C in members AB, BC, and CD and a temperature increase of 60°C in member EF. Use the method of consistent deformations. CO3, PO2: [25]

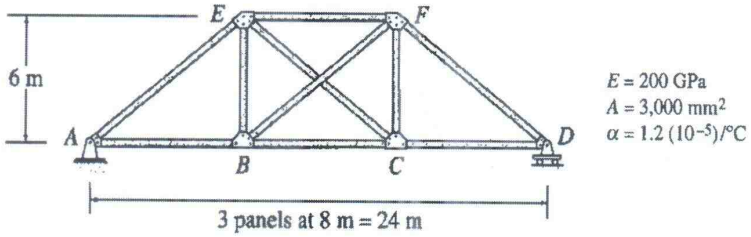


Fig. 3 for Question 3

or

Determine the reactions and the force in each member of the trusses shown in ***Fig. 4*** using the method of consistent deformations. Given, **E = 29000 ksi**

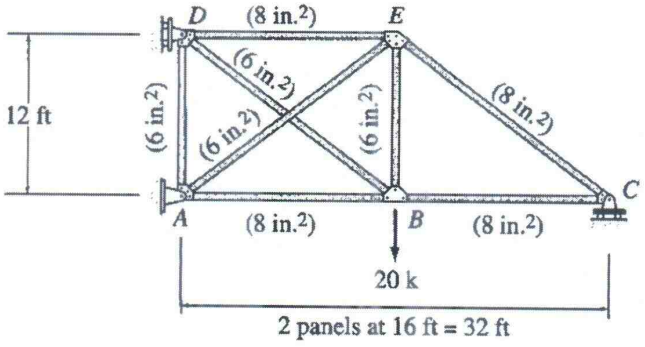


Fig. 4 for Question 3

4. Draw the (a) shear force and (b) bending moment diagrams of the girder **ABC** as shown in ***Fig. 5***. CO2, PO2: [25]

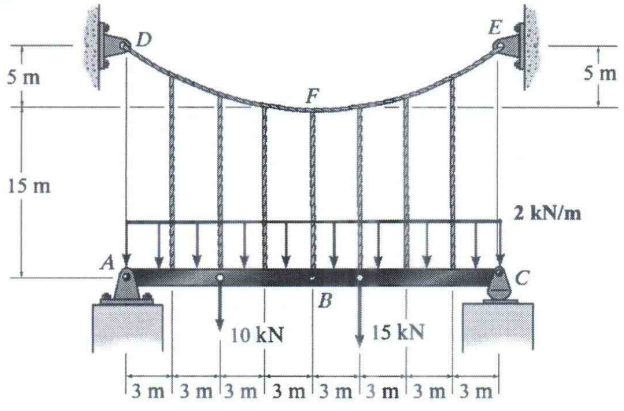


Fig. 5 for Question 4

or

Draw Influence line diagram for the bar forces of members "**IC**", "**ID**", "**CD**" and "**JD**" of the truss shown in ***Fig. 6.***

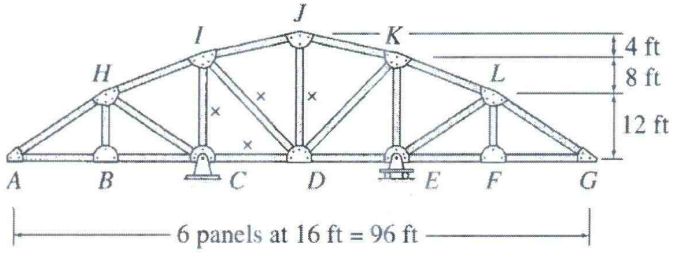


Fig. 6 for Question 4

5. Determine the member forces ***GM***, ***MN***, and ***FP***. Apply necessary assumptions as required. Also, (a) draw shear force and (b) bending moment diagram of the column ***AJI***. CO3, PO2: [25]

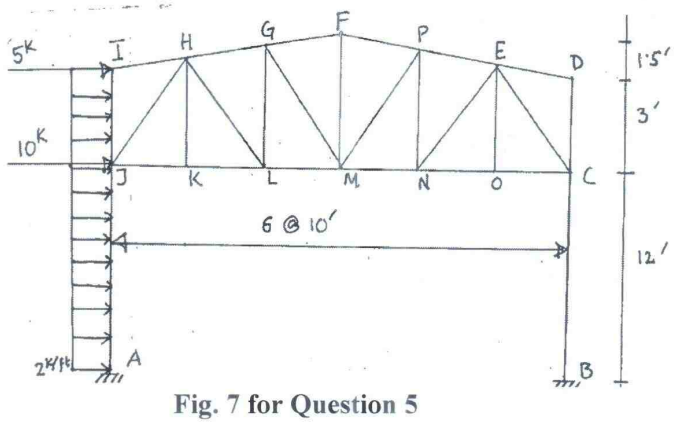


Fig. 7 for Question 5