L-4/T-2/CE **Date: 07/05/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **CE 403** (Socio-economic Aspects of Development Projects)

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.
Assume reasonable values for missing data.

1. The Dhaka Mass Rapid Transit (MRT) line 1 project is a government-led initiative with financial support from the Japan International Cooperation Agency (JICA). Its goal is to reduce traffic congestion and air pollution in Dhaka, Bangladesh by constructing a 31.2 km MRT line with 19 stations and one depot in the Pitolganj, Rupgonj area. **Figure 1** shows the proposed route of the MRT Line 1. Suppose an initial screening assessment indicates that the project will require the acquisition of 39 ha of land, including 25 ha for the Depot and 14 ha for the Construction Yard. The majority of the project area is rural, with the land mostly used for agriculture, vita/homestead, and khal (water body). Land acquisition for this project will displace households and commercial premises, both titled and non-titled, including landowners, squatters, sharecroppers, leaseholders, and non-titled land users. The project may directly impact 1,200 households comprising a total population of about 5,000. Additionally, the project will impact more than 20 Common Property Resources (CPR), including mosques, madrasas, schools/colleges, graveyards, and offices.

   Suppose you are asked to prepare a study framework for a detailed assessment of the impacts of land acquisition and resettlement plans for this project. Answer the following questions related to your study design:

   (a) What are the relevant social and economic factors that you need to consider for assessing the socio-economic impacts of this project explicitly associated with land acquisition, relocation, and resettlement? Please list at least ten factors. **(15)**

   (b) How will you collect relevant socio-economic data to assess the impacts related to land acquisition, relocation, and resettlement of this project? How will you ensure public participation and their views in the study design? **(20)**

2. Suppose you are tasked with proposing feasible mitigation measures for minimizing the negative impacts associated with land acquisition, relocation, and resettlement for the Dhaka Mass Rapid Transit (MRT) Line 1 project, described in question 1. Answer the following questions related to you proposed mitigation measures:

   (a) What are some feasible mitigation measures you propose to minimize the negative impacts of land acquisition, relocation, and resettlement related to the MRT Line 1 project? **(15)**

Contd …… P/2

CE 403

Contd... Q. No. 2

(b) Propose a framework for implementing your proposed mitigation measures that considers institutional aspects, monitoring requirements, and grievance redress mechanisms. **(20)**

3. (a) Table 1 presents the Human Development Index (HDI) and Gender Development Index (GDI) scores for Bangladesh and other countries. Gender inequality remains a significant issue in Bangladesh, and many development projects require the preparation of a Gender Action Plan (GAP) during the feasibility study phase. Using the Dhaka Mass Rapid Transit (MRT) Line 1 project (as described in Question 1) as a case study, propose a framework for a GAP that can effectively address gender disparities. Explain the key considerations of your framework and justify your selection by highlighting their potential impact on reducing gender inequality in the project. **(15)**

(b) The Human Development Index (HDI) and Multi-Dimensional Poverty Index (MPI) are commonly used to measure development progress in countries. Explain the basic parameters used in calculating each index and provide a simple sketch to illustrate their calculation methods. Additionally, discuss the limitations of the HDI and compare it with the MPI in terms of their approach to measuring development and how they differ. **(20)**

4. (a) Explain the concept of sustainable development and how it differs from conventional development models. Identify and describe the three key pillars of sustainable development and provide a clear and concise visual representation of their interdependence. Additionally, discuss the significance of balancing these pillars to achieve sustainable development objectives effectively. **(15)**

(b) The Government of Bangladesh has undertaken several development initiatives, including the Dhaka Mass Transit (MRT) Line 1 project described in Question 1. Using the Sustainable Development Goals (SDGs) framework outlined in Table 2, analyze the potential impact of MRT Line 1 project on achieving the 2030 Agenda for Sustainable Development. Identify the relevant SDGs and explain how the project aligns with them. Furthermore, evaluate any potential synergies or conflicts between the project's objectives and the broader SDG agenda. **(20)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) Briefly describe the different levels of community participation with the example of arsenic mitigation program for the rural areas of Bangladesh. **(20)**

Contd P/3

CE 403
Contd... Q. No. 5

(b) What is a client Centered approach? Explain this as a strategic issue for the WSS policies of Bangladesh. **(15)**

6. (a) What are the major difficulties in conducting socio economic assessments in developing countries? Explain with examples. **(20)**

(b) Briefly discuss methodologies in practice to ensure community participation. **(15)**

7. (a) What are the advantages and features of Social Impact Assessment (SIA) process? Describe. **(20)**

(b) Explain the following terms with explanations in the context of a WSS project in Bangladesh: **(15)**

(i) Clientele groups ii) Clientele need iii) Clientele demand iv) Absorptive Capacity.

8. (a) What are the major differences between Human Development Index (HDI) and Gender Development Index (GDI)? **(10)**

(b) Using the data given in table below, calculate the Human Development Index (HDI) and Gender Development Index (GDI) for Bangladesh and the USA. Compare and discuss any differences or similarities observed between the HDI and GDI values for the two countries. **(25)**

Country	Population	Life expectancy at birth	Expected years of schooling	Mean years of schooling	GNI per capita (2019 PPP US$)
Bangladesh	All	72.6 years	11.6 years	5.2 years	5,259
	Female	74.2 years	9.9 years	4.6 years	3,858
	Male	71.1 years	13.1 years	6.1 years	6,607
USA	All	78.9 years	16.3 years	13.4 years	63,826
	Female	81.4 years	17.4 years	14.1 years	49,958
	Male	76.3 years	15.2 years	12.7 years	77,696

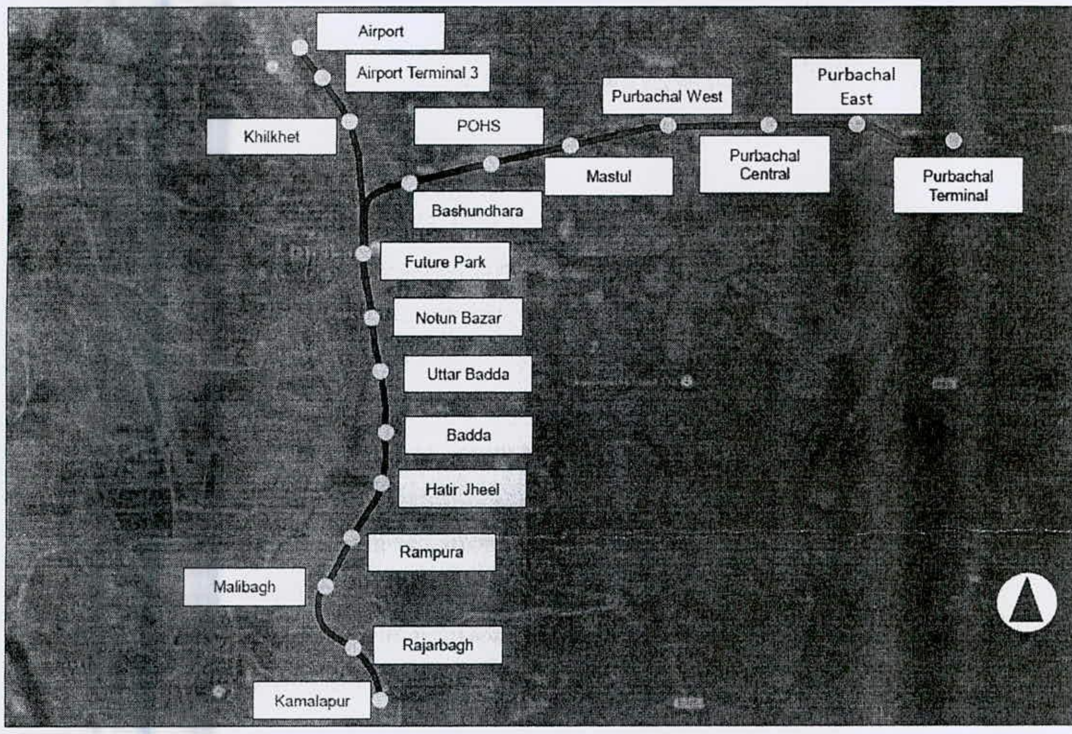


Figure 1: Map showing the Route of the MRT line 1.

Table 1: Human Development Index and Gender Development Index of Bangladesh and a few other countries.

		Gender Development Index		Human Development Index		SDG 3 Life expectancy at birth (years)		SDG 4.3 Expected years of schooling (years)		SDG 4.4 Mean years of schooling (years)		SDG 8.5 Estimated gross national income per capita[a] (2017 PPP $)	
				Value									
		Value	Group[b]	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
HDI RANK		2021	2021	2021	2021	2021	2021	2021[c]	2021[c]	2021[c]	2021[c]	2021	2021
118	Bolivia (Plurinational State of)	0.964	2	0.680	0.705	66.8	60.9	14.9	15.0	9.2	10.5	6,856	9,359
118	Kyrgyzstan	0.966	2	0.675	0.698	74.4	65.8	13.4	13.0	11.6[e]	11.1[e]	2,863	6,331
120	Venezuela (Bolivarian Republic of)	0.983	1	0.679	0.691	75.2	66.3	13.8[i]	11.8[i]	11.4[j]	10.8[j]	2,866	6,796
121	Iraq	0.803	5	0.585	0.728	72.4	68.2	11.5[e]	12.7[e]	7.2[m]	8.4[m]	2,184	17,748
122	Tajikistan	0.909	4	0.648	0.713	73.7	69.6	11.2[i]	12.1[i]	10.9[e]	11.8[e]	2,980	6,096
123	Belize	0.975	1	0.672	0.689	74.3	67.1	13.3	12.7	9.0	8.7	4,249	8,345
123	Morocco	0.861	5	0.621	0.722	76.4	71.9	13.9	14.4	5.0	6.9	3,194	11,356
125	El Salvador	0.964	2	0.660	0.685	75.1	66.1	12.7[e]	12.6[e]	6.8	7.6	5,824	11,015
126	Nicaragua	0.956	2	0.648	0.678	76.8	70.8	12.7[i]	12.6[e]	7.4	6.8	3,646	7,661
127	Bhutan	0.937	3	0.641	0.684	73.8	70.1	13.6[i]	12.8[i]	4.5[i]	5.8[i]	6,671	11,896
128	Cabo Verde	0.981	1	0.653	0.666	78.5	69.6	12.8[i]	12.3[i]	6.0[i]	6.6[i]	4,682	7,796
129	Bangladesh	0.898	5	0.617	0.688	74.3	70.6	13.0	11.9	6.8	8.0	2,811	8,176
130	Tuvalu	..	..	..	..	69.1	60.8	9.5[i]	9.3[i]	10.4	10.8	..	..
131	Marshall Islands	..	..	..	..	67.2	63.7	10.4	10.1	10.7	11.1	..	..
132	India	0.849	5	0.567	0.668	68.9	65.8	11.9	11.8	6.3[e]	7.2[e]	2,277	10,633
133	Ghana	0.946	3	0.614	0.649	66.0	61.6	12.1	12.0	7.8[e]	9.0[e]	4,723	6,771
134	Micronesia (Federated States of)	..	..	..	..	74.6	67.1	..	..	..	..	..	..
135	Guatemala	0.917	4	0.596	0.650	72.7	66.0	10.5	10.6	5.2	6.2	4,909	12,614
136	Kiribati	..	..	..	..	69.1	65.5	12.4	11.3	..	..	..	..
137	Honduras	0.960	2	0.607	0.633	72.5	67.9	10.4[n]	9.9[n]	6.8	7.4	4,271	6,304
138	Sao Tome and Principe	0.907	4	0.584	0.643	70.4	65.2	13.5	13.3	5.6[m]	6.8[m]	2,415	5,635
139	Namibia	1.004	1	0.616	0.613	63.0	55.7	11.9[n]	11.9[n]	7.5[e]	6.9[e]	7,271	10,094
140	Lao People's Democratic Republic	0.949	3	0.591	0.623	70.1	66.2	9.9	10.3	5.0	5.8	6,757	8,627
140	Timor-Leste	0.917	4	0.580	0.633	69.5	66.1	12.2[i]	13.0[i]	4.7	6.2	3,642	5,248
140	Vanuatu	..	..	..	..	72.9	68.4	11.4[i]	11.7[i]	..	..	2,354	3,809
143	Nepal	0.942	3	0.584	0.621	70.4	66.6	12.9	12.8	4.2[e]	6.2[e]	3,677	4,095
144	Eswatini (Kingdom of)	0.986	1	0.593	0.601	61.2	53.4	13.2[i]	14.2[i]	5.7	5.5	6,384	8,993
145	Equatorial Guinea	..	..	..	..	62.7	58.8	..	..	4.2[p]	7.6[p]	8,351	15,399
146	Cambodia	0.926	3	0.570	0.615	72.3	66.8	11.0[e]	11.9[e]	4.4	5.9	3,464	4,706
146	Zimbabwe	0.961	2	0.580	0.604	62.0	56.2	12.0[i]	12.3[i]	8.3[i]	9.2[i]	3,286	4,397
148	Angola	0.903	4	0.557	0.617	64.3	59.0	11.5	12.9	4.2	6.9	4,751	6,197

Table 2: Sustainable Development Goals (SDGs).

SDG 1	End poverty in all its forms everywhere.
SDG 2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
SDG 3	Ensure healthy lives and promote well-being for all at all ages
SDG 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
SDG 5	Achieve gender equality and empower all women and girls
SDG 6	Ensure availability and sustainable management of water and sanitation for all
SDG 7	Ensure access to affordable, reliable, sustainable and modern energy for all
SDG 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
SDG 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
SDG 10	Reduce inequality within and among countries
SDG 11	Make cities and human settlements inclusive, safe, resilient and sustainable
SDG 12	Ensure sustainable consumption and production patterns
SDG 13	Take urgent action to combat climate change and its impacts
SDG 14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
SDG 15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
SDG 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
SDG 17	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

L-4/T-II /CE **Date : 27/03/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **CE 413** (Introduction to steel concrete composite structures)

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

Assume reasonable values for missing data, if any.

Necessary tables & formulae are provided in ANNEXURE.

1. (a) A typical bay of a composite floor system consisting of composite deck slab resting on steel beam is illustrated in Fig. 1. Calculate the service load flexural stresses in concrete and steel of the secondary composite beam SB1 (W21×68) for unshored construction. In addition to the self-weight of the slab and beam consider 60 psf of partition wall load, 30 psf for floor finish, 20 psf for construction live load and 80 psf for service live load. Consider the beam to be a partially composite beam with 80% composite action between steel and concrete. Given: f'_c=4 *ksi* and E_c=3600 *ksi*; F_y=50 *ksi* and E_s=*29000 ksi* **(18)**

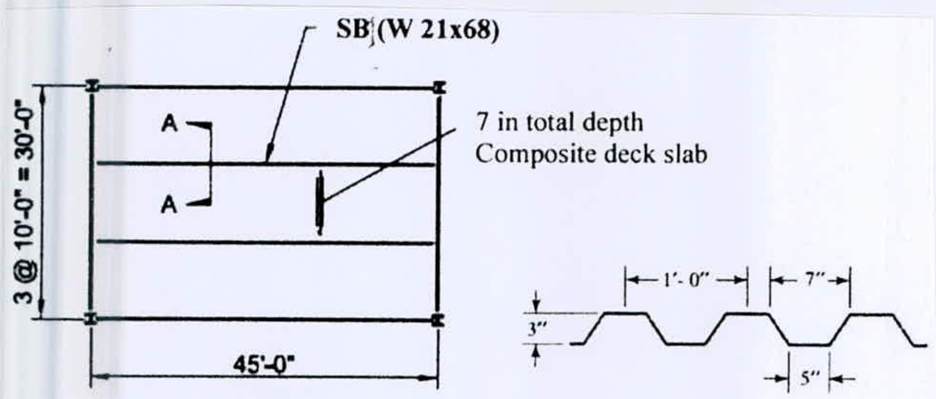


Fig. 1

(b) Show the flexural stress distribution across the depth of the beam SB1 for pre-composite and composite stages of construction. **($5\frac{1}{3}$)**

2. (a) List the design considerations for serviceability limit state for composite beams. **($5\frac{1}{3}$)**

(b) Determine the number and placement of 1.0 inch diameter stud type shear connectors for secondary composite beam SB1 (W21×68) shown in Fig. 1, develop the design moment capacity of the beam under 75% composite action. Show the detailing in a neat sketch. (use AISC-ASD method) **(18)**

Assume: R_p=0.6, Rg=0.85 and F_u=65 ksi for shear connectors

Given: For concrete f'_c=4 *ksi* and E_c=3600 *ksi*; for steel F_y=*50 ksi* and E_s=*29000 ksi*

3. (a) Differentiate between full and partial composite beams. **($5\frac{1}{3}$)**

Contd P/2

CE 413

Contd...Q.No. 3

(b) Determine the midspan deflection of the fully composite beam shown in Fig. 2, for unshored construction. This is an interior beam with a simply supported span of 25 ft; c/c spacing of the beam is 8 ft. Calculate the total vertical deflection for composite as well as for precomposite stage and compare the values with the allowable limits for total deflection (i.e. L/240) specified in AISC guide. The calculated uniformly distributed service loads on the beam is 0.65 k/ft for self weight of slab and beam; 0.1 k/ft for construction live load; 0.2 k/ft for floor finish; 0.45 k/ft for partition walls and 1.1 k/ft floor live load. **(18)**

Given: For concrete f_c'=4 *ksi* and E_c=3600 *ksi*; for steel F_y=*50 ksi* and E_s=*29000 ksi*

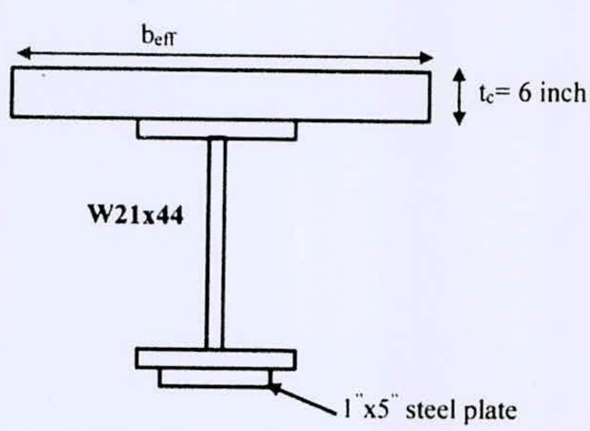


Fig. 2

4. (a) Why shear connectors are required in composite floor system? Name different types of shear connectors with sketches. **($5\frac{1}{3}$)**

(b) Determine the nominal flexural strength (use AISC-LRFD) of the following composite beam: **(18)**

W18×46, F_y=*50 ksi*

f_c'=4 *ksi* and E_c=3600 *ksi*

Effective slab width=84 inch

Total slab thickness 6 inch

Span length=28 ft

Formed steel deck is used (Fig. 3)

The beam is designed as partial composite beam with one 1 inch diameter studs placed in each rib (deck ribs are oriented perpendicular to the beam span). Assume: R_p=0.6, R_g=1.0 and F_u=65 ksi for stud connectors. **(10)**

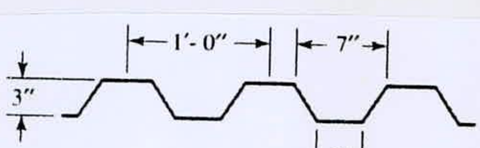


Fig. 3

CE 413

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

Assume reasonable values for missing data, if any. Necessary tables & formulae are provided in ANNEXURE.

5. (a) Name the different types of composite columns (with neat sketch) commonly used in buildings. In your opinion which type of composite column section is most suitable for medium to high rise buildings in Bangladesh? Give three reasons behind your selection. **($5\frac{1}{3}$)**

(b) A partially encased composite column with compact steel section is shown in Fig. 4. Determine the design axial load capacity of the column in compression and tension. Use AISC-LRFD method. **(18)**

Hot Rollled I-shape: W 18x65
Longitudinal Rebar: 4 - #9 bars
Stirrup: #3 @ 6 inch c/c
Length of the column: 18 ft
End condition: both end pinned

Concrete: $f_c'=4$ *ksi and* $E_c=3600$ *ksi*
Steel: $F_{ys}=50$ *ksi*, $F_{yr}=50$ *ksi* **and** $E_s=29000$ *ksi*

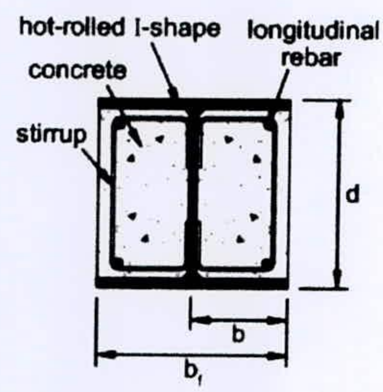


Fig. 4

6. (a) State the failure behaviour of (i) PEC columns with compact steel section and (ii) PEC column with noncompact steel section. **($5\frac{1}{3}$)**

(b) For the PEC column section shown in Fig. 5, **(18)**

(i) Check the given section for code specified limits for geometric and material properties.

(ii) Determine the nominal axial compression capacity of the given section.

Given: $f_c'=30$ *MPa;* $F_y=350$ *MPa* and $E_s=200$ *GPa. Use length of the column as 4.25m*

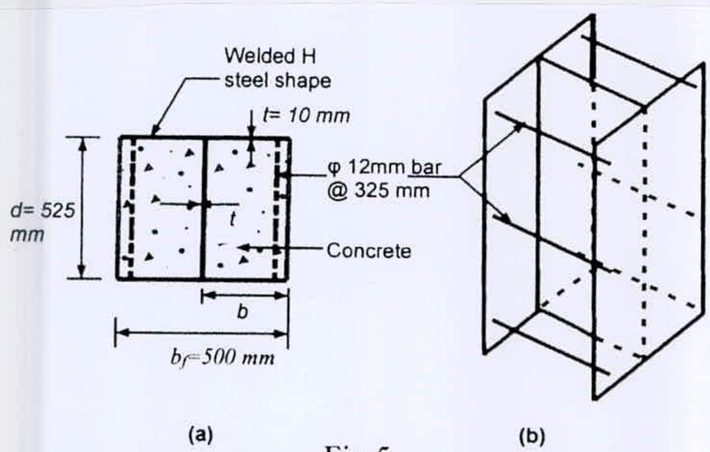


Fig.5

CE 413

7. (a) Using basic principles, calculate the nominal axial load and bending moment diagram for the five points (according to AISC 2010) in the P-M interaction diagram about the x-axis of the square steel tube filled with concrete as shown in Fig. 6. Show the diagram in a neat sketch. **(18)**

Given:
Steel tube: 12 x 12 in, t = 0.25 in.
Length of the column: 15 ft
End condition: both end pinned

Concrete $f_c' = 4\ ksi$ *and* $E_c = 3600\ ksi$
Steel $F_y = 50\ ksi$ and $E_s = 29000\ ksi$

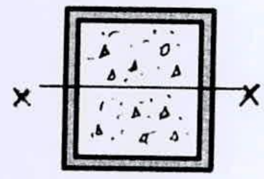


Fig. 6

(b) Calculate and draw the design P-M interaction diagram for the above composite column including the global slenderness effect. Use AISC-LRFD method. **($5\frac{1}{3}$)**

8. (a) A 15 ft long pin ended FEC column section is constructed by encasing a W18×50 steel shape in a 30×30 inch square RC section. Longitudinal rebers of 8#9 bars are provided in symmetric arrangement in the RC column with #4 bars spaced at 8 inch c/c as lateral ties. Check the design adequacy of the composite column for a factored axial compressive load of 1120 kips and a factored bending moment of 725 kip-ft about the strong axis of the steel I-section using,

    (i) Simplified plastic stress distribution method and

    (ii) Interaction equation of Chapter H in AISC code. **(20)**

Given: For concrete f_c'=4 *ksi* and E_c=3600 *ksi*; for steel $F_y = 50\ ksi$ and $E_s = 29000\ ksi$; for rebar $F_{yr} = 60\ ksi$, $E_s = 29000\ ksi$;

(b) Compare your results from the two methods and provide your comments. **($3\frac{1}{3}$)**

Table 1-1 (continued)
W Shapes
Properties

W21 – W18

Nom-inal Wt.	Compact Section Criteria		Axis X-X				Axis Y-Y				r_{ts}	h_o	Torsional Properties	
	$\frac{b_f}{2t_f}$	$\frac{h}{t_w}$	I	S	r	Z	I	S	r	Z			J	C_w
lb/ft			in.^{4}	in.^{3}	in.	in.^{3}	in.^{4}	in.^{3}	in.	in.^{3}	in.	in.	in.^{4}	in.^{6}
93	4.53	32.3	2070	192	8.70	221	92.9	22.1	1.84	34.7	2.24	20.7	6.03	9940
83	5.00	36.4	1830	171	8.67	196	81.4	19.5	1.83	30.5	2.21	20.6	4.34	8630
73	5.60	41.2	1600	151	8.64	172	70.6	17.0	1.81	26.6	2.19	20.5	3.02	7410
68	6.04	43.6	1480	140	8.60	160	64.7	15.7	1.80	24.4	2.17	20.4	2.45	6760
62	6.70	46.9	1330	127	8.54	144	57.5	14.0	1.77	21.7	2.15	20.4	1.83	5960
55	7.87	50.0	1140	110	8.40	126	48.4	11.8	1.73	18.4	2.11	20.3	1.24	4980
48	9.47	53.6	959	93.0	8.24	107	38.7	9.52	1.66	14.9	2.05	20.2	0.803	3950
57	5.04	46.3	1170	111	8.36	129	30.6	9.35	1.35	14.8	1.68	20.4	1.77	3190
50	6.10	49.4	984	94.5	8.18	110	24.9	7.64	1.30	12.2	1.64	20.3	1.14	2570
44	7.22	53.6	843	81.6	8.06	95.4	20.7	6.37	1.26	10.2	1.60	20.2	0.770	2110
311	2.19	10.4	6970	624	8.72	754	795	132	2.95	207	3.53	19.6	176	76200
283	2.38	11.3	6170	565	8.61	676	704	118	2.91	185	3.47	19.4	134	65900
258	2.56	12.5	5510	514	8.53	611	628	107	2.88	166	3.42	19.2	103	57600
234	2.76	13.8	4900	466	8.44	549	558	95.8	2.85	149	3.37	19.0	78.7	50100
211	3.02	15.1	4330	419	8.35	490	493	85.3	2.82	132	3.32	18.8	58.6	43400
192	3.27	16.7	3870	380	8.28	442	440	76.8	2.79	119	3.28	18.6	44.7	38000
175	3.58	18.0	3450	344	8.20	398	391	68.8	2.76	106	3.24	18.5	33.8	33300
158	3.92	19.8	3060	310	8.12	356	347	61.4	2.74	94.8	3.20	18.3	25.2	29000
143	4.25	22.0	2750	282	8.09	322	311	55.5	2.72	85.4	3.17	18.2	19.2	25700
130	4.65	23.9	2460	256	8.03	290	278	49.9	2.70	76.7	3.13	18.1	14.5	22700
119	5.31	24.5	2190	231	7.90	262	253	44.9	2.69	69.1	3.13	17.9	10.6	20300
106	5.96	27.2	1910	204	7.84	230	220	39.4	2.66	60.5	3.10	17.8	7.48	17400
97	6.41	30.0	1750	188	7.82	211	201	36.1	2.65	55.3	3.08	17.7	5.86	15800
86	7.20	33.4	1530	166	7.77	186	175	31.6	2.63	48.4	3.05	17.6	4.10	13600
76	8.11	37.8	1330	146	7.73	163	152	27.6	2.61	42.2	3.02	17.5	2.83	11700
71	4.71	32.4	1170	127	7.50	146	60.3	15.8	1.70	24.7	2.05	17.7	3.49	4700
65	5.06	35.7	1070	117	7.49	133	54.8	14.4	1.69	22.5	2.03	17.6	2.73	4240
60	5.44	38.7	984	108	7.47	123	50.1	13.3	1.68	20.6	2.02	17.5	2.17	3850
55	5.98	41.1	890	98.3	7.41	112	44.9	11.9	1.67	18.5	2.00	17.5	1.66	3430
50	6.57	45.2	800	88.9	7.38	101	40.1	10.7	1.65	16.6	1.98	17.4	1.24	3040
46	5.01	44.6	712	78.8	7.25	90.7	22.5	7.43	1.29	11.7	1.58	17.5	1.22	1720
40	5.73	50.9	612	68.4	7.21	78.4	19.1	6.35	1.27	10.0	1.56	17.4	0.810	1440
35	7.06	53.5	510	57.6	7.04	66.5	15.3	5.12	1.22	8.06	1.52	17.3	0.506	1140

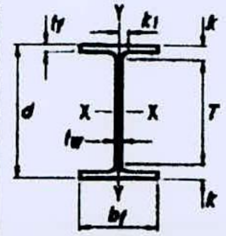


Table 1-1 (continued)
W Shapes
Dimensions

Shape	Area, A	Depth, d		Web			Flange				Distance				
				Thickness, t_w		$\frac{t_w}{2}$	Width, b_f		Thickness, t_f		k		k_1	T	Workable Gage
											k_{des}	k_{det}			
	in.^{2}	in.		in.		in.	in.		in.		in.	in.	in.	in.	in.
W21×93	27.3	21.6	21 5/8	0.580	9/16	5/16	8.42	8 3/8	0.930	15/16	1.43	1 5/8	15/16	18 3/8	5 1/2
×83[c]	24.3	21.4	21 3/8	0.515	1/2	1/4	8.36	8 3/8	0.835	13/16	1.34	1 1/2	7/8		
×73[c]	21.5	21.2	21 1/4	0.455	7/16	1/4	8.30	8 1/4	0.740	3/4	1.24	1 7/16	7/8		
×68[c]	20.0	21.1	21 1/8	0.430	7/16	1/4	8.27	8 1/4	0.685	11/16	1.19	1 3/8	7/8		
×62[c]	18.3	21.0	21	0.400	3/8	3/16	8.24	8 1/4	0.615	5/8	1.12	1 5/16	13/16		
×55[c]	16.2	20.8	20 3/4	0.375	3/8	3/16	8.22	8 1/4	0.522	1/2	1.02	1 3/16	13/16		
×48[c,f]	14.1	20.6	20 5/8	0.350	3/8	3/16	8.14	8 1/8	0.430	7/16	0.930	1 1/8	13/16		
W21×57[c]	16.7	21.1	21	0.405	3/8	3/16	6.56	6 1/2	0.650	5/8	1.15	1 5/16	13/16	18 3/8	3 1/2
×50[c]	14.7	20.8	20 7/8	0.380	3/8	3/16	6.53	6 1/2	0.535	9/16	1.04	1 1/4	13/16		
×44[c]	13.0	20.7	20 5/8	0.350	3/8	3/16	6.50	6 1/2	0.450	7/16	0.950	1 1/8	13/16		
W18×311[h]	91.6	22.3	22 3/8	1.52	1 1/2	3/4	12.0	12	2.74	2 3/4	3.24	3 7/16	1 3/8	15 1/2	5 1/2
×283[h]	83.3	21.9	21 7/8	1.40	1 3/8	11/16	11.9	11 7/8	2.50	2 1/2	3.00	3 3/16	1 5/16		
×258[h]	75.9	21.5	21 1/2	1.28	1 1/4	5/8	11.8	11 3/4	2.30	2 5/16	2.70	3	1 1/4		
×234[h]	68.8	21.1	21	1.16	1 3/16	5/8	11.7	11 5/8	2.11	2 1/8	2.51	2 3/4	1 3/16		
×211	62.1	20.7	20 5/8	1.06	1 1/16	9/16	11.6	11 1/2	1.91	1 15/16	2.31	2 9/16	1 3/16		
×192	56.4	20.4	20 3/8	0.960	15/16	1/2	11.5	11 1/2	1.75	1 3/4	2.15	2 7/16	1 1/8		
×175	51.3	20.0	20	0.890	7/8	7/16	11.4	11 3/8	1.59	1 9/16	1.99	2 7/16	1 1/4	15 1/8	
×158	46.3	19.7	19 3/4	0.810	13/16	7/16	11.3	11 1/4	1.44	1 7/16	1.84	2 3/8	1 1/4		
×143	42.1	19.5	19 1/2	0.730	3/4	3/8	11.2	11 1/4	1.32	1 5/16	1.72	2 3/16	1 3/16		
×130	38.2	19.3	19 1/4	0.670	11/16	3/8	11.2	11 1/8	1.20	1 3/16	1.60	2 1/16	1 3/16		
×119	35.1	19.0	19	0.655	5/8	5/16	11.3	11 1/4	1.06	1 1/16	1.46	1 15/16	1 3/16		
×106	31.1	18.7	18 3/4	0.590	9/16	5/16	11.2	11 1/4	0.940	15/16	1.34	1 13/16	1 1/8		
×97	28.5	18.6	18 5/8	0.535	9/16	5/16	11.1	11 1/8	0.870	7/8	1.27	1 3/4	1 1/8		
×86	25.3	18.4	18 3/8	0.480	1/2	1/4	11.1	11 1/8	0.770	3/4	1.17	1 5/8	1 1/16		
×76[c]	22.3	18.2	18 1/4	0.425	7/16	1/4	11.0	11	0.680	11/16	1.08	1 9/16	1 1/16		
W18×71	20.8	18.5	18 1/2	0.495	1/2	1/4	7.64	7 5/8	0.810	13/16	1.21	1 1/2	7/8	15 1/2	3 1/2[g]
×65	19.1	18.4	18 3/8	0.450	7/16	1/4	7.59	7 5/8	0.750	3/4	1.15	1 7/16	7/8		
×60[c]	17.6	18.2	18 1/4	0.415	7/16	1/4	7.56	7 1/2	0.695	11/16	1.10	1 3/8	13/16		
×55[c]	16.2	18.1	18 1/8	0.390	3/8	3/16	7.53	7 1/2	0.630	5/8	1.03	1 5/16	13/16		
×50[c]	14.7	18.0	18	0.355	3/8	3/16	7.50	7 1/2	0.570	9/16	0.972	1 1/4	13/16		
W18×46[c]	13.5	18.1	18	0.360	3/8	3/16	6.06	6	0.605	5/8	1.01	1 1/4	13/16	15 1/2	3 1/2[g]
×40[c]	11.8	17.9	17 7/8	0.315	5/16	3/16	6.02	6	0.525	1/2	0.927	1 3/16	13/16		
×35[c]	10.3	17.7	17 3/4	0.300	5/16	3/16	6.00	6	0.425	7/16	0.827	1 1/8	3/4		

[c] Shape is slender for compression with F_y = 50 ksi.
[f] Shape exceeds compact limit for flexure with F_y = 50 ksi.
[g] The actual size, combination, and orientation of fastener components should be compared with the geometry of the cross-section to ensure compatibility.
[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

=6=

ANNEXURE
Design Equations According to AISC 2010

For CFT Columns

TABLE I1.1A
Limiting Width-to-Thickness Ratios for Compression Steel Elements in Composite Members Subject to Axial Compression For Use with Section I2.2

Description of Element	Width-to-Thickness Ratio	λ_p Compact/ Noncompact	λ_r Noncompact/ Slender	Maximum Permitted
Walls of Rectangular HSS and Boxes of Uniform Thickness	b/t	$2.26\sqrt{\frac{E}{F_y}}$	$3.00\sqrt{\frac{E}{F_y}}$	$5.00\sqrt{\frac{E}{F_y}}$
Round HSS	D/t	$\frac{0.15E}{F_y}$	$\frac{0.19E}{F_y}$	$\frac{0.31E}{F_y}$

TABLE I1.1B
Limiting Width-to-Thickness Ratios for Compression Steel Elements in Composite Members Subject to Flexure For Use with Section I3.4

Description of Element	Width-to-Thickness Ratio	λ_p Compact/ Noncompact	λ_r Noncompact/ Slender	Maximum Permitted
Flanges of Rectangular HSS and Boxes of Uniform Thickness	b/t	$2.26\sqrt{\frac{E}{F_y}}$	$3.00\sqrt{\frac{E}{F_y}}$	$5.00\sqrt{\frac{E}{F_y}}$
Webs of Rectangular HSS and Boxes of Uniform Thickness	h/t	$3.00\sqrt{\frac{E}{F_y}}$	$5.70\sqrt{\frac{E}{F_y}}$	$5.70\sqrt{\frac{E}{F_y}}$
Round HSS	D/t	$\frac{0.09E}{F_y}$	$\frac{0.31E}{F_y}$	$\frac{0.31E}{F_y}$

(a) For *compact sections*

$$P_{no} = P_p$$

where

$$P_p = F_y A_s + C_2 f_c'\left(A_c + A_{sr}\frac{E_s}{E_c}\right)$$

$C_2 = 0.85$ for rectangular sections and 0.95 for round sections

ANNEXURE
Design Equations According to AISC 2010

(b) For *noncompact sections*

$$P_{no} = P_p - \frac{P_p - P_y}{(\lambda_r - \lambda_p)^2}(\lambda - \lambda_p)^2$$

where

λ, λ_p and λ_r are slenderness ratios determined from Table I1.1a

P_p is determined from Equation I2-9b

$$P_y = F_y A_s + 0.7 f_c'\left(A_c + A_{sr}\frac{E_s}{E_c}\right)$$

(c) For slender sections

$$P_{no} = F_{cr} A_s + 0.7 f_c'\left(A_c + A_{sr}\frac{E_s}{E_c}\right)$$

where

(i) For rectangular filled sections

$$F_{cr} = \frac{9E_s}{\left(\frac{b}{t}\right)^2}$$

(ii) For round filled sections

$$F_{cr} = \frac{0.72F_y}{\left(\left(\frac{D}{t}\right)\frac{F_y}{E_s}\right)^{0.2}}$$

$$EI_{eff} = E_s I_s + E_s I_{sr} + C_1 E_c I_c$$

$$C_1 = 0.6 + 2\left(\frac{A_s}{A_c + A_s}\right) \le 0.9$$

$$If \ldots \frac{P_{no}}{P_e} \le 2.25 \qquad P_n = P_{no}\left[0.658^{\left(\frac{P_{no}}{P_e}\right)}\right]$$

$$Else \ldots \frac{P_{no}}{P_e} > 2.25 \qquad P_n = 0.877P_e$$

For FEC Column/PEC Column with Compact Steel Section

$$\boldsymbol{P_o = A_s F_y + A_{sr} F_{yr} + 0.85 A_c f_c'}$$

$$\boldsymbol{EI_{eff} = E_s I_s + 0.5 E_s I_{sr} + C_1 E_c I_c}$$

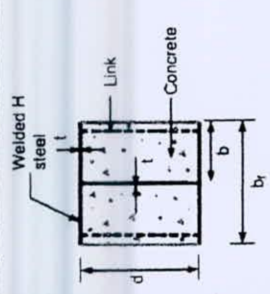
$$\boldsymbol{C_1 = 0.1 + 2\left(\frac{A_s}{A_c + A_s}\right) \le 0.3}$$

$$\boldsymbol{If \ldots \frac{P_o}{P_e} \le 2.25 \qquad P_n = P_o\left[0.658^{\left(\frac{P_o}{P_e}\right)}\right]}$$

$$\boldsymbol{Else \ldots \frac{P_o}{P_e} > 2.25 \qquad P_n = 0.877P_e}$$

ANNEXURE
Design Equations According to AISC 2010

For PEC Column with Non-compact Steel Section



$$C_r = A_{se} F_y + 0.85 A_c f_c'$$

$$A_{se} = (d - 2t + 2b_e)t$$

$$b_e = \frac{b_f}{\left(1 + \lambda_p^{2n}\right)^{1/n}} \le b_f \qquad \text{where, } n = 1.5$$

$$\lambda_p = \frac{b}{t}\sqrt{\frac{12\left(1 - \nu_s^2\right)F_y}{\pi^2 E_s k}}$$

$$k = \frac{0.9}{(s/b_f)^2} + 0.2(s/b_f)^2 + 0.75, \qquad (0.5 \le s/b_f \le 1) \qquad \text{where, s = link spacing}$$

AISC Chapter H Interaction Equations:

- *For $P_r/P_c \ge 0.2$,*
  - $P_r/P_c + 8/9\,(M_{rx}/M_{cx} + M_{ry}/M_{cy}) \le 1.0$
- *For $P_r/P_c < 0.2$,*
  - $P_r/(2P_c) + (M_{rx}/M_{cx} + M_{ry}/M_{cy}) \le 1.0$

L-4/T-II /CE **Date: 27/03/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **CE 415** (Prestressed Concrete)

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer **Q. No. 1** and any **TWO** from the rest. Symbols carry their usual meaning. Assume reasonable values for missing data, if any. Use the provided equations in Appendix-A as appropriate.

1. (a) Briefly write the design consideration of prestressed concrete railway sleepers and electrical poles. **(4)**

(b) What is the danger of flexural bond length overlapping with transfer length? Explain with figure. **(6)**

(c) Determine the bearing plate area (width 8 in.) required for a tendon consisting of 12-0.5 in diameter, 7-wire strands, Figure 1. At the time of posttensioning assume that f'_{ci} is approximately 3500 psi and at service load f'_c =4500 psi. The tendon forces for design are: 400 k due to maximum jacking force and 300 k at service load after losses. Follow the Guide Specification of the Post-Tensioning Institute (PTI) for allowable bearing stresses on the concrete. **(10)**

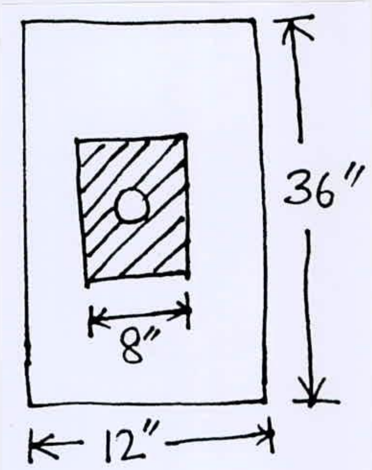


Figure 1

(d) Using the AASHTO-PCI Load Table provided in Appendix-B, determine the number of strand required for a span of 60 ft and a safe superimposed service load of 65 lb/ft^2. Consider both topping and no topping. Draw the strand layout (longitudinal) and find the estimated cambers for each case. **(10)**

2. (a) Briefly discuss the advantages of prestressed concrete over reinforced concrete. **(7)**

Contd P/2

CE 415

Contd. Q. No. 2

(b) A posttensioned simple beam on a span of 50 ft is shown in Figure 2. The initial prestress in the steel is 150 ksi, reducing to 130 ksi after deducting all losses and assuming no bending of the beam. The parabolic cable has an area of 2.5 sq. in., n = 6. Compute the total dead and live uniform load that can be carried by the beam, (i) for zero tensile stress in the bottom fibre, (ii) for cracking in the bottom fibre at modulus of rupture of 750 psi, and assuming concrete to take tension up to that value. **(13)**

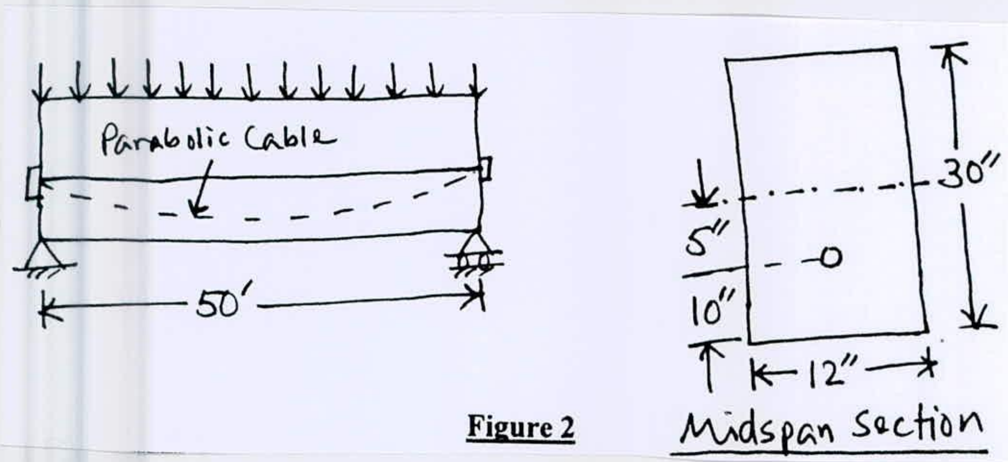


Figure 2

3. Using AASHTO code, determine the nominal moment capacity of a partially prestressed concrete T section with dimension shown in Figure 3. Assume bonded tendons are used. **(20)**

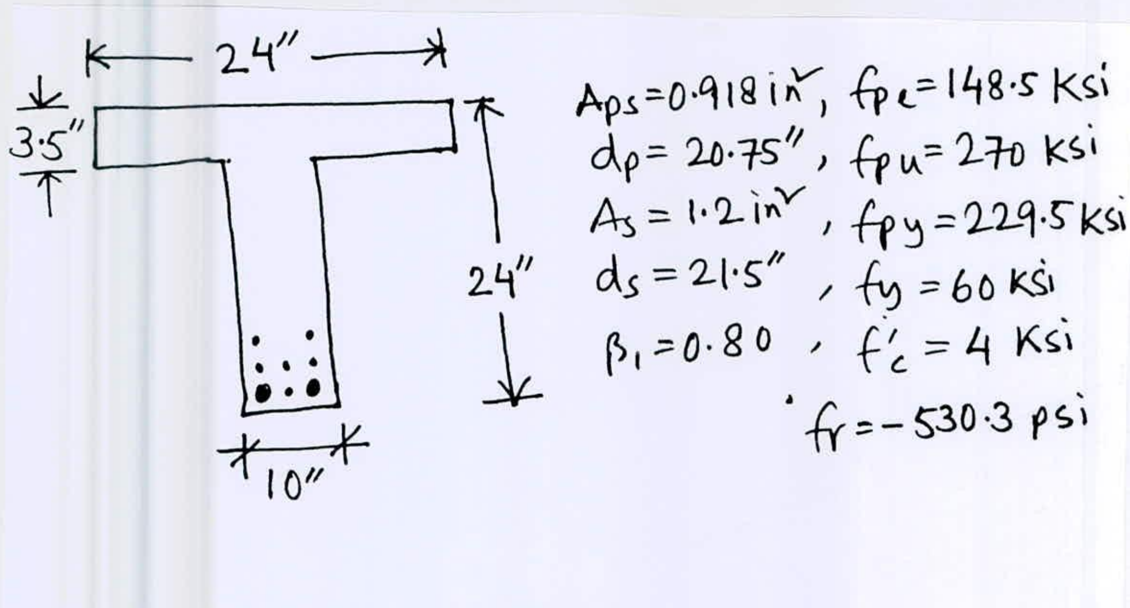


Figure 3

4. Design the shear reinforcement at a distance of 5 ft from the support for the T-beam shown in Figure 4. Given: A_{ps} = 1.53 in^2, f_c'=4 *ksi* (normal weight concrete), f_y=60 *ksi*, f_{pu}=270 *ksi*, f_{pe} > 0.4 f_{pu}, F = 200 kips, live load = 0.5 klf, live load = 0.5 klf, superimposed dead load = 0.05 klf. Use AASHTO LFRD method. **(20)**

Contd P/3

CE 415
Contd. Q. No. 4

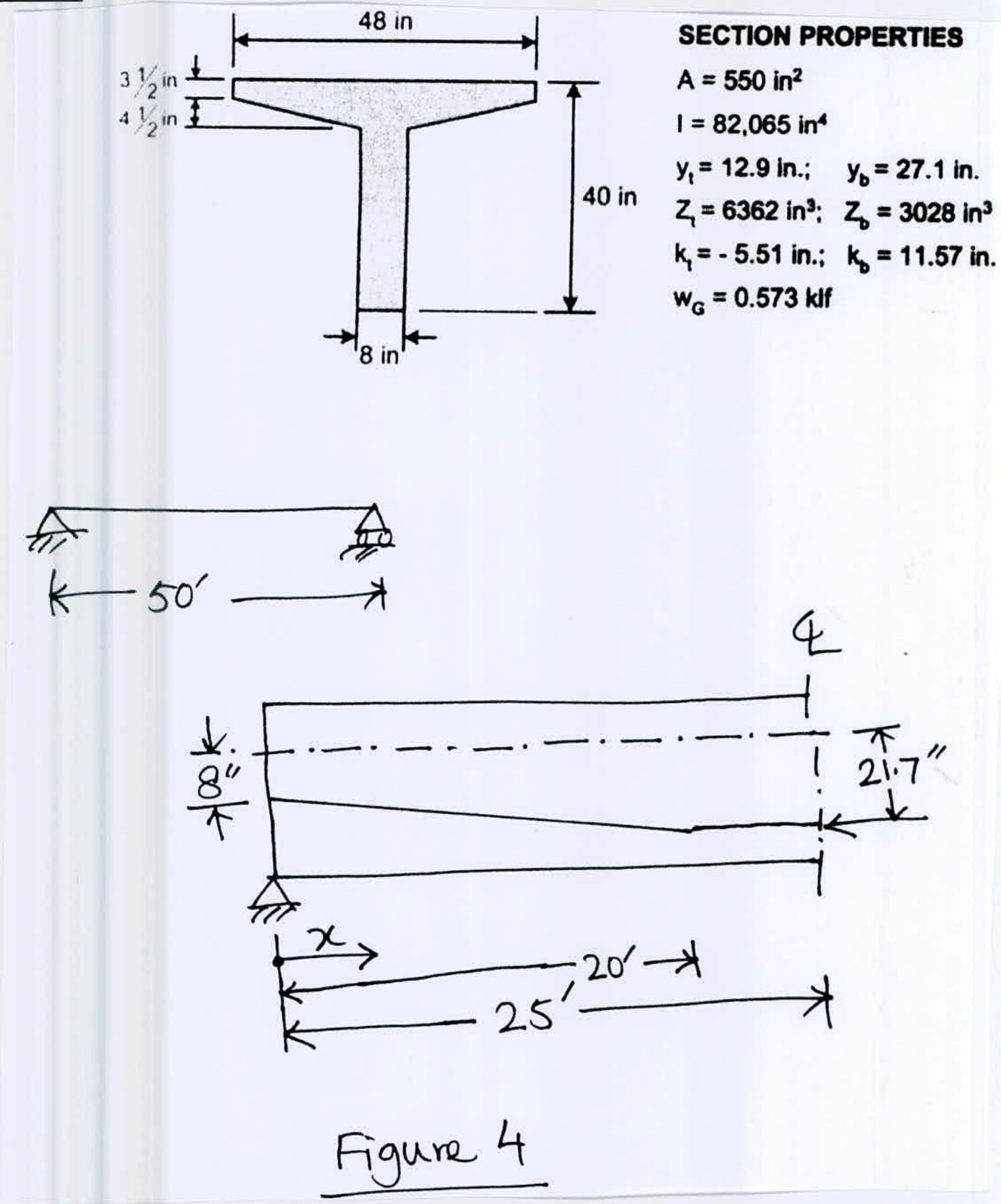


Figure 4

SECTION – B

There are **FOUR** questions in this section. Answer **Q. No. 5** and any **TWO** from the rest.

5. Consider the simple supported T beam shown in Figure 5. The live load is assumed to be 600 plf. The following design information is given. Normal weight of concrete with unit weight = 150 pcf, f'_c=8000 *psi*: f'_{ci}=5600 *psi*; ultimate creep coefficient C_{CU} = 2.2. The prestressing steel consists of half-inch diameter strands: f_{pu} = 270 ksi, f_{pe} = 150 ksi; f_{py} = 240 ksi; η = 0.80; d_{cmin} = 3 in. Section properties: A_c = 272 in^2, I_g = 14970 in^4, y_t = 9.06 in; y_b = 14.94 in, Z_t = 1652 in^3, Z_b = 1002 in^3, k_t = −3.86 in, k_b = 6.07 in. The area of prestressing tendons is 9 strands, i.e., A_{ps} = 1.377 in^2, at an eccentricity at midspan e_0= 12.54 in. The profile of the centroid of the prestressing force is draped at midspan with an eccentricity at support equal k_b.
Compute the instantaneous deflection at the transfer of prestress. The additional long-term deflection, under dead load and prestress using the Heuristic Rule or Rule of Thumb. Check if the deflection criteria are satisfied according to the ACI code. **(30)**

Contd P/4

CE 415
Contd...Q. No. 5

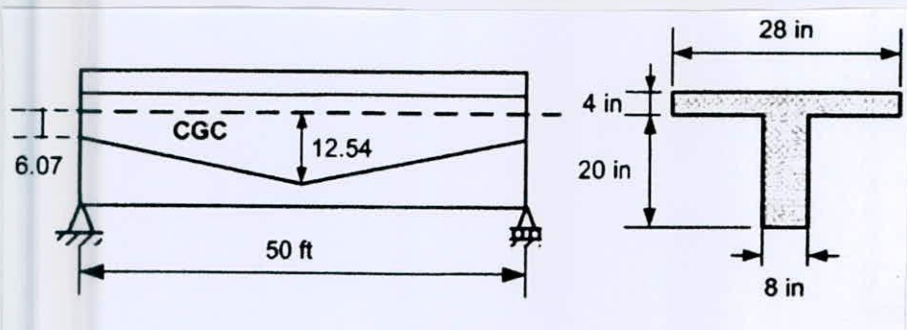


Figure 5

6. (a) Draw qualitative isobars for transverse tension in end blocks for (i) one concentrated load and (ii) two distributed loads. Also identify the "Bursting Zone", "Spalling Zone" and "Compression Zone". **(8)**

(b) Consider the simply supported beam shown in Figure 6. Calculate the elastic shortening loss in the steel at midspan using the AASHTO LRFD method. The following information is provided. **(12)**

$A_{ps} = 0.459$ in^2; $e_0 = 10.64$ in, $E_{ps} = 27000$ ksi, $f_{pu} = 270$ ksi, f'_c=6000 psi, $f'_{ci} = 4500$ psi, normal weight concrete $\gamma_c = 150$ pcf, $E_c = 33\,\gamma_c^{1.5}\sqrt{f'_c}$, $n_{pi} = 7.3$, $n_p = 6.53$, $\varepsilon_{su} = 4\times10^{-4}$, $C_{CU} = 1.8$; H = 80 percent. The beam is steam cured, that the transfer of prestress occurs 24 hours after tensioning, and that the curing ends at the time of transfer. Low relaxation strands are used.

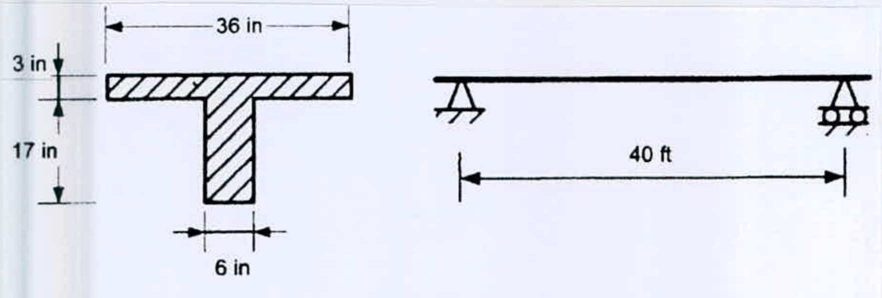


Figure 6

7. (a) Briefly discuss the advantages and disadvantages of continuous prestressed concrete beams. **(5)**

(b) The midspan section of a composite beam is shown in Figure 7. The precast stem is 12 in. by 36 in. deep posttensioned with an initial force of 550 kips. The effective prestress after losses is taken as 480 kips. Moment due to the weight of that precast section is 200 k-ft at midspan. After it is erected in place, the top slab of 6 in. by 36 in. wide is to be cast in place producing a moment of 100 k-ft. After the slab concrete has hardened, how much live load the composite section can carry for no cracking and allowable compressive stress of $0.45 f'_c$? Given, A_s = 3.7 in^2, f'_s = 240 ksi and $f'_c = 5000$ psi. **(15)**

CE 415

Contd. Q. No. 7(b)

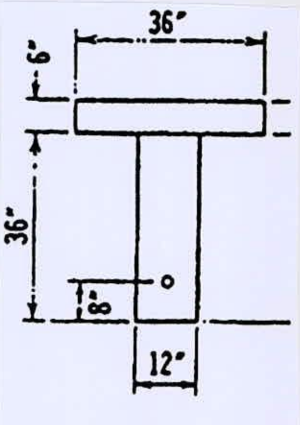


Figure 7

8. (a) Why high strength materials (concrete, steel) are required for prestressed concrete? **(5)**

(b) Determine the area of prestressed reinforcement required to develop a design moment resistance M_u = 170 kips-ft in the rectangular section shown in Figure 8 assuming the following properties: $f_c' = 4$ ksi, $\beta_1 = 0.8$; $f_{pu} = 270$ ksi, $f_{pe} = 0.55\ f_{pu}$; bonded tendons. Assume stress relieved strands, thus $\gamma_p = 0.4$. Use AASHTO Method. **(15)**

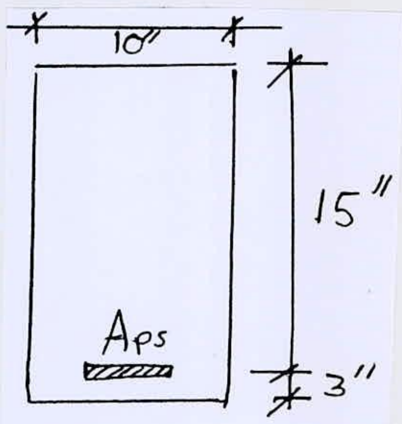


Figure 8

APPENDIX-A

Use the following equations as appropriate:

At service load—

$$f_{cp} = 0.6 f_c' \sqrt{A_b'/A_b}$$

but not greater than f_c'

At transfer load—

$$f_{cp} = 0.8 f_{ci}' \sqrt{(A_b'/A_b) - 0.2}$$

but not greater than $1.25 f_{ci}'$

$$c = \frac{A_{ps} f_{pu} + A_s f_y - A_s' \left| f_y' \right|}{0.85 f_c' \beta_1 b + k A_{ps} f_{pu} / d_p}$$

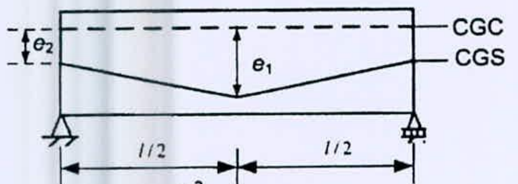
$$c = \frac{A_{ps} f_{pu} + A_s f_y - A_s' \left| f_y' \right| - 0.85 f_c' \beta_1 (b - b_w) h_f}{0.85 f_c' \beta_1 b_w + k A_{ps} f_{pu} / d_p}$$

$$A_{ps} = \frac{b d_p f_c'}{f_{pu}} \left(1 - \sqrt{1 - \frac{(\beta_1 / \gamma_p) T_{np}}{b d_p f_c'}} \right)$$

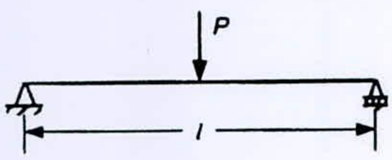
$$\varepsilon_x = \frac{\dfrac{M_u}{d_v} + 0.5 N_u + 0.5\,(V_u - V_p)\cot\theta - A_{ps} f_{po}}{E_s A_s + E_p A_{ps}}$$

$$\varepsilon_x = \frac{(M_u / d_v) + 0.5 N_u + 0.5 (V_u - V_p) \cot\theta - A_{ps} f_{po}}{2(E_s A_s + E_p A_{ps})}$$

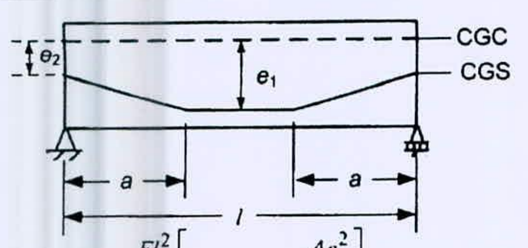
$$\varepsilon_x = \frac{(M_u / d_v) + 0.5 N_u + 0.5 (V_u - V_p) \cot\theta - A_{ps} f_{po}}{2(E_c A_c + E_s A_s + E_p A_{ps})}$$



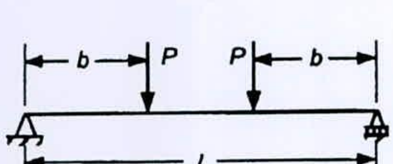
$$\Delta = -\frac{Fl^2}{24EI}[2e_1 + e_2] = \phi_1 \frac{l^2}{8} + (\phi_2 - \phi_1)\frac{l^2}{24} = \phi_1 \frac{l^2}{12} + \phi_2 \frac{l^2}{24}$$



$$\Delta = \frac{Pl^3}{48EI} = \phi_1 \frac{l^2}{12}$$



$$\Delta = -\frac{Fl^2}{8EI}\left[e_1 + (e_2 - e_1)\frac{4a^2}{3l^2} \right] = \phi_1 \frac{l^2}{8} + (\phi_2 - \phi_1)\frac{a^2}{6}$$



$$\Delta = -\frac{Pb}{24EI}\left(3l^2 - 4b^2\right) = \phi_1 \frac{3l^2 - 4b^2}{24}$$

=7=

Table 6.4 Values of θ and β for concrete sections with at least minimum transverse steel reinforcement (from AASHTO LRFD, Interim 2002).

$\frac{v}{f'_c}$	$\varepsilon_x \times 1,000$										
	≤-0.20	≤-0.10	≤-0.05	≤0	≤0.125	≤0.25	≤0.50	≤0.75	≤1.0	≤1.5	≤2.0
≤ 0.075	22.3	20.4	21.0	21.8	24.3	26.6	30.5	33.7	36.4	40.8	43.9
	6.32	4.75	4.10	3.75	3.24	2.94	2.59	2.38	2.23	1.95	1.67
≤ 0.100	18.1	20.4	21.4	22.5	24.9	27.1	30.8	34.0	36.7	40.8	43.1
	3.79	3.38	3.24	3.14	2.91	2.75	2.50	2.32	2.18	1.93	1.69
≤ 0.125	19.9	21.9	22.8	23.7	25.9	27.9	31.4	34.4	37.0	41.0	43.2
	3.18	2.99	2.94	2.87	2.74	2.62	2.42	2.26	2.13	1.90	1.67
≤ 0.150	21.6	23.3	24.2	25.0	26.9	28.8	32.1	34.9	37.3	40.5	42.8
	2.88	2.79	2.78	2.72	2.60	2.52	2.36	2.21	2.08	1.82	1.61
≤ 0.175	23.2	24.7	25.5	26.2	28.0	29.7	32.7	35.2	36.8	39.7	42.2
	2.73	2.66	2.65	2.60	2.52	2.44	2.28	2.14	1.96	1.71	1.54
≤ 0.200	24.7	26.1	26.7	27.4	29.0	30.6	32.8	34.5	36.1	39.2	41.7
	2.63	2.59	2.52	2.51	2.43	2.37	2.14	1.94	1.79	1.61	1.47
≤ 0.225	26.1	27.3	27.9	28.5	30.0	30.8	32.3	34.0	35.7	38.8	41.4
	2.53	2.45	2.42	2.40	2.34	2.14	1.86	1.73	1.84	1.51	1.39
≤ 0.250	27.5	28.6	29.1	29.7	30.6	31.3	32.8	34.3	35.8	38.6	41.2
	2.39	2.39	2.33	2.33	2.12	1.93	1.70	1.58	1.50	1.38	1.29

Table 6.5 Values of θ and β for concrete sections without or with less than minimum transverse steel reinforcement (from AASHTO LRFD, Interim 2002).

s_{xe}	$\varepsilon_x \times 1,000$										
(in)	≤-0.20	≤-0.10	≤-0.05	≤0	≤0.125	≤0.25	≤0.50	≤0.75	≤1.00	≤1.50	≤2.00
≤ 5	25.4	25.5	25.9	26.4	27.7	28.9	30.9	32.4	33.7	35.6	37.2
	6.36	6.06	5.56	5.15	4.41	3.91	3.26	2.86	2.58	2.21	1.96
≤ 10	27.6	27.6	28.3	29.3	31.6	33.5	36.3	38.4	40.1	42.7	44.7
	5.78	5.78	5.38	4.89	4.05	3.52	2.88	2.50	2.23	1.88	1.65
≤ 15	29.5	29.5	29.7	31.1	34.1	36.5	39.9	42.4	44.4	47.4	49.7
	5.34	5.34	5.27	4.73	3.82	3.28	2.64	2.26	2.01	1.68	1.46
≤ 20	31.2	31.2	31.2	32.3	36.0	38.8	42.7	45.5	47.8	50.9	53.4
	4.99	4.99	4.99	4.61	3.65	3.09	2.46	2.09	1.85	1.52	1.31
≤ 30	34.1	34.1	34.1	34.2	38.9	42.3	46.9	50.1	52.6	56.3	59.0
	4.45	4.45	4.45	4.43	3.39	2.82	2.19	1.84	1.60	1.30	1.10
≤ 40	36.6	36.6	36.6	36.6	41.2	45.0	50.2	53.7	56.3	60.2	63.0
	4.06	4.06	4.06	4.06	3.20	2.62	2.00	1.66	1.43	1.14	0.95
≤ 60	40.8	40.8	40.8	40.8	44.5	49.2	55.1	58.9	61.8	65.8	68.6
	3.50	3.50	3.50	3.50	2.92	2.32	1.72	1.40	1.18	0.92	0.75
≤ 80	44.3	44.3	44.3	44.3	47.1	52.3	58.7	62.8	65.7	69.7	72.4
	3.10	3.10	3.10	3.10	2.71	2.11	1.52	1.21	1.01	0.78	0.62

Once ε_x is obtained for the assumed angle θ, the shear factor β and a new value for the angle θ can be read from Tables 6.4 and 6.5 (Tables 5.8.3.4.2-1 and 5.8.3.4.2-2 of the AASHTO LRFD). However, in order to verify the validity of the selected

=8=

APPENDIX-B

3.4 Double-Tee Load Tables

3

Strand Pattern Designation

1 2 8 - D 1

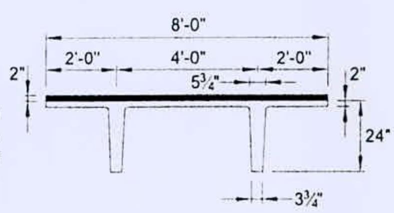
- Number of strand (12)
- S = straight D = depressed
- Number of depression points
- Diameter of strand in 16ths

Safe loads shown include dead load of 10 lb/ft² for untopped members and 15 lb/ft² for topped members. Remainder is live load. Long-time cambers include superimposed dead load but do not include live load.

Key
186 – Safe superimposed service load, lb/ft²
0.7 – Estimated camber at erection, in.
0.9 – Estimated long-time camber, in.

Check with regional producers for availability.

8'-0" x 24" Normalweight Concrete



f'_c = 5000 psi

f_{pu} = 270,000 psi

½-in.-diameter regular strand

Section Properties

	No Topping	2 in. Topping
A	= 401 in.²	–
I	= 20,985 in.⁴	27,720 in.⁴
y_b	= 17.15 in.	19.27 in.
y_t	= 6.85 in.	6.73 in.
S_b	= 1224 in.³	1439 in.³
S_t	= 3064 in.³	4119 in.³
wt	= 418 lb/ft	618 lb/ft
DL	= 52 lb/ft²	77 lb/ft²
V/S	= 1.41 in.	

8DT24

Table of safe superimposed service load, lb/ft², and cambers, in. **No Topping**

Strand pattern	y_s(end) y_s(center) in.	Span, ft 32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76
68-S	4.00 4.00	186 0.7 0.9	161 0.8 1.0	140 0.8 1.1	122 0.9 1.1	106 0.9 1.1	93 1.0 1.1	81 1.0 1.1	71 1.0 1.1	62 1.0 1.0	55 1.0 0.9	48 0.9 0.8	42 0.8 0.6	36 0.7 0.4	31 0.6 0.1	27 0.5 −0.2								
88-S	5.00 5.00			185 1.1 1.4	162 1.2 1.5	143 1.3 1.6	126 1.3 1.6	112 1.4 1.7	99 1.4 1.7	88 1.5 1.7	78 1.5 1.7	70 1.5 1.6	62 1.5 1.5	55 1.4 1.4	49 1.4 1.2	43 1.3 0.9	38 1.1 0.6	33 1.0 0.3	29 0.8 −0.2					
108-S	6.00 6.00				197 1.4 1.8	174 1.5 1.9	155 1.6 2.0	138 1.7 2.1	123 1.7 2.1	110 1.8 2.1	98 1.9 2.1	88 1.9 2.1	79 1.9 2.1	71 1.9 2.0	64 1.9 1.9	57 1.9 1.8	51 1.8 1.6	45 1.7 1.3	39 1.5 0.9	34 1.3 0.5	29 1.1 0.0			
128-S	7.00 7.00							159 1.8 2.3	142 1.9 2.4	128 2.0 2.4	114 2.1 2.5	101 2.1 2.5	90 2.2 2.4	81 2.2 2.4	73 2.2 2.3	66 2.2 2.2	59 2.2 2.1	53 2.1 1.8	47 2.0 1.6	42 1.9 1.2	37 1.7 0.8	32 1.5 0.3	27 1.2 −0.3	
128-D1	11.67 3.25												114 2.5 2.9	103 2.6 2.9	92 2.6 2.9	83 2.7 2.8	74 2.7 2.6	66 2.6 2.4	59 2.6 2.2	53 2.5 1.8	48 2.3 1.5	43 2.1 1.1	39 1.9 0.6	35 1.6 0.0
148-D1	12.86 3.50																		71 3.1 3.0	64 3.1 2.7	58 3.0 2.4	52 2.9 2.0	46 2.7 1.6	42 2.5 1.1

8DT24 + 2

Table of safe superimposed service load, lb/ft², and cambers, in. **2 in. Normalweight Topping**

Strand pattern	y_s(end) y_s(center) in.	Span, ft 28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70
48-S	3.00 3.00	169 0.4 0.4	141 0.4 0.4	117 0.5 0.4	97 0.5 0.4	81 0.5 0.3	67 0.5 0.3	55 0.5 0.2	45 0.5 0.0	36 0.5 −0.1	29 0.4 −0.3												
68-S	4.00 4.00			189 0.7 0.7	161 0.8 0.8	138 0.8 0.8	118 0.9 0.7	101 0.9 0.7	87 1.0 0.6	74 1.0 0.6	64 1.0 0.4	54 1.0 0.2	45 1.0 0.0	38 0.9 −0.3	30 0.8 −0.6								
88-S	5.00 5.00					188 1.1 1.1	163 1.1 1.2	142 1.3 1.1	124 1.3 1.1	108 1.4 1.1	94 1.4 1.0	82 1.5 0.9	71 1.5 0.7	62 1.5 0.5	52 1.5 0.3	42 1.4 −0.1	33 1.4 −0.5						
108-S	6.00 6.00							176 1.5 1.4	155 1.6 1.4	136 1.7 1.4	120 1.7 1.4	104 1.8 1.3	90 1.9 1.2	77 1.9 1.0	66 1.9 0.8	56 1.9 0.6	47 1.9 0.3	39 1.9 −0.1	31 1.8 −0.6				
128-S	7.00 7.00									160 1.8 1.6	140 1.9 1.6	121 2.0 1.6	104 2.1 1.5	90 2.1 1.3	77 2.2 1.1	67 2.2 0.9	57 2.2 0.6	48 2.2 0.3	41 2.2 −0.1	33 2.1 −0.6	27 2.0 −1.1		
128-D1	11.67 3.25														105 2.5 1.6	91 2.6 1.4	79 2.6 1.1	68 2.7 0.8	58 2.7 0.4	49 2.6 0.0	40 2.6 −0.6	34 2.5 −1.2	28 2.3 −1.8

Strength is based on strain compatibility; bottom tension is limited to $12\sqrt{f'_c}$; see pages 3-8 through 3-11 for explanation.
Shaded values require release strengths higher than 3500 psi.

L-4/T-II/CE **Date : 10/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **CE 421** (Dynamics of Structures)

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) A full water tank is supported on a 25-m-high cantilever tower. It is idealized as an SDF system with mass m = 7,000 kg, lateral stiffness k = 700 kN/m, and damping ratio ζ = 5%. The tower is to be designed for ground motion characterized by the design spectrum of Fig. 1 scaled to 0.5g peak ground acceleration. Determine the lateral deformation and base shear. (b) Determine the deformation and base shear for the modified system if its lateral stiffness is 1400 kN/m. Comment on how stiffening the system has affected the design requirements. (c) If the stiffened tower were to support a tank with a mass of 14,000 kg, determine the base shear. Comment on how the increased weight has affected the design requirements. **($15\frac{1}{3}$)**

   (b) What is Response Spectrum? Why do we need three spectra when each of them contains the same information? **(8)**

2. (a) Find the steady-state response of a viscously damped system with m = 2 kg, k = 450 N/m, and c = 5 N-s/m subject to the periodic force shown in Fig. 2, where P_o = 500 kN and T_p = 1 sec. Determine only the first four terms of the Fourier coefficients a_o, a_n, and b_n of the periodic loading. **(20)**

   (b) Describe briefly the response of a rigid system when subjected to a ground motion? **($3\frac{1}{3}$)**

3. Find the response of a viscously damped system with m = 500 kg, k = 750 N/m, and c = 200 N-s/m subject to the forcing function F(t). The values F(t) at discrete times are given in Table 1. Use Newmark's Beta method (Constant average acceleration method). Given, initial displacement, v_o = 0 and initial velocity, $\dot{v}_0$ = 0. Use equation 1 to 4 given herewith. **($23\frac{1}{3}$)**

$$\tilde{k}_c = k + \frac{2c}{h} + \frac{4m}{h^2} \quad (1)$$

$$\tilde{p}_{1c} = p_1 + c\left(\frac{2v_0}{h} + \dot{v}_0\right) + m\left(\frac{4v_0}{h^2} + \frac{4}{h}\dot{v}_0 + \ddot{v}_0\right) \quad (2)$$

$$\dot{v}_1 = \frac{2}{h}(v_1 - v_0) - \dot{v}_0 \quad (3)$$

$$\ddot{v}_1 = \frac{1}{m}(p_1 - c\dot{v}_1 - kv_1) \quad (4)$$

Table 1

t (sec)	0	1	2	3	4	5	6	7	8	9	10
F(t) (N)	0	400	800	1200	1600	2000	2000	2000	2000	2000	2000

CE 421

4. Determine natural frequency, mode shape and the free vibration response of the two DOF shear frame as shown in Fig. 3. Given, EI_1 = 8000 k-in^2, EI_2 = 8000 k-in^2, h_1 = 15 ft, h_2 = 15 ft, $m_1 = m_2$ = 2 kip/in/sec^2.

   The initial condition is given as, **(23 ⅓)**

$$x(0) = \begin{bmatrix} 1/2 \\ 2 \end{bmatrix} \qquad \dot{x}(0) = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) The mass m, stiffness k, and natural frequency ω_n of an undamped SDF system are unknown. These properties are to be determined by harmonic excitation tests. At an excitation frequency of 4 Hz, the response tends to increase without bound (i.e., a resonant condition). Next, a mass, m_0 = 2 kg is attached to the mass m and the resonance test is repeated. This time resonance occurs at f = 3 Hz. Determine the mass and the stiffness of the system. **(10)**

   (b) A small one-story industrial building, 6 by 10 m in plan, is shown in Fig. 4 with braced frames in both directions. The mass of the structure can be idealized as 150 kg/m^2 lumped at the roof level. The horizontal cross bracing is at the bottom chord of the roof trusses. All columns are HE-A 200 sections with I_x = 2510 cm^4 and I_y = 925 cm^4, respectively; for steel, E = 200 GPa. The vertical cross-bracings are made of 30-mm-diameter steel rods. The building is subjected to a harmonic ground acceleration (due to an earthquake) of amplitude 0.5 g and frequency 2 Hz in the north-south (N-S) direction. Determine the displacement of the building in the N-S direction assuming the system is initially at rest. Assume 2% damping of the system. **(13 ⅓)**

6. (a) The vertical suspension system of an automobile is idealized as a viscously damped SDF system. Under the 1300 kg mass of the car the suspension system deflects 5 cm. The suspension is designed to be critically damped. **(10)**

   (i) Calculate the damping and stiffness coefficients of the suspension.

   (ii) With four 80 kg passengers in the car, what is the effective damping ratio?

   (b) An Air-conditioning unit with a mass of 400 kg is bolted at the middle of two parallel simply supported steel beams (Fig. 5). The clear span of the beams is 3 m. The second moment of cross-sectional area of each beam is 400 cm^4. The motor in the unit runs at 300 rpm and produces an unbalanced vertical force of 250 N at this speed. The mass of each beam is 100 kg and assume 1% viscous damping in the system; for steel E = 200,000 MPa. Determine the amplitudes of steady-state deflection and steady-state acceleration (in g's) of the beams at their midpoints. **(13 ⅓)**

Contd P/3

CE 421

7. (a) The displacement amplitude u of an SDF system due to harmonic force is known for two excitation frequencies. At $\omega = \omega_n$, u = 15 cm; at $\omega = 4\omega_n$, u = 0.1 cm. Estimate the damping ratio of the system. **(10)**

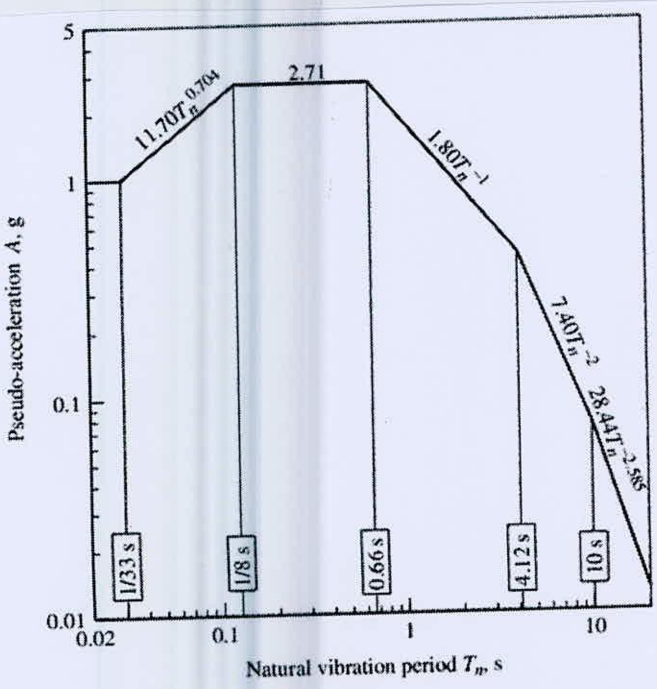
(b) A one-story building, idealized as a 4-m-high frame with two columns hinged at the base and a rigid beam, has a natural period of 0.5 sec. Each column is a made of steel section with $I_x = 2772\ cm^4$, section modulus, $S = 252\ cm^3$; E = 200 GPa, Determine the response of this frame due to a rectangular pulse force of amplitude 20 kN and duration $t_d = 0.4$ sec. Determine the displacement at the top of the frame and bending stress in the columns at t = 0.2 sec. Assume 2% damping of the system. **($13\frac{1}{3}$)**

8. (a) Using Duhamel's integral, determine the response of an undamped system to a rectangular pulse force of amplitude P_o and duration t_d during the time $0 \le t \le t_d$. **(5)**

(b) The 20-m-high full water tank is subjected to an impulse, I = 6 kN-sec as shown in Fig.6 caused by an aboveground explosion. The maximum bending moment at the base of the tower supporting the tank is calculated as 678 kN-m. Determine the mass of the full water tank. **($8\frac{1}{3}$)**

(c) Determine the maximum response of a damped SDF system to a step force of magnitude P_o. The system is initially at rest. **(10)**

=4=



Elastic pseudo-acceleration design spectrum (84.1th percentile) for ground motions with $\ddot{u}_{go} = 1$g, $\dot{u}_{go} = 122$ cm/sec, and $u_{go} = 91$ cm; $\zeta = 5\%$.

Fig. 1

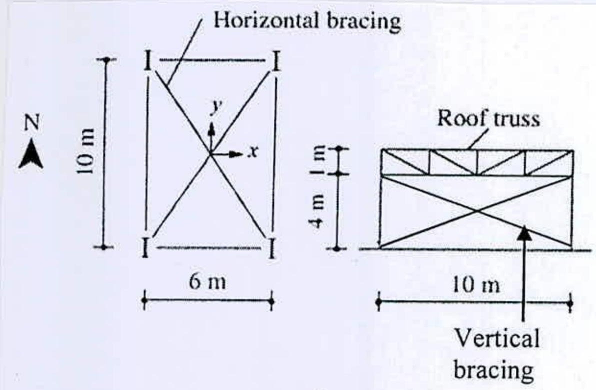


Fig. 4

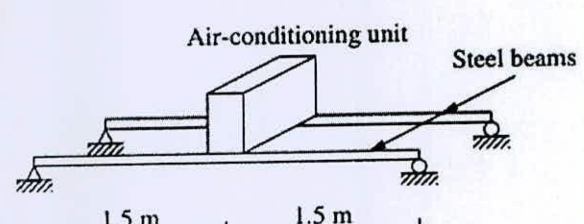


Fig. 5

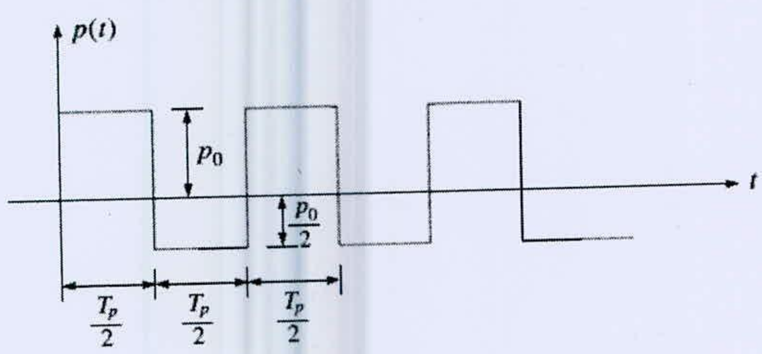


Fig. 2

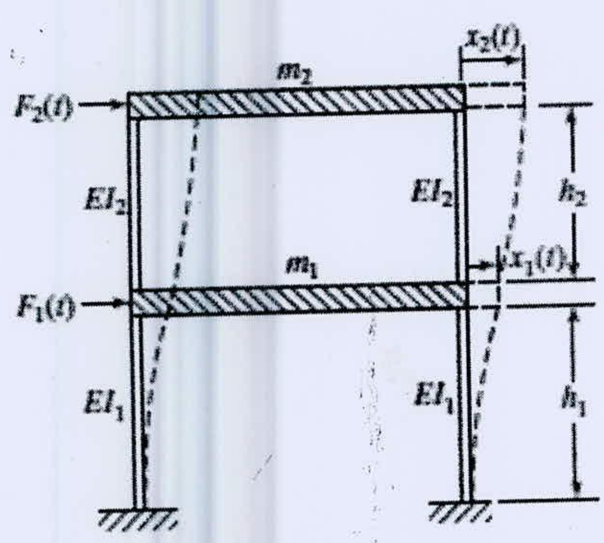


Fig. 3

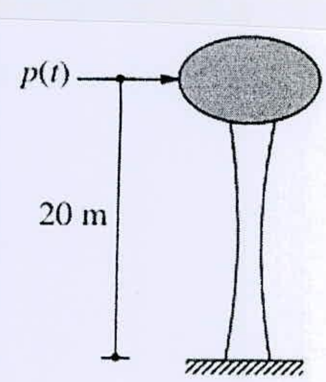


Fig. 6

L-4/T-2/CE Date: 15/04/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **CE 433** (Solid and Hazardous Waste Management)

Full Marks: 140 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) Draw the schematic diagram for the system boundaries for Environmental Life Cycle Inventory of solid waste. Briefly explain the diagram in context to Bangladesh (provide example, if needed). **(10)**

(b) Solid waste from a commercial area are to be collected using a stationary-collection-system having $5m^3$ containers. Determine the appropriate truck capacity for the following conditions: **($13\frac{1}{3}$)**

Container utilization factor = 0.70

Average number of containers at each location = 2

Collection vehicle compaction ratio = 2.5

Container unloading time = 0.15h/container

Average drive-time between container location = 0.15h

One-way haul distance = 25 km

Speed limit = 88 km

Time from garage to first container location = 0.35h

Time from last disposal location to garage = 0.25h

Number of trips to disposal site per day = 2

Length of the working day = 8h

Off-route factor = 0.15

2. (a) Draw a qualitative particle size distribution curve of MSW received at an STS in Dhaka City along with the same particle size leaving the STS. Briefly explain the reasons for the differences. **(10)**

(b) A small township is planning to install an incineration plant as a part of its Waste-to-energy program (see the following Table). The community plans to recycle parts of its wastes by separating 70% of paper, 80% of cardboard, 60% Plastics and 90% of wood. How is this source separation going to affect the feasibility of the waste to energy facility compared to a case where there is no source separation? **($13\frac{1}{3}$)**

Contd P/2

CE 433

Contd... Q. No. 2(b)

Component	Solid Wastes, kg	Energy (kJ/kg)
Food wastes	32.5	19,342
Paper (mixed)	35	15,072
Newsprint	5	17,661
Cardboard	4	15,365
Rubber	0.5	41,375
Plastics	3	26,191
PVC	0.5	23,018
Leather	0.5	17,803
Textile	3	22,338
Yard wastes	13	18,733
Wood	3	18,090

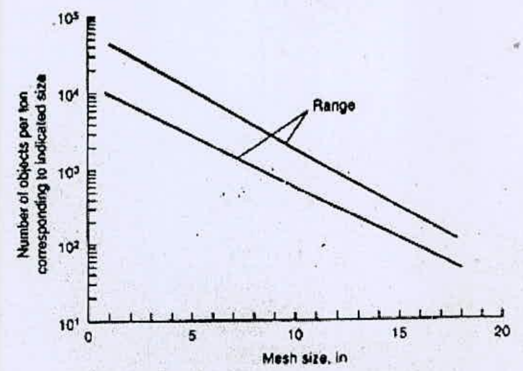
3. (a) Draw and label the schematic diagrams of Conventional and Exchange Mode Hauled Container Systems for MSW. Identify the differences between them and explain the effects of the differences. **(10)**

(b) Determine the round-trip break-even time for solid waste collection system in which the 30-yd^3 self-loading compactors used for collection are driven to the disposal site, and compare that with using a transfer and transport system. Assume that the following data are applicable: **($13\frac{1}{3}$)**

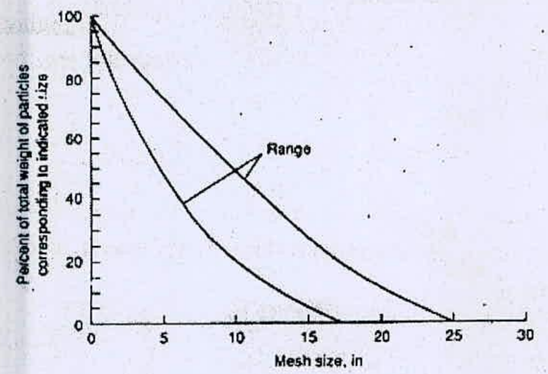
Specific weight of wastes in self-loading compactor = 600 lb/yd^3
Specific weight of wastes in transport trailers = 325 lb/yd^3
Volume of tractor-semitrailer transport unit = 150 yd^3
Optional cost for self-loading compactor = \$40/h
Optional cost for tractor-semitrailer transport unit = \$60/h
Transfer station operational costs including amortization = \$3.25/ton
Extra unloading time cost for transport units, compared with compactors =\$0.40/ton

(Both **GRAPHICAL AND MATHEMATICAL SOLUTIONS MANDATORY**)

4. (a)



Typical sizes of individual components comprising residential and commercial MSW [4, 12].



Percentage of total mass of residential and commercial MSW as a function of mesh size [4, 12

Briefly describe the information that can be extracted from the two sets of graphs shown above. Also, explain the use of the extracted information in the solid waste management system. **(10)**

(b) Draw the schematic diagram representing for allocation of solid waste from 5 transfer stations to 4 disposal sites. Write the objective functions to minimize the haul cost with appropriate constraints. Explain each constraint in context to the allocation plan. **$(13\frac{1}{3})$**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) What is a sanitary landfill? List the advantages and disadvantages of a sanitary landfill. **(7)**

(b) What are the key features in the planning of a sanitary landfill? **(7)**

(c) Provide the list of area exclusion criteria for a sanitary landfill. **$(9\frac{1}{3})$**

Contd P/4

CE 433

6. (a) Draw a typical layout plan of a sanitary landfill site. **(8)**

(b) Write a short note on leachate recirculation in a sanitary landfill. **($7\frac{1}{3}$)**

(c) A solid waste has the following components and bulk densities: **(8)**

Component	% by weight	Uncompacted bulk density (lb/ft^3)
Miscellaneous paper	45	3.83
Garden waste	20	4.52
Glass	10	18.35
Food waste	25	12.68

The food waste is diverted for biogas generation. The rest of the waste is disposed of in a sanitary landfill. Assume that the compacted waste density in the landfill is 43.2 lb/ft^3. Estimate the volume reduction achieved during compaction of the waste.

7. (a) Draw leachate collection system of a sanitary landfill. Deduce an expression for determining the spacing of laterals for leachate collection. **(6)**

(b) What are the methods of estimation of quantity of landfill gas generation? Which method do you prefer and why? **($7\frac{1}{3}$)**

(c) Draw a flow sheet for hazardous waste treatment and disposal facilities for selecting appropriate type of hazardous waste management method. **(10)**

8. (a) List the important factors in the design of a leachate treatment system. Assess the suitability of different treatment options of leachate. **(9)**

(b) Draw a Figure showing a general flow diagram of hospital waste management. **($6\frac{1}{3}$)**

(c) The following four soil layers are lying between the base of a landfill and the underline aquifer. How long does it take for leachate to migrate to the aquifer? Calculate the quantity of leachate flowing down if the landfill area is 65 hectare. **(8)**

Soil Type	Depth (m)	Porosity (%)	Permeability (m/s)
Soil A	1.5	41	2.9×10^{-9}
Soil B	2.1	43	5.3×10^{-8}
Soil C	1.7	44	2.2×10^{-7}
Soil D	2.6	42	3.1×10^{-9}

L- 4/T-II/CE **Date : 10/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L- 4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **CE 419** (Introduction to Finite Element Method)

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer **ALL**.

1. (a) What is a Taig quadrilateral? Explain the isoparametric concept in Finite Element analysis as the purpose of defining the geometry and deformed shape of an element using the same function? **($7\frac{1}{2}$)**

(b) List four benefits of suing iso-parametric element. **(6)**

(c) What is Jacobian? What is the purpose of Jacobian matrix in the finite element formulation? **(4)**

2. (a) Foundation of a building rests on bored piles. Introduce substructure concept to model the structural system of the foundation in finite element method. In this process, explain the advantages of the substructure concept in modeling soil-structure interaction. **($8\frac{2}{3}$)**

(b) Explain how finite element method considers material science, cross sectional geometry and architectural dimensions in the process of computer aided analysis and design. Briefly discuss the analogy of the procedure with fluid mechanics or electrical circuit solutions. **($8\frac{2}{3}$)**

3. Answer 3(a) **OR** 3(b):

(a) Numerical Integration is needed in finite element solution procedure-Explain by introducing a purposeful equation and a numerical integration method used in the procedure. **($17\frac{1}{2}$)**

OR

(b) Explain the assumptions of a linear static analysis. Linearization is the first step to solve a nonlinear problem – Explain. **($17\frac{1}{2}$)**

4. Answer "4(a) and 4(b)" **OR** "4(c) and 4(d)".

(a) Generated stiffness in a civil engineering problem is usually banded in nature – explain the advantages of this property in obtaining an efficient solution. **(10)**

(b) What are the ways you may consider to reduce the band width while modeling a problem in finite element method? **($7\frac{1}{2}$)**

OR

(c) What are the basic conditions we do expect from a stiffness matrix to satisfy? Explain with examples, figures and equations. **($9\frac{1}{2}$)**

(d) Provide four specific examples of civil engineering problem where conventional analytical methods remain far away for reaching a solution and demands a finite element solution to reach a reasonable analysis for design. **(8)**

Contd P/2

CE 419

SECTION – B

There are **FOUR** questions in this section. Answer **ALL**.

5. (a) What are the basic components of a general purpose finite element software? **($5\frac{1}{2}$)**

(b) "A thin plate is subjected to forces in its plane only." Write down the stress-strain relation along with necessary assumptions. **(6)**

(c) "A long body is subjected to significant lateral forces but very little longitudinal forces". Write down stress-strain relations for this range of problem and consider necessary assumptions for the derivation. **(6)**

6. (a) Approximate the area of a circle by dividing it into a number of triangles. In this process show that $S_N = \pi R^2$ when $N \to \infty$. Where, R = radius of the circle, N = number of triangles, S_N = Area of the circle. **(12)**

(b) Summarize the basic procedural steps that are followed in FEM for analyzing a structure. **($5\frac{1}{2}$)**

7. Answer 7(a) OR 7(b)

(a) Introduce shape function by considering stored strain energy for deriving general formula for the element stiffness matrix ($\underline{k}$) in a beam element, **($17\frac{1}{2}$)**

$$k = \int \underline{\underline{B}}^T \, \underline{\underline{E}}\,\underline{\underline{B}} \, dv$$

OR

(b) Introduce shape function by considering stored strain energy for deriving general formula for the element stiffness matrix ($\underline{k}$) in a spring element,

$$k = \int \underline{\underline{B}}^T \, \underline{\underline{E}}\,\underline{\underline{B}} \, dv$$

In this process explain why the element stiffness you derive is unsuitable for stress analysis of the spring itself. **($17\frac{1}{2}$)**

8. Answer "8(a) and 8(b)" OR "8(c) and 8(d)".

(a) Name the different types of symmetry conditions that an engineer may adopt in modelling a problem in finite element approach. Explain with one example for each. **(12)**

(b) In modeling a 2D space, triangular element is often superior than quadrilateral element while in modeling a 3D solid cube, tetrahedral elements are often better than brick elements-Explain. **($5\frac{1}{2}$)**

OR

(c) Write a short note on element aspect ratio on accuracy. **(9)**

(d) "An inadequately defined displacement based finite element mesh may provide a lower bound solution"-Explain. **($8\frac{1}{2}$)**

L-4/T-2/CE **Date: 01/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **CE 435** (Environmental Pollution Management)

Full Marks: 140 Time: 3 Hours

The figures in the margin indicate full marks

Assume reasonable values for missing parameters.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) What do you understand by the aerodynamic diameter of a particulate mater (PM)? What are "coarse," "fine," and "ultrafine" particulate matters? **(9)**

On a particular day, the air quality index (AQI) values for $PM_{2.5}$ (24-hr) and O_3 (8-hr) for a city are 240 and 175, respectively. Calculate the concentrations of $PM_{2.5}$ and O_3 in $\mu g/m^3$. [Given: P = 1 atm and Temperature = 25°C.]

(b) What do you understand by "ambient" and "adiabatic" lapse rates? How are these rates used to define atmospheric stability? Explain. **($7\frac{1}{3}$)**

What do you understand by "temperature inversion" of the atmosphere? What are the common types of inversions? Explain the process of radiation inversion.

(c) What are the major anthropogenic sources of SO_2? Why is SO_2 particularly harmful in the dusty atmosphere? Explain. **(7)**

How does SO_2 affect building materials? Explain.

2. (a) What do you understand by photochemical smog? Discuss its adverse impacts. How might SO_2 promote the formation of ozone (O_3) in the atmosphere? Explain with appropriate equations. **(7)**

(b) A power plant is being proposed at a location 2.5 km up-wind from the center of a town. The power plant would emit SO_2 at a rate of 150 g/s. What minimum stack height should be used to ensure that the ground level SO_2 concentration at the center of the town does not exceed 100 $\mu g/m^3$ for a stability class D. Assume the plume rise to be zero and wind speed at the stack height to be 4 m/s. [Note: Table for calculation of dispersion coefficient provided.] **(10)**

(c) What are the important processes leading to the emission of pollutants into the atmosphere? What do you understand by "primary" and "secondary" pollutants? Give two examples of each. **($6\frac{1}{3}$)**

3. (a) Write down the assumptions of the point source Gaussian plume model. **(11)**

A highway has 625 vehicles passing a given spot per hour. Each vehicle, on average, emits 8.8 g/km of NOx. If wind speed across the highway is 2.3 m/s, estimate the NOx concentration at the ground level and the roof level of a 31 m high building located 100 m downwind of the road. [Note: Table for calculation of dispersion coefficient provided.]

Contd P/2

CE 435

Contd.... for Q. No. 3

(b) The atmospheric, temperature profile on a particular day is given by the following equations: **(7)**

$$\Lambda\,(^\circ C) = 20 + 0.10\,z \qquad ;\ z \leq 230\text{ m}$$
$$= 43 - 0.002(z-230) \qquad ;\ z > 230\text{ m}$$

Where, z = altitude in m.

If a plume is emitted at a temperature of 47°C from the top of a 50 m stack, how high is the plume expected to rise? If the wind speed at 10 m height is 2.5 m/s, estimate the "ventilation coefficient" and comment on the pollution potential of the area. [Given: $p = 0.15$].

(c) What do you understand by "halocarbons"? How do they influence radiative forcing in the troposphere and the stratosphere? Explain. **($5\frac{1}{3}$)**

4. (a) Determine the stoichiometric ratio for the fuel C_8H_{18}. Is it possible to control/reduce automotive emissions of CO, HC, and NOx just by controlling the air-fuel ratio? Explain with an appropriate figure. **(8)**

(b) Name the commonly used devices (post-combustion) for the control of particulate contaminants from industrial emissions. **($8\frac{1}{3}$)**

Explain the working principles of "exhaust gas recirculation (EGR)" and "thermal reactor" in reducing automotive emissions.

(c) What are the major sources of black carbon (BC)? How do black carbon and other particulate matters (including sulfate particles) affect global warming? Explain. **(7)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) Briefly discuss the effects that arsenic-contaminated groundwater may have on food chain and irrigated soil in Bangladesh. **(5)**

(b) Briefly describe the zones of pollution and species distribution in a polluted river. Show a schematic sketch. **(5)**

(c) Writ a neat sketch, briefly explain biological zones in lakes. **($3+10\frac{1}{3}=13\frac{1}{3}$)**

A lake with surface area of 100×10^6 m^2 is fed by a stream having a flow rate of 20 m^3/s with 0.01 mg/L phosphorus. Effluent from a wastewater treatment plant also discharges into the lake. The effluent flow rate is 0.5 m^3/s, and its phosphorus concentration is 8 mg/L. Furthermore, agricultural runoff adds on average 0.2 g/s phosphorus into the lake.

(i) If the phosphorus settling rate is 10 m/yr, calculate the average phosphorus concentration in the lake.

(ii) Estimate the level of additional phosphorus removal required at the treatment plant to keep the concentration of phosphorus in the lake below 0.010 mg/L.

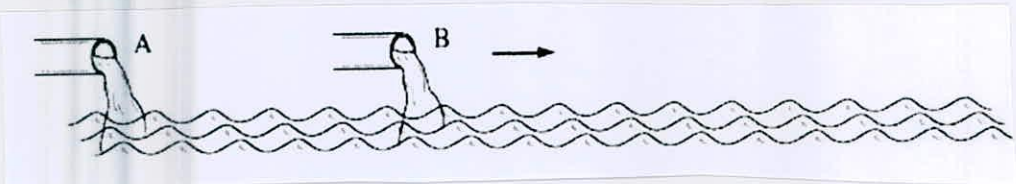
Contd P/3

CE 435

6. (a) Effluent from two industrial effluent treatment plant (A and B) falls into a river as shown below. Sketch the typical profile for the following: **(5)**

   (i) DO profile as a function of downstream distance.

   (ii) BOD remaining in the river as a function of downstream distance.



(b) Briefly explain fall overturn and spring overturn of a lake. Show the variation of temperature and dissolved oxygen along the depth of a lake in these stages. **(5)**

(c) Briefly describe the significances of bioaccumulation in toxicity impact of DDT on Human. **$(4+9\frac{1}{3}=13\frac{1}{3})$**

One-third of the energy content of fuel entering a 1000 MW nuclear power plant is removed by condenser cooling water that is withdrawn from a local river (there are no stack losses). The river has an upstream flow of 120 m^3/s and a temperature of 25°C.

   (i) If the cooling water is only allowed to rise in temperature by 10°C, calculate the flow rate required to be withdrawn from the river.

   (ii) Determine the river temperature after it receives the heated cooling water.

7. (a) With appropriate sketches, briefly describe the flow of light NAPLs and dense NAPLs through an aquifer. **(4)**

(b) Define cultural eutrophication. Briefly explain measures for controlling entrophication. **(4)**

(c) The ultimate BOD of a river just below a sewage outfall is 50.0 mg/L, and the DO is at the saturation value of 10.0 mg/L. The deoxygenation rate coefficient is 0.30/day, and the reaeration rate coefficient is 0.90/day. The river is flowing at the speed of 60.0 km/day. Consider the sewage outfall as the only source of BOD on this river. **$(15\frac{1}{3})$**

   (i) Find the critical distance downstream at which DO is a minimum.

   (ii) Find the minimum DO.

   (iii) If a wastewater treatment plant is to be built, what fraction of the BOD would have to be removed from the sewage to assure a minimum DO of 5.0 mg/L everywhere downstream?

Assume complete and instantaneous mixing of sewage and river water.

[Note: Relevant equations are provided]

8. (a) Briefly discuss the basic principle of following Arsenic removal technologies: **(5)**

(i) Oxidation, (ii) Coagulatio-Adsorption-Coprecipitation, and (iii) Adsorption

(b) Define hydrodynamic dispersion. Explain the effect of hydrodynamic dispersion on contaminant flow in groundwater. **(5)**

(c) Define Capture Zone. Draw a neat sketch showing the capture zone of an extraction well in a typical aquifer. **(3+10$\frac{1}{3}$)**

Suppose a spill of trichloroethylene (TCE) distributes itself evenly throughout an aquifer 10.0 m thick, forming a rectangular plume 2,000 m long and 250 m wide. The aquifer has porosity 0.40, hydraulic gradient 0.001, and hydraulic conductivity 0.001 m/s. Using capture-zone type curves, design an extraction field to pump out the plume under the assumption that the wells are all lined up along the leading edge of the plume, with each well to be pumped at the same rate, not to exceed 0.003 m^3/s per well.

(i) What is the smallest number of wells that could be used to capture the whole plume?

(ii) What minimum pumping rate would be required for each well?

(iii) What would be the optimal spacing between the wells (at the minimum pumping rate)?

5

$$D = \frac{k_d L_0}{k_r - k_d}(e^{-k_d t} - e^{-k_r t}) + D_0 e^{-k_r t}$$

$$t_c = \frac{1}{k_r - k_d}\ln\left\{\frac{k_r}{k_d}\left[1 - \frac{D_0(k_r - k_d)}{k_d L_0}\right]\right\}$$

$$Dc = \frac{k_d}{k_r} L_o e^{-k_d t}$$

Equations for Ques. 7(c)

Table for calculation of AQI [for Question No. 1(a)]

Breakpoints							AQI
O_3 (ppm) 8-hr	O_3(ppm) 1-hr (i)	$PM_{2.5}$ ($\mu g/m^3$) 24-hr	PM_{10} ($\mu g/m^3$) 24-hr	CO (ppm) 8-hr	SO_2 (ppm) 24-hr	NO_2 (ppm) Annual	
0.000-0.064	--	0.0-15.4	0-54	0.0-4.4	0.000-0.034	(ii)	0-50
0.065-0.084	--	15.5-40.4	55-154	4.5-9.4	0.035-0.144	(ii)	51-100
0.085-0.104	0.125-0.164	40.5-65.4	155-254	9.5-12.4	0.145-0.224	(ii)	101-150
0.105-0.124	0.165-0.204	65.5-150.4	255-354	12.5-15.4	0.225-0.304	(ii)	151 -200
0.125-0.374	0.205-0.404	150.5-250.4	355-424	15.5-30.4	0.305-0.604	0.65-1.24	201-300
(iii)	0.405-0.504	250.5-350.4	425-504	30.5-40.4	0.605-0.804	1.25-1.64	301-400
(iii)	0.505-0.604	350.5-500.4	505-604	40.5-50.4	0.805-1.004	1.65-2.04	401-500

(i) In some cases, in addition to calculating the 8-hr ozone index, the 1-hr ozone index may be calculated, and the maximum of the two values reported
(ii) NO_2 has no short-term air quality standard and can generate an AQI only above 200
(iii) 8-hr O_3 values do not define higher AQI values (≥301). AQI values of 301 or higher are calculated with 1-hr O_3 concentrations

Table for estimation of dispersion coefficients [for Questions 2(b) and 3(a)]

		$x \le 1$ km			$x \ge 1$ km		
Stability	a	c	d	f	c	d	f
A	213	440.8	1.941	9.27	459.7	2.094	−9.6
B	156	106.6	1.149	3.3	108.2	1.098	2.0
C	104	61.0	0.911	0	61.0	0.911	0
D	68	33.2	0.725	−1.7	44.5	0.516	−13.0
E	50.5	22.8	0.678	−1.3	55.4	0.305	−34.0
F	34	14.35	0.740	−0.35	62.6	0.180	−48.6

[a] The computed values of σ will be in meters when x is given in kilometers.

$\sigma_y = a.x^{0.894}$

$\sigma_z = c.x^d + f$

L-4/T-2/CE **Date: 15/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **CE 437** (Environmental and Sustainable Management)

Full Marks: 140 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section.

1. (a) What do you mean by Environmental Management? Why is it necessary? Explain with examples. **(7+3=10)**

Describe one of the Environmental Management tools that can be used to reduce environmental impacts in industries.

(b) It has been found that many developed countries have higher Ecological Footprint than developing countries. How do you view the development of the developed countries considering sustainability? Describe with examples. **($7\frac{1}{3}$+6= $13\frac{1}{3}$)**

Write short notes on : i) Human Development Index, ii) Design for Environment

2. (a) What are the environmental implications of Water Development and Flood control projects in Bangladesh? Describe with examples. How can you minimize those effects? **(7+$6\frac{1}{3}$=$13\frac{1}{3}$)**

(b) State the challenges of implementing Nuclear Energy and Wind Energy in Bangladesh. **(10)**

3. (a) Why should an industry/organisation perform 'Environmental Audit'? Explain with logic. Why is it important to make 'Environmental Auditing' an on-going process? Explain with an example. **($7\frac{1}{3}$+6= $13\frac{1}{3}$)**

(b) An auditor visited a Washing Plant Industry to conduct an Environmental audit. During his visit, he observed that the industry did not have any documented environmental policy in place. The have an Effluent Treatment Plant (ETP) to treat wastewater before discharge. They conducted regular fire drills but they did not have any training on health and safety issues of the workers. The auditor also found that the BOD_5 and COD of the treated effluent were 50 mg/L and 220 mg/L respectively. What are the audit criteria and audit evidence in this case? Do you think that the industry should be given compliance certificate? Justify your answer. **(10)**

4. (a) What is the role of Environmental Economics in Environmental Management? Describe with examples. **($5\frac{1}{3}$+8=$13\frac{1}{3}$)**

How can the residuals from production and consumption be minimized? What are the shortcomings of these means?

Contd …… P/2

CE 437
Contd... Q. No. 4

(b) The City Corporation of a Metropolitan City is planning to shift its present Waste Dumping Site from the existing urban location to the periphery of the City by filling up wetland there. They have a plan to prepare the new site as a sanitary landfill site. As an environmental engineer, identify and analyse 3 major Environmental Cost and Benefits of the project that you should consider in taking the decision. **(6+4=10)**

Define Externalities. State one example of positive externalities and one negative externalities.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) According to ECA 1995, which kind of activities would constitute as offences and would incur penalties? Describe the legal framework and institutional arrangements for Bangladesh Environmental Policy 2018. **(11 ⅓)**

   (b) What are the merits and demerits of public consultation? How is public participation related to the EIA process? Name 10 different public participation techniques. **(12)**

6. (a) What are the major provisions of Bangladesh Water Act 2013 and Labour Act 2006? What major issues were addressed in the 2013 amendment of the Labour Act? **(12)**

   (b) What is a Strategic Environmental Assessment (SEA)? How is it different from an EIA, explain. What are the key challenges and barriers in mainstreaming SEA? **(11 ⅓)**

7. (a) What are the salient features of the Environment Court Act? What are the guiding legislations of environmental court in Bangladesh? State the criticisms of environmental court. **(10 ⅓)**

   (b) What were the environmental impacts due to closure of the Northern intake of Dhaleswari river in the Jamuna Multipurpose Bridge Project (JMBP)? Describe impacts on flora, fauna, wildlife and human interest values. What were the noise, social and occupational health and safety hazards associated during construction phase of JMBP? **(13)**

8. (a) According to the Brick Manufacturing and Kiln Establishment (Control) Act 2013, what are the directives of establishing kilns regarding the i) use of fuel, ii) location of the kiln, iii) procedure for obtaining clearance, iv) violations and penalties? **(12)**

   (b) What are the different environmental management strategies in an Environmental Management Plan? Construct a typical environmental monitoring table format. **(11 ⅓)**

L-4/T-II/CE **Date : 03/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **CE 443** (Earth Retaining Structures)

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols carry their usual meaning. Assume reasonable values for any missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. A cantilever sheet pile is required to retain 4 m of sandy backfill material. It is embedded in cohesive soil as shown in Fig. 1.

(a) Consider ground water table acting on both sides of the sheet pile at a depth of 1.5 m from top of backfill material. Determine the required depth of penetration of the sheet pile into the cohesive soil. Consider short term analysis. Comment on the factor of safety to be used. **(13)**

(b) Consider the water table in front (left side) of the sheet pile to suddenly fall by 1 m, while the water table in the backfill remains unchanged. Surcharge load of 15 kPa acts on the backfill. Show the change in lateral pressure on the wall. Also, describe how you would calculate the effect of upward seepage caused by the drop of water table on one side of wall. **($5\frac{1}{3}$)**

(c) Draw the pressure diagram if you consider long term analysis. **(5)**

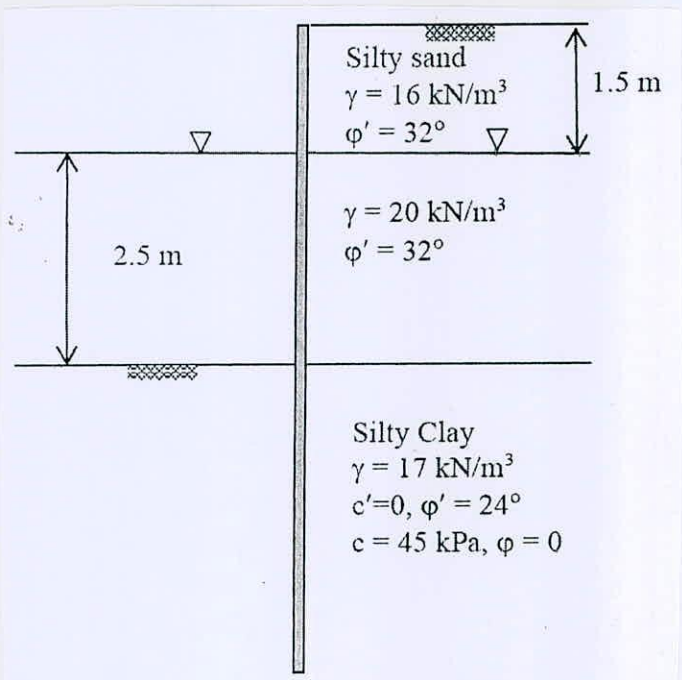


Fig.1 for Qus. 1.

2. (a) Determine the required embedment of an anchored sheet pile, shown in Fig. 2, retaining 7 m of sandy backfill material and embedded in silty sand deposit. Consider an additional surcharge load of 20 kPa on the backfill. Water table is 3 m below the top surface of backfill. Also, determine the spacing and size of mild steel tie-rods to be used for anchor. Also, show the required distance of the anchor block from the sheet pile wall. **(19)**

Contd P/2

CE 443

Contd. Q. No. 2(a)

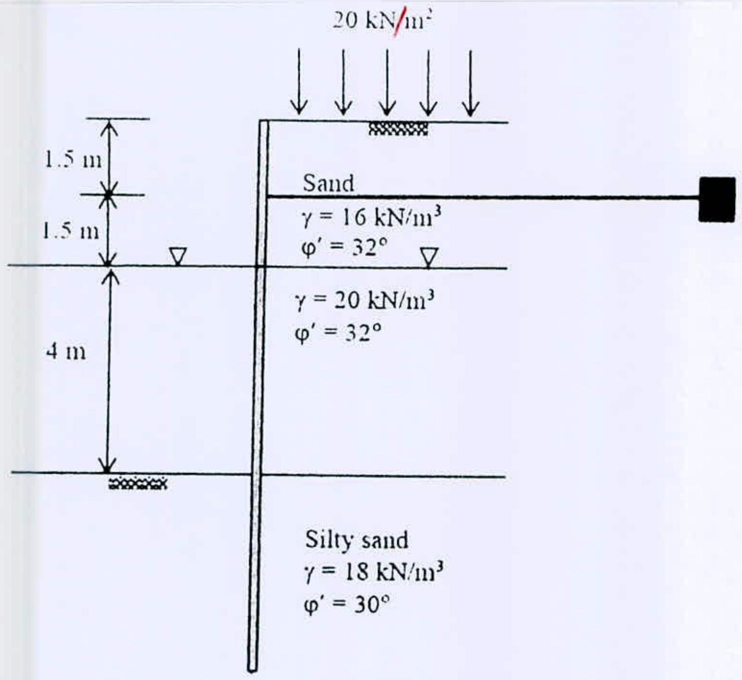


Fig.2 for Ques. 2a.

(b) Define modulus of horizontal subgrade reaction. Where is it used? How can you determine this parameter? **($4\frac{1}{3}$)**

3. (a) When should you be alerted about the possibility of bottom heaving in a braced excavation? How do you calculate the factor of safety against such bottom heave? Present neat sketches and relevant expressions. **($5\frac{1}{3}$)**

(b) A 0.5 m diameter 10 m long pile in clay is subjected to a horizontal load of 50 kN. Consider the pile to be connected to rigid pile cap. Using Broms' method, determine the factor of safety for the lateral load. Finally determine the horizontal deflection of the pile at pile top, using theoretical solutions. Soil properties are: Unit weight = 20 kN/m^3, Undrained shear strength = 45 kPa, Modulus of horizontal subgrade reaction = 1000 kN/m^3, Moment capacity of pile = 100 kN-m, Elastic Modulus of Pile = 21700 MPa. **(14)**

[Given: $\beta = \left(\frac{k_h D}{E_p I_p}\right)^{0.25}$;

For horizontal load H, $\Delta_H = \frac{2H\beta}{k_h D} K_{\Delta H}$, $\theta_H = \frac{2H\beta^2}{k_h D} K_{\theta H}$

For moment M, $\Delta_M = \frac{2M\beta^2}{k_h D} K_{\Delta M}$, $\theta_M = \frac{2M\beta^3}{k_h D} K_{\theta M}$]

Use Charts and Table-1 if necessary.

(c) Briefly describe some applications of slurry trench wall construction. **(4)**

4. (a) What is the action of filter skin in slurry trench wall construction? Briefly describe the principles of slurry preparation, circulation and cleaning. Comment on limitations of slurry trench wall. Present neat sketches as applicable. **($12\frac{1}{3}$)**

Contd P/3

CE 443

Contd...Q. No. 4

(b) Describe with neat sketches the following methods of dewatering: **(4×2=8)**

(i) Cut-off wall (ii) Well points

(c) Briefly describe the design concept for deadman (anchorage). **(3)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Design a circular, cellular cofferdam of total height 15 m resting on rock as shown in the Figure 3. Use the TVA method. Consider allowable interlock tension of 1500 kN/m, $\phi = 30°$, $\delta = 25°$, K = 0.60, and f = 0.30. Assume D = 1.2H, b = 0.875D, and 90°-Tees for ring tension. Also, consider perfectly draining fill in your design. **($13\frac{1}{3}$)**

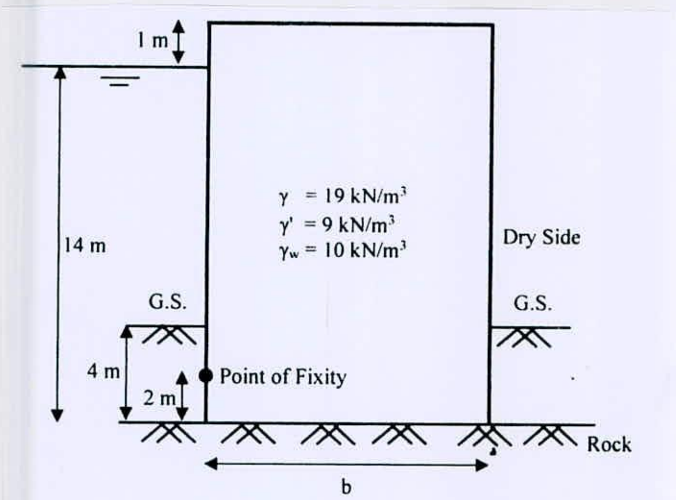


Figure ~~1~~ 3 for Question 5(a)

(b) Briefly describe the classification of conventional retaining walls. **(6)**

(c) Show in a neat sketch the approximate dimensions for various components of the cantilever retaining walls for initial stability checks. **(4)**

6. (a) What is the main difference between a caisson and a cofferdam? Write down five shortcomings in the current cofferdam design. **(7)**

(b) A 10 m high retaining wall with galvanized steel strip reinforcement in a granular backfill will be constructed. Given:

Granular backfill:	$\phi_1' = 36°$
	$\gamma_1 = 16.5$ kN/m^3
Foundation soil:	$\phi_2' = 28°$
	$\gamma_2 = 17.3$ kN/m^3
	$c' = 50$ kN/m^2
Galvanized steel reinforcement:	Width of the strip, w = 75 mm
	$S_v = 0.6$ m c/c
	$S_H = 1$ m c/c
	$f_y = 240$ MPa
	$\phi_\mu' = 20°$
	Required $FS_{(B)} = 3$ and $FS_{(P)} = 3$

Contd P/4

CE 443

Contd...Q. No. 6(b)

Check for external and internal stability. Assume the corrosion rate of the galvanized steel to be 0.025 mm/year and the life span of the structure to be 50 years. Also, assume the water table is much below the base of the wall. Use Table 2 if necessary.

Table 2 Bearing capacity factors **($16\frac{1}{3}$)**

ϕ'	N_c	N_q	N_γ	ϕ'	N_c	N_q	N_γ
22	16.88	7.82	7.13	37	55.63	42.92	66.19
23	18.05	8.66	8.20	38	61.35	48.93	78.03
24	19.32	9.60	9.44	39	67.87	55.96	92.25
25	20.72	10.66	10.88	40	75.31	64.20	109.41
26	22.25	11.85	12.54	41	83.86	73.90	130.22
27	23.94	13.20	14.47	42	93.71	85.38	155.55
28	25.80	14.72	16.72	43	105.11	99.02	186.54
29	27.86	16.44	19.34	44	118.37	115.31	224.64
30	30.14	18.40	22.40	45	133.88	134.88	271.76
31	32.67	20.63	25.99	46	152.10	158.51	330.35
32	35.49	23.18	30.22	47	173.64	187.21	403.67
33	38.64	26.09	35.19	48	199.26	222.31	496.01
34	42.16	29.44	41.06	49	229.93	265.51	613.16
35	46.12	33.30	48.03	50	266.89	319.07	762.89
36	50.59	37.75	56.31				

7. (a) For a 5 m high geotextile-reinforced retaining wall, the following information is given: **($16\frac{1}{3}$)**

Granular backfill: $\phi_1' = 36°$
$\gamma_1 = 15.7$ kN/m^3
Foundation soil: $\phi_2' = 22°$
$\gamma_2 = 18.0$ kN/m^3
$c' = 28$ kN/m^2
Geotextile: $T_{ult} = 52.5$ kN/m
$RF_{id} = 1.2$, $RF_{cr} = 2.5$, $RF_{cbd} = 1.25$
Required $FS_{(B)} = 1.5$ and $FS_{(P)} = 1.5$

Determine the vertical spacing of the layers, the length of each layer of geotextile, and the lap length. Also, calculate the factor of safety against overturning, sliding, and bearing capacity failure. Assume the water table is much below the base of the wall. Use Table 2 if necessary.

(b) Draw the modes of failure of cellular sheet-piled structures as per BS 6349-2:2010. **(7)**

Contd P/5

Table ~~2~~ 3: Variation of $K_{a(R)}$

α (deg)	θ (deg)	$K_{a(R)}$, ϕ' (deg) 28	30	32	34	36	38	40
	0	0.361	0.333	0.307	0.283	0.260	0.238	0.217
	2	0.363	0.335	0.309	0.285	0.262	0.240	0.220
	4	0.368	0.341	0.315	0.291	0.269	0.248	0.228
0	6	0.376	0.350	0.325	0.302	0.280	0.260	0.242
	8	0.387	0.362	0.338	0.316	0.295	0.276	0.259
	10	0.402	0.377	0.354	0.333	0.314	0.296	0.280
	15	0.450	0.428	0.408	0.390	0.373	0.358	0.345
	0	0.366	0.337	0.311	0.286	0.262	0.240	0.219
	2	0.373	0.344	0.317	0.292	0.269	0.247	0.226
	4	0.383	0.354	0.328	0.303	0.280	0.259	0.239
5	6	0.396	0.368	0.342	0.318	0.296	0.275	0.255
	8	0.412	0.385	0.360	0.336	0.315	0.295	0.276
	10	0.431	0.405	0.380	0.358	0.337	0.318	0.300
	15	0.490	0.466	0.443	0.423	0.405	0.388	0.373
	0	0.380	0.350	0.321	0.294	0.270	0.246	0.225
	2	0.393	0.362	0.333	0.306	0.281	0.258	0.236
	4	0.408	0.377	0.348	0.322	0.297	0.274	0.252
10	6	0.426	0.395	0.367	0.341	0.316	0.294	0.273
	8	0.447	0.417	0.389	0.363	0.339	0.317	0.297
	10	0.471	0.441	0.414	0.388	0.365	0.344	0.324
	15	0.542	0.513	0.487	0.463	0.442	0.422	0.404
	0	0.409	0.373	0.341	0.311	0.283	0.258	0.235
	2	0.427	0.391	0.358	0.328	0.300	0.274	0.250
	4	0.448	0.411	0.378	0.348	0.320	0.294	0.271
15	6	0.472	0.435	0.402	0.371	0.344	0.318	0.295
	8	0.498	0.461	0.428	0.398	0.371	0.346	0.323
	10	0.527	0.490	0.457	0.428	0.400	0.376	0.353
	15	0.610	0.574	0.542	0.513	0.487	0.463	0.442
	0	0.461	0.414	0.374	0.338	0.306	0.277	0.250
	2	0.486	0.438	0.397	0.360	0.328	0.298	0.271
	4	0.513	0.465	0.423	0.386	0.353	0.323	0.296
20	6	0.543	0.495	0.452	0.415	0.381	0.351	0.324
	8	0.576	0.527	0.484	0.446	0.413	0.383	0.355
	10	0.612	0.562	0.518	0.481	0.447	0.417	0.390
	15	0.711	0.660	0.616	0.578	0.545	0.515	0.488

8. The cross-section of a cantilever retaining wall is shown in Figure 4. Calculate the factors of safety with respect to overturning, sliding, and bearing capacity. Use Table 2, 3 and 4 where necessary. **($23\frac{1}{3}$)**

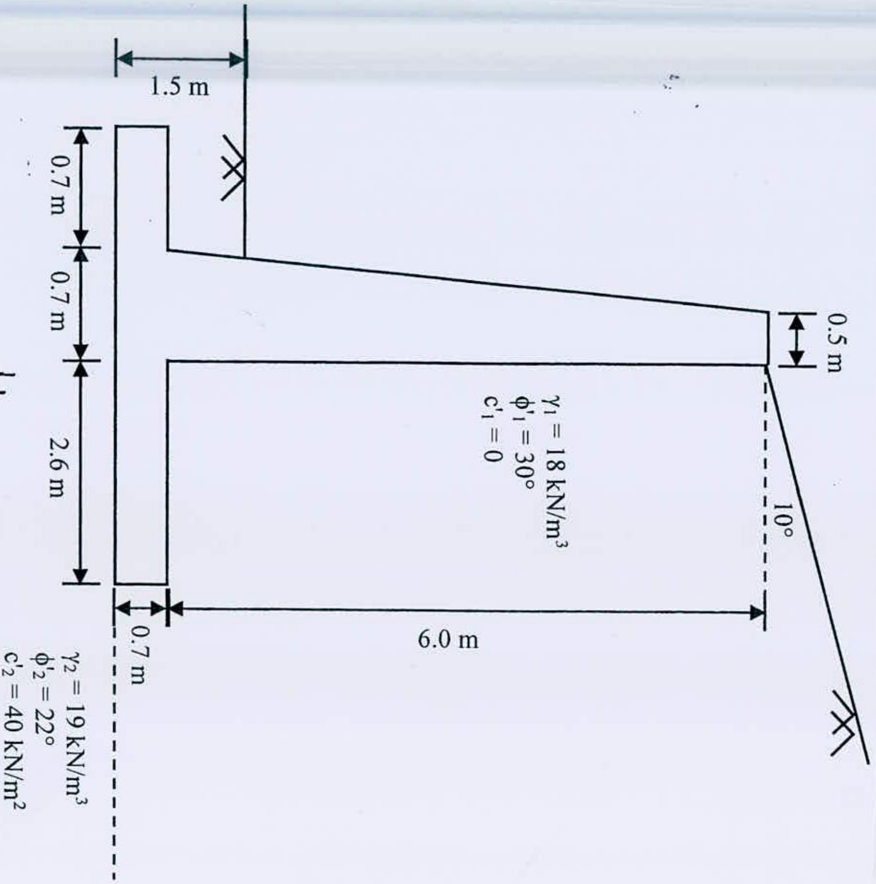
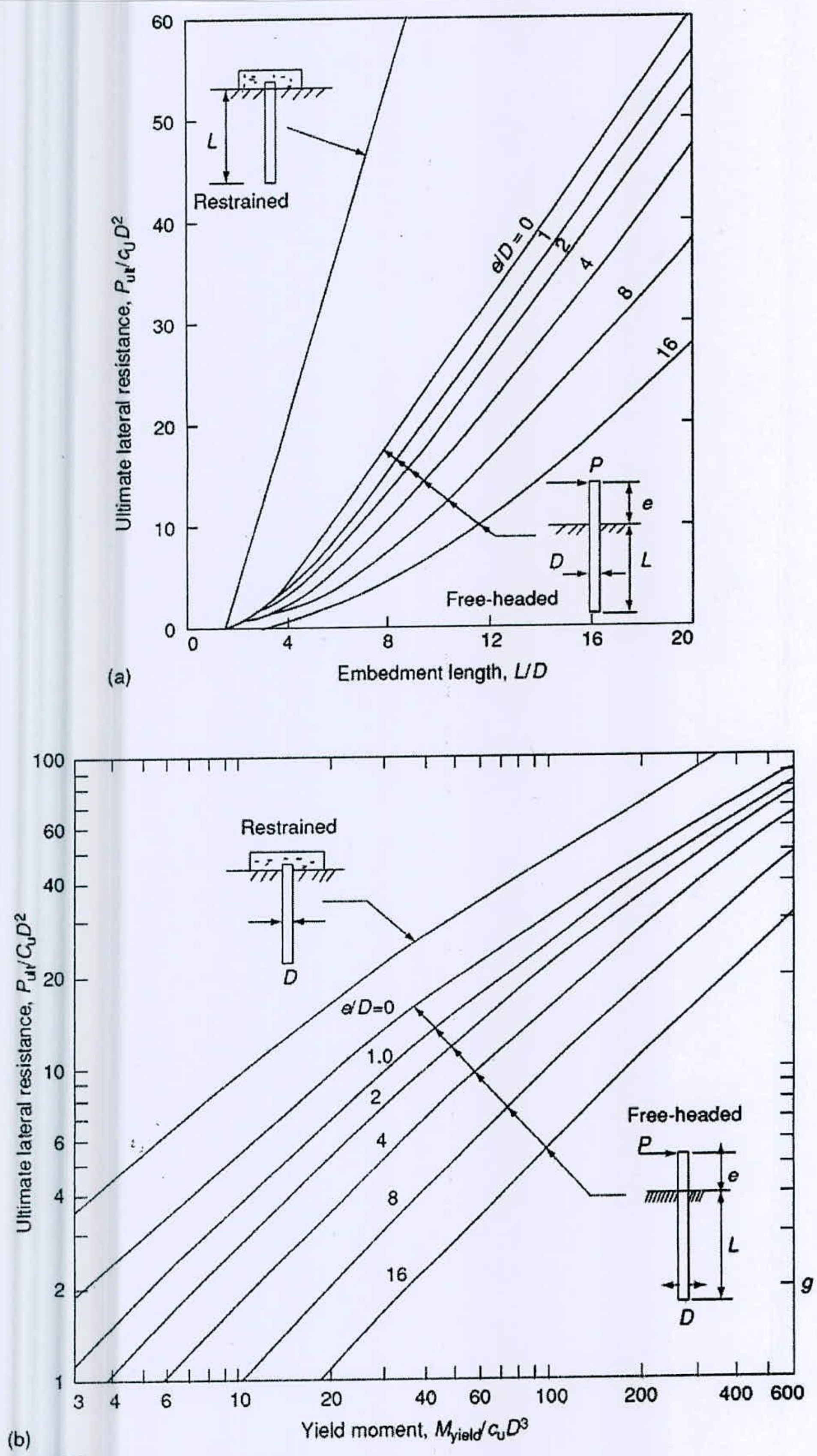


Figure ~~2~~ 4 for Question 8

Table 4: Shape, Depth, and Inclination Factors

Factor	Relationship	Reference
Shape	$F_{cs} = 1 + \left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$ $F_{qs} = 1 + \left(\frac{B}{L}\right)\tan\phi'$ $F_{\gamma s} = 1 - 0.4\left(\frac{B}{L}\right)$	DeBeer (1970)
Depth	$\frac{D_f}{B} \leq 1$ For $\phi = 0$: $F_{cd} = 1 + 0.4\left(\frac{D_f}{B}\right)$ $F_{qd} = 1$ $F_{\gamma d} = 1$ For $\phi' > 0$: $F_{cd} = F_{qd} - \frac{1 - F_{qd}}{N_c \tan\phi'}$ $F_{qd} = 1 + 2\tan\phi'(1 - \sin\phi')^2\left(\frac{D_f}{B}\right)$ $F_{\gamma d} = 1$ $\frac{D_f}{B} > 1$ For $\phi = 0$: $F_{cd} = 1 + 0.4\underbrace{\tan^{-1}\left(\frac{D_f}{B}\right)}_{\text{radians}}$ $F_{qd} = 1$ $F_{\gamma d} = 1$ For $\phi' > 0$: $F_{cd} = F_{qd} - \frac{1 - F_{qd}}{N_c \tan\phi'}$ $F_{qd} = 1 + 2\tan\phi'(1 - \sin\phi')^2\underbrace{\tan^{-1}\left(\frac{D_f}{B}\right)}_{\text{radians}}$ $F_{\gamma d} = 1$	Hansen (1970)
Inclination	$F_{ci} = F_{qi} = \left(1 - \frac{\beta^\circ}{90^\circ}\right)^2$ $F_{\gamma i} = \left(1 - \frac{\beta^\circ}{\phi'}\right)^2$ β = inclination of the load on the foundation with respect to the vertical	Meyerhof (1963); Hanna and Meyerhof (1981)

=7=



~~FIGURE 6.4~~ 5
Ultimate lateral resistance of piles in cohesive soils: (a) short piles and (b) long piles. (From Broms, B., 1964a, *J. Soil Mech. Found. Div., ASCE*, 90(SM3):27–56. With permission.)

Chart 1 (for ques 3(b))

=8=

TABLE 1 for Q no. 3(b).

Influence Factors for the Linear Solution

βL	Z/L	$K(\Delta H)$	$K(\theta H)$	$K(MH)$	$K(VH)$	$K(\Delta M)$	$K(\theta M)$	$K(MM)$	$K(VM)$
2.0	0	1.1376	1.1341	0	1	−1.0762	1.0762	1	0
2.0	0.125	0.8586	1.0828	0.1848	0.5015	−0.6579	0.8314	0.9397	0.2214
2.0	0.25	0.6015	0.9673	0.262	0.1377	−0.2982	0.6133	0.7959	0.3387
2.0	0.375	0.3764	0.8333	0.2637	−0.1054	−0.0376	0.4366	0.6138	0.3788
2.0	0.5	0.1838	0.7115	0.218	−0.2442	0.1463	0.3068	0.4262	0.3639
2.0	0.625	0.0182	0.6192	0.1491	−0.2937	0.2767	0.222	0.2564	0.3101
2.0	0.75	−0.1288	0.5628	0.0776	−0.2654	0.3747	0.1757	0.1208	0.2282
2.0	0.875	−0.2659	0.5389	0.0222	−0.1665	0.4572	0.1578	0.0318	0.1241
2.0	1	−0.3999	0.5351	0	0	0.5351	0.1551	0	0
3.0	0.125	0.6459	0.8919	0.2508	0.3829	−0.3854	0.6433	0.8913	0.2514
3.0	0.25	0.3515	0.6698	0.3184	0.0141	−0.0184	0.3493	0.6684	0.3202
3.0	0.375	0.1444	0.4394	0.285	−0.1664	0.1607	0.1429	0.436	0.2887
3.0	0.5	0.0164	0.2528	0.2091	−0.2223	0.2162	0.0168	0.2458	0.215
3.0	0.625	−0.0529	0.1271	0.1272	−0.2057	0.2011	−0.0489	0.1148	0.1353
3.0	0.75	−0.0861	0.0584	0.0594	−0.1519	0.1524	−0.0763	0.0396	0.0684
3.0	0.875	−0.1021	0.0321	0.0154	−0.0807	0.0916	−0.0839	0.0069	0.0225
3.0	1	−0.113	0.0282	0	0	0.0282	−0.0847	0	0
4.0	0	1.0008	1.0015	0	−0.0000	0.0282	−0.0847	0.0000	0
4.0	0.1250	0.5323	0.8247	0.2907	0.2411	−0.2409	0.5344	0.8229	0.2910
4.0	0.2500	0.1979	0.5101	0.3093	−0.1108	0.1136	0.2010	0.5082	0.3090
4.0	0.3750	0.0140	0.2403	0.2226	−0.2055	0.2118	0.0178	0.2397	0.2200
4.0	0.5000	−0.0590	0.0682	0.1243	−0.1758	0.1858	−0.0558	0.0720	0.1176
4.0	0.6250	−0.0687	−0.0176	0.0529	−0.1084	0.1200	−0.0696	−0.0043	0.0406
4.0	0.7500	−0.0505	−0.0488	0.0147	−0.0475	0.0538	−0.0616	−0.0206	−0.0025
4.0	0.8750	−0.0239	−0.0552	0.0014	−0.0101	−0.0033	−0.0535	−0.0096	−0.0148
4.0	1.0000	0.0038	−0.0555	−0	0.0000	−0.0555	−0.0517	−0.0000	−0
5.0	0	1.0003	1.0003	0	1.0000	−1.0003	1.0002	1.0000	0
5.0	0.1250	0.4342	0.7476	0.3131	0.1206	−0.1210	0.4343	0.7472	0.3133
5.0	0.2500	0.0901	0.3628	0.2716	−0.1817	0.1818	0.0907	0.3620	0.2720
5.0	0.3750	−0.0466	0.1013	0.1461	−0.1919	0.1930	−0.0455	0.1002	0.1461
5.0	0.5000	−0.0671	−0.0157	0.0494	−0.1133	0.1163	−0.0654	−0.0161	0.0482
5.0	0.6250	−0.0456	−0.0435	0.0026	−0.0412	0.0461	−0.0444	−0.0409	−0.0012
5.0	0.7500	−0.0197	−0.0369	−0.0088	−0.0008	0.0055	−0.0221	−0.0276	−0.0159
5.0	0.8750	0.0002	−0.0279	−0.0044	0.0108	−0.0139	−0.0110	−0.0086	−0.0125
5.0	1.0000	0.0167	−0.0259	−0	0.0000	−0.0259	−0.0091	−0.0000	−0

L- 4/T-II/CE **Date : 29/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L- 4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **CE 445** (Soil Dynamics)

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

Use attached chart where necessary.

1. (a) Explain Data Completeness for seismic hazard with necessary figures. **(13)**

(b) Estimate the probability of seismic hazard for a nuclear power plant for a return period of (i) 150 yr, (ii) 250 yr, (iii) 500 yr, and (iv) 2500 yr. **(10 ⅓)**

2. (a) Write short notes on: **(15)**

(i) Microzonations

(ii) Microtremors

(b) Explain different types of Earthquake Source Models with necessary figures. **(8 ⅓)**

3. (a) Write short notes on: **(10)**

(i) Vulnerability Class and Damage Grades

(ii) Attenuation Laws

(b) For the following data, shown in Table 1, estimate Liquefaction Resistance Factor and Liquefaction Potential Index for α_{max}= 0.35g for M = 7.5, Ground Water Table is located at a depth of 2.5 m from the EGL. **(13 ⅓)**

Table 1

Soil Layer Thickness (m)	Soil Profile	d_{50}(mm)	SPT-N Value
0-5	Fill	0.19	2
5-10	Loose Fine Sand	0.27	5
10-16	Medium Dense Sand	0.31	12
16-22	Dense Sand	0.42	18

4. (a) Graphically explain magnitude saturation. Explain the importance of Moment Magnitude with an example. **(5+4=9)**

(b) There are five Seismoactive zones (Table 2) in and around a nuclear power plant site. Estimate SDE and SSE on the basis of cumulative intensity- frequency relation. **(14 ⅓)**

Table 2

Zones	a	b	I_{max}	Attenuation Value
1	1.27	0.67	X	1.5
2	0.47	0.31	IX	1.1
3	0.69	0.57	VIII	1.3
4	1.05	0.61	XI	2.3
5	0.79	0.45	VIII	0.5

Contd P/2

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

Assume any reasonable value of missing data.

5. (a) Define cyclic loading in the light of imparting dynamic effects to the structure. Describe the rate-dependent response of granular soils, especially its effects on pore water dissipation characteristics when saturated. How can you relate it with soil liquefaction phenomenon? **(10)**

(b) A body weighing 65 kg is suspended from a spring which deflects 1.57 cm under the load. It is subjected to a damping effect adjusted to a value 0.25 times that required for critical damping. Find the natural frequency of the undamped and damped vibrations, and, in the latter case, determine the ratio of successive amplitudes. If the body is subjected to a periodic disturbing force with a maximum value of 25 kg and a frequency equal to 0.75 times the natural undamped frequency, find the amplitude of forced vibrations and the phase difference with respect to the disturbing force. **($13\frac{1}{3}$)**

6. (a) Describe briefly (if necessary, with neat sketches) the steps for the field determination of dynamic soil properties stated below: **(10)**

   (i) Natural frequency using forced vibration

   (ii) Damping ratio by free vibration

   (iii) Damping ratio using forced vibration

(b) Define damping capacity and coefficient loss of a material, and evaluate, by using the definition of energy and the rate of change of energy, the above two entities as $4\pi D$ and $2D$, respectively (D = damping ratio). **($13\frac{1}{3}$)**

7. (a) The maximum permissible recoil distance of a gun is specified as 0.5 m. If the initial recoil velocity is to be 10 m/s, find the mass of the gun and the stiffness of the recoil mechanism. Assume that a critically damped dashpot is used in the recoil and the mass of the gun has to be at least 500 kg. **(10)**

(b) Considering a vibrating system excited by a constant amplitude time dependent force, show that acceleration response factor R_a is equal to the square of the frequency ratio times its displacement response factor, R_d. And, also obtain the resonant frequency of the response R_a and the acceleration amplitude at resonance. **($13\frac{1}{3}$)**

8. (a) A bungee jumper weighing 160 lb ties one end of a elastic rope of length 200 ft and stiffness 10 lb/in to bridge and the other to himself and jumps from the bridge as shown in Fig. 1. Assuming the bridge to be rigid, determine the vibratory motion of the jumper about his static equilibrium position. **(10)**

Contd P/3

CE 445
Contd...Q. No. 8(a)

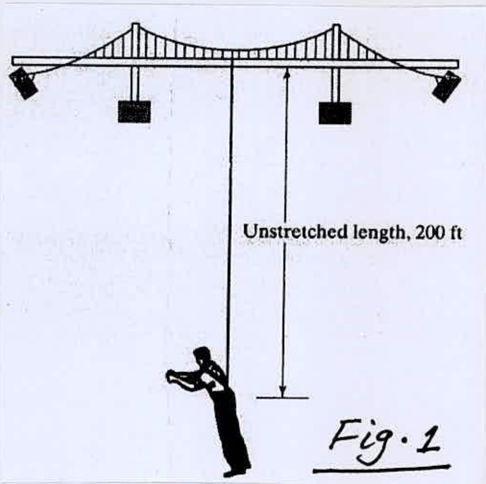


Fig. 1

(b) State the differential equation of motion of a damped free vibration. With the help of a trail solution z = e^{st}, find the condition for critical damping state in motion and obtain an expression for the critical damping coefficient, and hence, establish the expression for solution of above motion as: $z = (C_1 + C_2 t)e^{-\omega_n t}$; then, apply the initial condition as: at time t = 0, displacement vector, z = z_0 and the velocity vector, $\dot{z} = \ddot{z}_0$ to obtain the solution for above motion as: $z = \{z_1 + (\dot{z}_0 + \omega_n z_0)t\}e^{-\omega_n t}$. **(13 ⅓)**

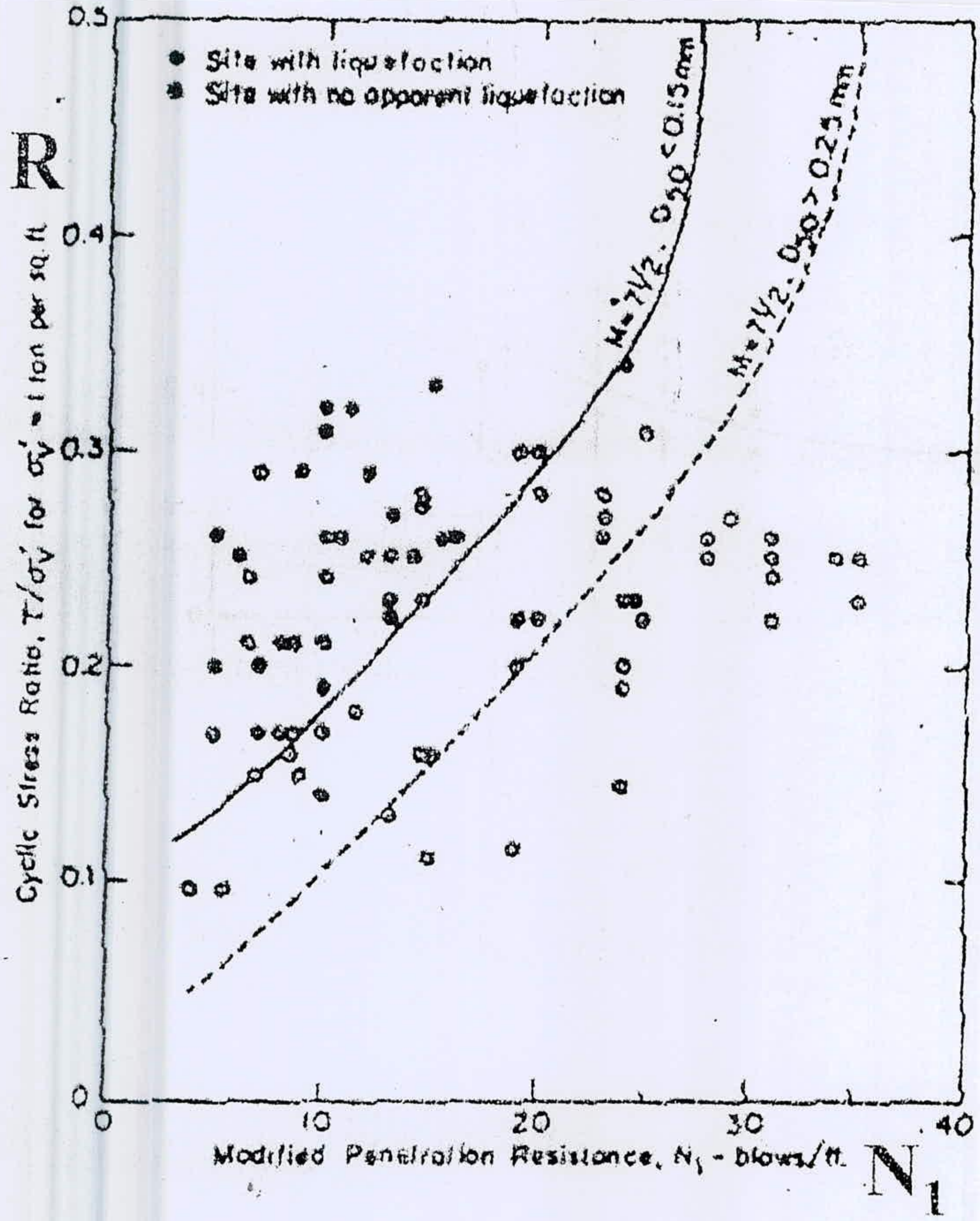


Chart 1

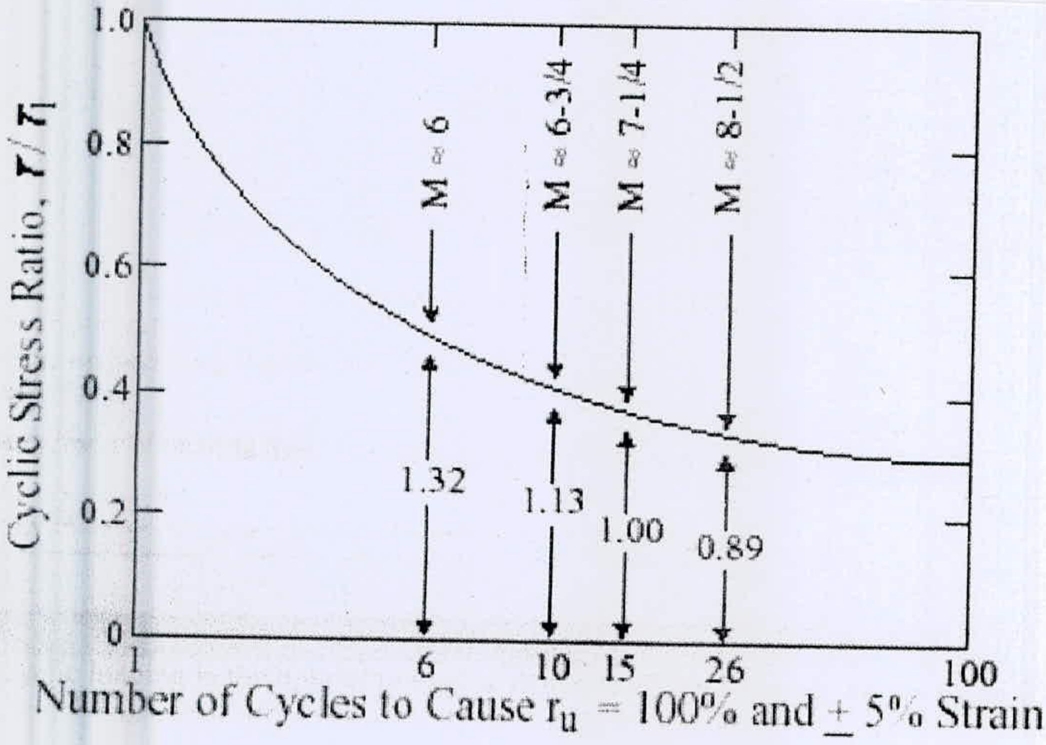


Chart 2

L-4/T-II/CE Date : 29/04/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **CE 447** (Soil Water Interaction)

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Describe the effects of water on: **(6)**

   (i) the bearing capacity of foundation

   (ii) stability of slopes

   (iii) stability of earthen dam and embankments

   (b) Explain the measures, with appropriate sketches, that may be adopted to avoid the adverse effects of water in cases of retaining walls. **($8\frac{1}{3}$)**

   (c) Erosion protection measures have been taken on a river bank with rock rip-rap. The bank slope is 1(V): 3(H). The river is a tidal river and the water level varies from RL = +4.5 m (HWL) at high tide to RL = +2.5 m (LWL) at low tide in about 6 hours. The bank soil is fine sand with d_{15} = 0.08 mm, d_{60} = 0.28 mm, D_R = 70% and e = 1.5. When the water level in the river is at LWL, the water profile within the bank soil gradually varies from RL = +4.5 m at a distance of 50 m form bank slope. Check the adequacy, with respect to flow, of a geotextile of thickness with laboratory determined permittivity of $\psi = 0.6\ \text{sec}^{-1}$ to be used beneath the rock rip-rap. Consider partial safety factors as – Soil clogging and blinding: 10, Creep reduction of voids: 1.2, Intrusion into voids: 1.5, Chemical clogging: 2.0, Biological clogging: 3.0. **(9)**

2. (a) Discuss the information that need to be collected for the design of a hydraulic fill. **(8)**

   (b) Discuss the principle, suitability, advantages and limitations of various methods of ground improvement that fall under the category "Deep densification by vibration". **($7\frac{1}{3}$)**

   (c) Draw neat sketch showing the cross-section of a river bank with revetment work on it. Explain the necessity of the various elements of the revetment. **(8)**

3. (a) Differentiate between AOS/EOS and O_{95} of a geotextile. Describe the relevant laboratory test with its limitations. **($7\frac{1}{3}$)**

   (b) Draw sketches showing various types of granular filter and drain used in embankments and state their functions. How does the granular filter and drain vary with seepage volume? **(9)**

   (c) Write short notes on 'mass per unit area' and 'tensile strength' of geotextiles. **(7)**

Contd P/2

CE 447

4. (a) State the criteria for granular filter design. Mention the significance of each criterion. Are these criteria applicable for all soil types? If not, what can be done about the granular filter? **(8)**

(b) Discuss the various technical analyses that need to be carried out to determine the feasibility of a hydraulic fill. **(8)**

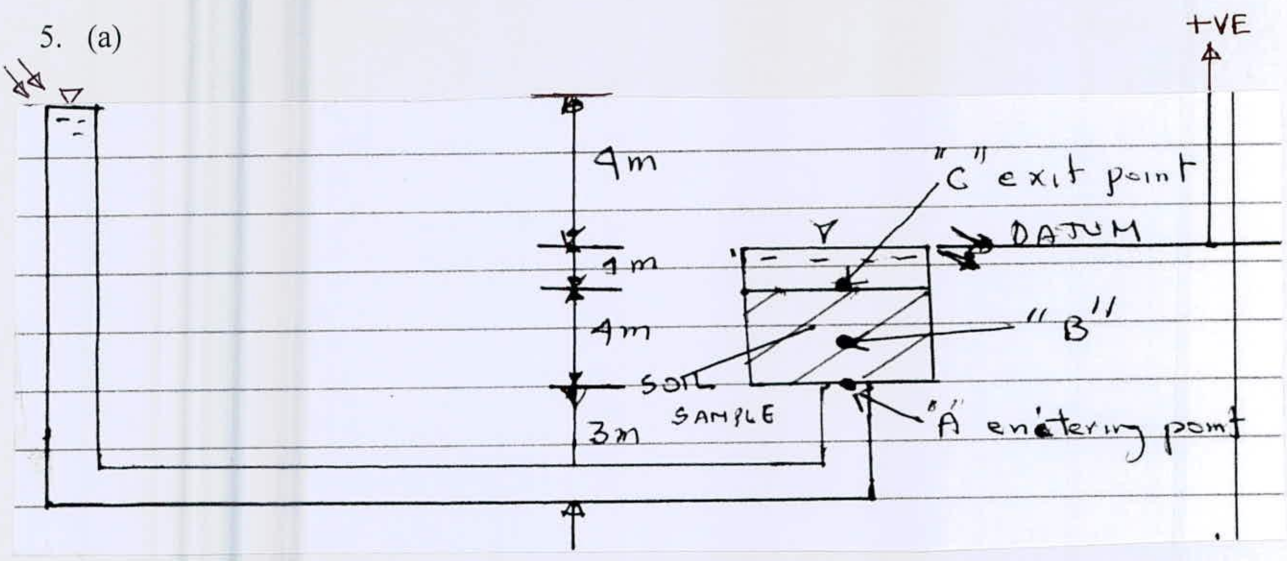
(c) Explain the various types of river bank failures with neat sketches? Comment on the type of bank soil and river characteristics for which they occur? **(7 ⅓)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

Assume reasonable value for missing data. Use attached chart where necessary.

5. (a)

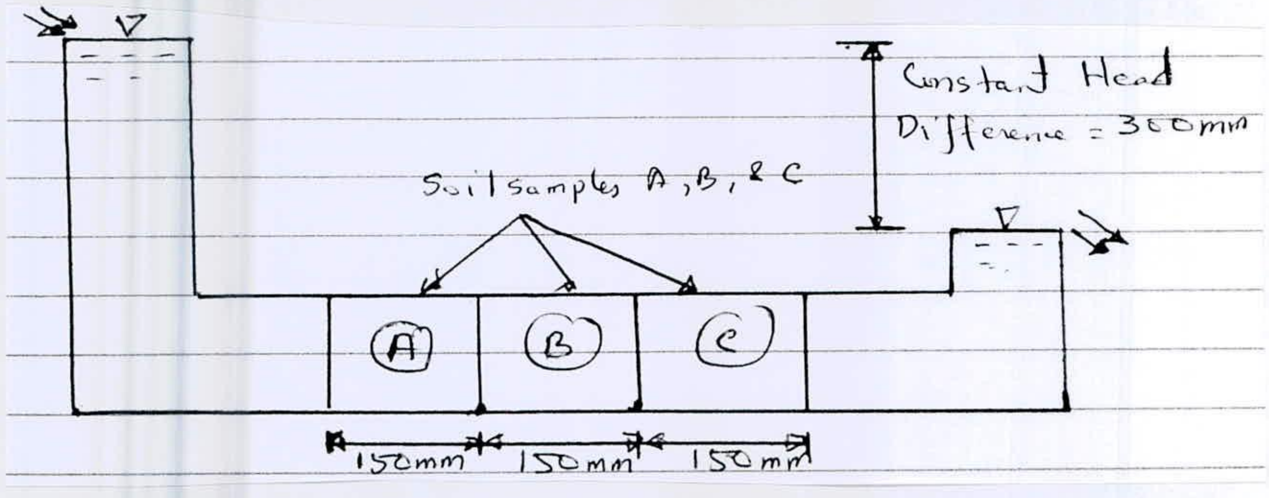


For the figure above, fill the table given below:

Point	Elevation Head (cm) measured from DATUM	Pressures Head (cm)	Total Head (cm)	Head loss (cm)
A				
B				
C				

Also, find the discharge and seepage velocity of flow through the soil sample if coefficient of permeability of the soil sample k = 0.01 cm/s. **(10)**

(b)



CE 447

Contd...Q. No. 5(b)

X-section of tube = 100 mm × 100 mm square **(13⅓)**

Soil Type	Permeability k(cm/s)
A	10^{-2}
B	3×10^{-3}
C	4.9×10^{-4}

(i) Find the equivalent permeability of combined soil layers A, B and C.

(ii) Find the discharge through the layered soil system in cm^3/hr.

(iii) Find the head loss as water flows through

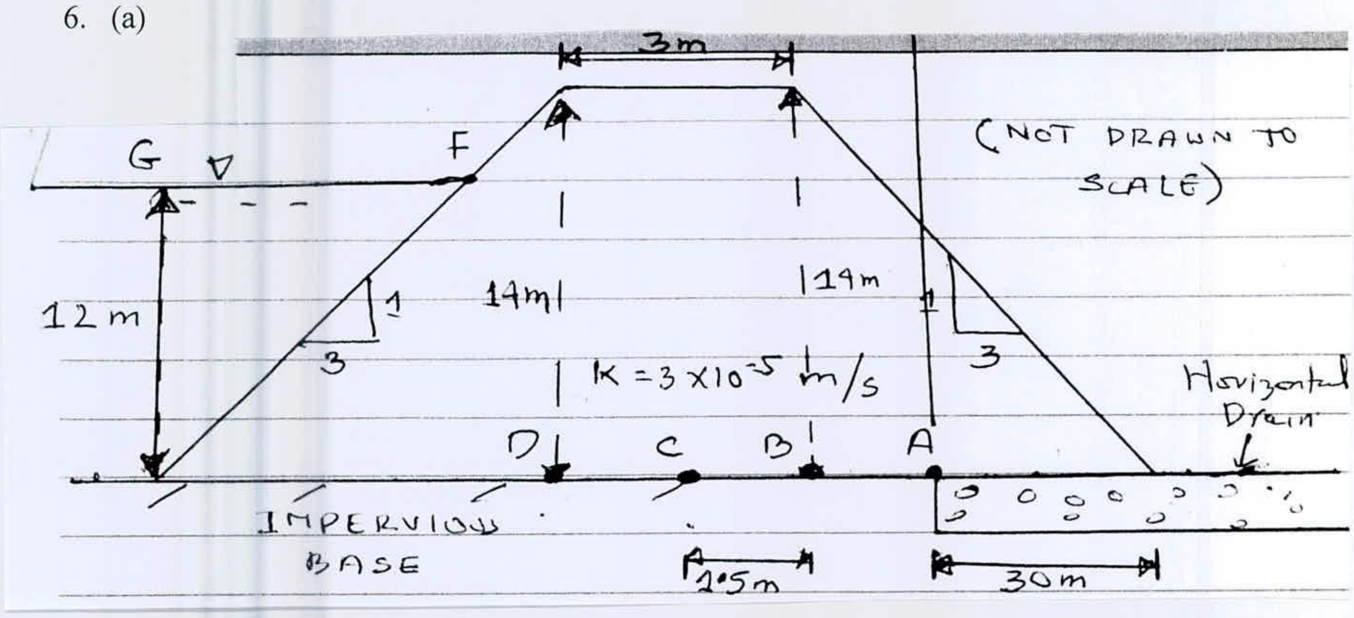
(1) soil sample A

(2) soil sample B and

(3) soil sample C

Compute the total head loss with the constant head difference 300 mm and give your comment.

6. (a)



For the section of the homogeneous earth dam as given above, calculate using Arthur Casagrande's method the following: **(10)**

(i) y coordinates of the phreatic line at points A, B, C and D.

(ii) the discharge through the earth dam

(ii) the boundary flow lines and equipotential lines

(iii) draw a qualitative flow net for the earth dam using two equally spaced interval flow lines and two equally spaced interval equipotential lines.

(b) Using basic assumptions, derive equations of continuity and Laplace's equation in two dimensions for flow of water through soil. Show that both the potential function and stream function satisfy the Laplace's equation. **(13⅓)**

7. (a) A long slope of average slope angle 20° has a saturated cohesive-frictional clay of average height 4 m with saturated unit wt γ_{SAT} = 20 kN/m^3, effective cohesion C' = 25 kN/m^3 and effective functional angle ϕ' = 30°. After heavy rains water seepage occurs approximately parallel to the slope and water table is at the surface. Assuming infinite slope failure conditions determine the factor of safety of the slope with respect to (i) sliding (ii) critical height H_c (iii) cohesion. **(10)**

Contd P/4

CE 447

Contd...Q. No. 7

(b) The upstream slope of an earth embankment of height 6m was constructed at a slope angle of 70°. The saturated unit weight γ_{SAT} = 20 kN/m^3, effective cohesion C' = 25 kN/m^3 and effective friction angle ϕ' = 10° of the embankment soil. Using Taylor's method, compute factor of safety of the slope when the reservoir is full and when sudden drawdown occurs. **(13 ⅓)**

8. (a) Draw a qualitative section of a revetment. **(6)**

(b) Estimate the size of CC blocks to the placed over geotextiles for protecting the river bank slope from the erosive action of river current and waves. CC blocks will be placed in a single layer is chess pattern with geotextile filters. The data is as given below: **(17 ⅓)**

DATA

Average flow velocity = 3.0 m/s

S. G. of CC block = 2.2, Mass density of CC block = 2200 kg/m^3

Angle of repose of CC block = 35°

Ratio of water depth to that of revetment = 5

Slope of river bank (H : V) = 2 : 1

Shield's constant = 0.05

Stability factor for CC block with exposed edge ψ_{sc} = 1.25

Stability factor for incipient motion ϕ_{sw} = 2.25

Stability upgrading factor ψ_u = 2.00

Interaction coefficient b = 0.5?

Assuming normal turbulence in river, k_T = 1.0, k_n = 1.0

Wind speed = 30 m/s; Wind duration = 2.5 hours;

Strength coefficient = 5; Damage coefficient = 5.5

Fetch length = 15 km; Wave height = 2.0 m;

Wave period = 5.0 seconds; Wave breaking pavements ξ_z = 2.096

CE 447

Contd…Q. No. 8(b)

FORMULAS

$$(i)\ D = 0.034V^2\ ?\ D_n = 0.81D$$

$$(ii)\ D_n = \frac{0.7V^2}{2(S_s-1)} \times \frac{2}{\left[\log_{10}\left\{\left(6\times {}^{h}\!/_{D}\right)\right\}\right]^2} \times \frac{1}{\left\{1-\left(\dfrac{\sin\theta}{\sin\phi}\right)\right\}^{1/2}}$$

$$(iii)\ D = \frac{V^2}{36g(s_s-1)\psi_{cr}\left({}^{h}\!/_{D}\right)^{1/6}},\quad D_n = 0.81D$$

$$(iv)\ D_n = \frac{0.035V^2}{2g\Delta m}\frac{\phi_{sc}}{\psi_{cr}}\frac{K_T K_H}{K_s},\qquad Ks = \left\{1-\left(\frac{\sin\theta}{\sin\phi}\right)^2\right\}^{1/2}$$

$$\Delta_m = \frac{\rho_s-\rho_w}{\rho_w}$$

$$(v)\ D_n = \frac{H_3}{\Delta m}\left(\frac{\tan\theta}{K_D}\right)^{1/3}$$

$$(vi)\ D_n = \frac{H_s}{s_s-1}\times\frac{1}{\beta}\times\frac{E^{1/2}}{\cos\theta},\ E = \frac{1.25T}{\sqrt{H_s}}\tan\theta$$

$$(vii)\ D_n = \frac{H_s\xi_z}{\Delta m\,\psi_u\phi_{sw}\cos\theta}$$

$$(viii)\ D_n = \frac{H_s\sqrt{\xi_z}}{\Delta_m\phi_T\cos\theta},\quad \phi_T = 4.25$$

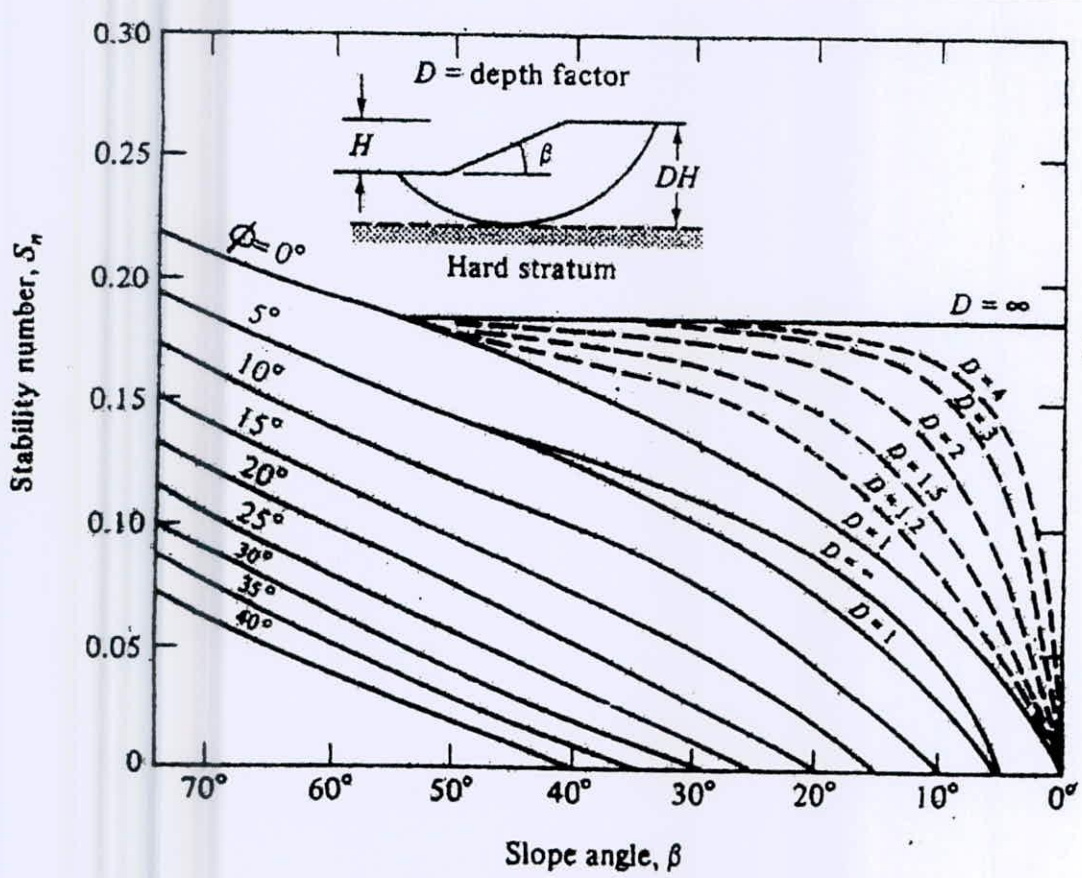


Chart 1 Taylor's Stability Chart

L-4/T-2/CE Date : 10/05/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2020-2021

Sub : **CE 455** (Transportation Engineering IV: Pavement Management, Drainage and Airport)

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

Assume any reasonable value of missing data.

1. (a) Explain Pavement Management System. Describe the Effects of Maintenance and Rehabilitation on Pavement Conditions. **(7 ⅓)**

   (b) Write short notes on: Present Serviceability Index (PSI), Present Serviceability Rating (PSR) and International Roughness Index (IRI). **(9)**

   (c) What are the three major components of Pavement Management? Briefly explain each of them. **(7)**

2. (a) State the functions of an Airport drainage system. Explain the Layout of Airport Surface drainage. **(8)**

   (b) When and where Subsurface drainage are essential? Explain with suitable figure the subsurface drainage in cut slopes, Subgrade and for Base course. **(9 ⅓)**

   (c) What are the shapes of commonly used culvert? What are the principles of culvert location? **(6)**

3. (a) The distance between the furthest point in the turf covered drainage (with an average slope of 1.5% towards the drain) and the point of entry to side drain is 250 meter. The weighted average value of the runoff co-efficient is 0.275. The length of the longitudinal open drain in a sandy clay soil from the inlet point to the cross drainage is 500 meter. The velocity of flow in the side drain may be assumed 0.525 m/s so that silting and erosion are prevented. Estimate the design quantity of flow on the side drain for a 100 years period of frequency of occurrence of the storm. Can use Fig. 1 and Fig. 2. **(9 ⅓)**

   (b) "There are three factors necessary for getting a good road: Drainage, drainage and more drainage". Explain the statement. **(6)**

   (c) Explain the mechanism of Road Surface water drainage with a figure. What are the requirements of Highway drainage system? **(8)**

4. (a) The maximum quantity of water expected in on open longitudinal drains on clayey soil is 1.10 m^3/sec. Design the X-section and longitudinal slope of Trapezoidal drain assuming the bottom width to be 1.1 meter and cross slope to be 1V: 1.5H. Allowable velocity of flow in the drain is 1.12 m/sec and Manning's roughness co-efficient is 0.022. Assume a free board = 0.15 m. **(10)**

Contd P/2

CE 455
Contd...Q.No. 4

(b) Explain the effects of drainage requirements on road geometry. **($6\frac{1}{3}$)**

(c) Describe the mechanism of damage to highways due to faulty drainage. **(7)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define airport. Briefly describe the different types of civilian airports? **(2+6)**

   (b) State the different types of airport planning studies and discuss any three of them. **(4+6)**

   (c) Schematically show how the signals transmitted by LOC and GS help to guide the pilot. **($5\frac{1}{3}$)**

6. (a) Classify parking based on aircraft maneuver with respect to the terminal building. Discuss the salient features for designing 'Holding Fix'. **(4+4)**

   (b) Explain with diagrams the different concepts for designing an airport terminal building. **(9)**

   (c) What are the various marking and lighting systems provided at airports to meet the visual requirements of pilots? **($6\frac{1}{3}$)**

7. (a) Write the functions and need of ATC. Explain how size of gate is affected by the size of aircraft and type of aircraft parking. **(4+5)**

   (b) State the factors that affect runway orientation. List and schematically show the basic forms of runway patterns/configuration. **(3+5)**

   (c) State the criteria for parallel runway numbering. Define TACAN. **($3+3\frac{1}{3}$)**

8. (a) What are the important components of an airport? What are the purposes of providing "High Speed Exit Taxiway"? **(5+4)**

   (b) Explain how wind affects orientation of runways. **($4\frac{1}{3}$)**

   (c) As per ICAO write down the color convention of runway and taxiway surface marking and lighting systems. **(10)**

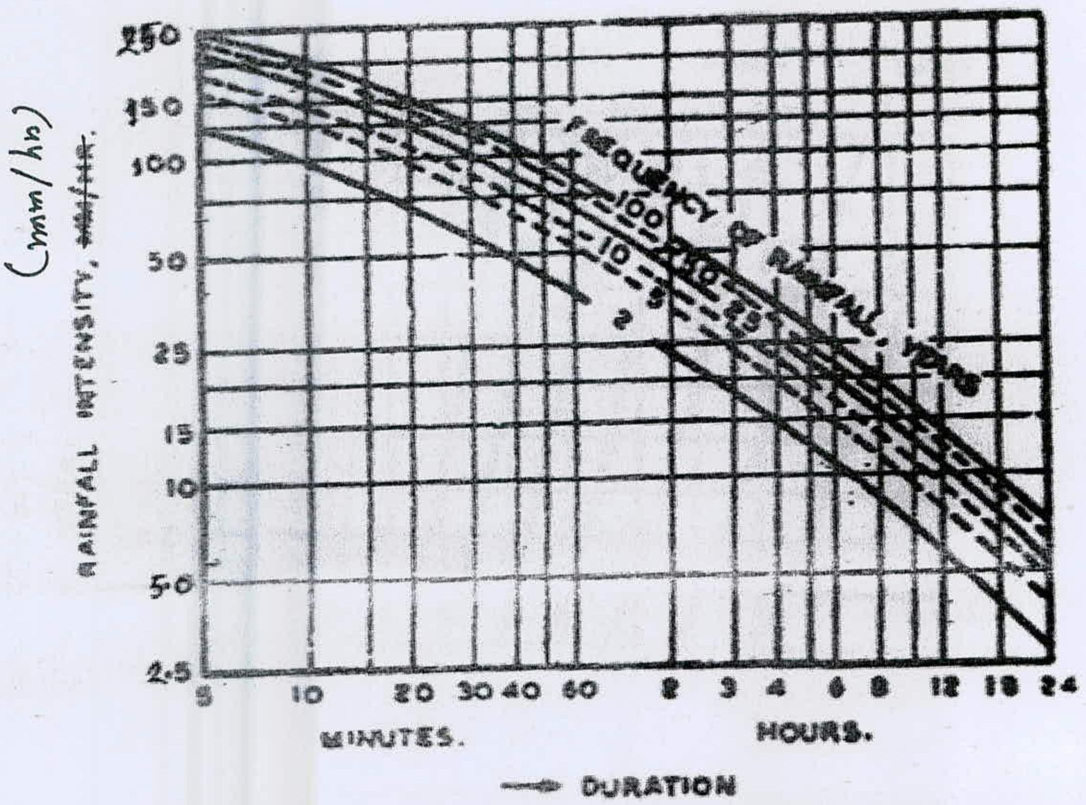


Fig. 1 Typical Rainfall Intensity Duration Curve (Q.3b)

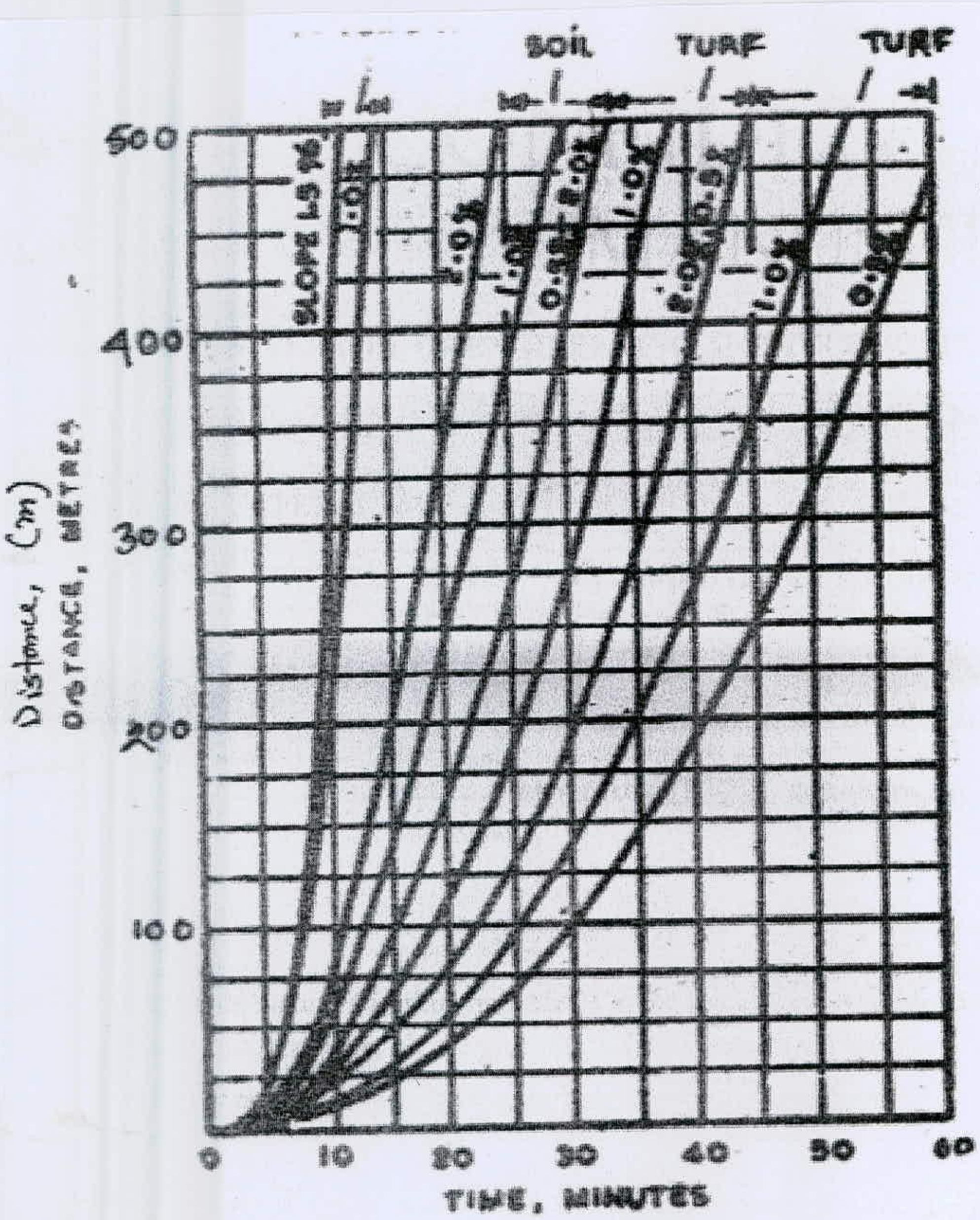


Fig. ~~11.3~~2 Time of Flow to Inlet (Q.3b)

L-4/T-2/CE **Date: 02/05/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **CE 457** (Transportation Engineering V:

Urban Transportation Planning and Management)

Full Marks: 140 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Elaborate on the statement- "Public transit often serves the purpose of a social function i.e. public service, as it provides accessibility and social equity, but with limited relationships with economic activities". Describe the components of an urban transit system with a neat sketch. **(5+10=15)**

   (b) What are the main reasons behind the lack of concern and awareness of transportation planners and traffic engineers about urban goods movement (UGM)? Identify the major public sector parties involved in the UGM process. **(5+3 $\frac{1}{3}$)**

2. (a) Explain the most difficult challenges faced by urban transit. What are the effects of rising fuel price on transit ridership? **(10+3=13)**

   (b) Write down the commonly encountered issues involving loading/ unloading of trucks in central business district (CBD) locations and discuss the strategies that may be useful to solve them.

   Mention some of the problems associated with movement of trucks in a community. **(7+3 $\frac{1}{3}$)**

3. (a) Write down the different characteristics of urban freight/goods movements compared to long haul freight movements. Why mobility of freight in urban areas is becoming increasingly problematic? **(4+6 $\frac{1}{3}$)**

   (b) What are the two fundamentally important conditions for the efficiency of transit? Write down the positive as well as possible negative consequences of the recently introduced Mass Rapid Transit line on the overall transportation system of Dhaka city and the overall economy of the country. What measures should be taken to mitigate the negative consequences? **(3+6+4=13)**

4. (a) Differentiate between truck terminals and truck stops. Briefly describe the classification of truck travel based on origin and destination of trips. **(5+5=10)**

Contd …… P/2

CE 457
Contd... Q. No. 4

(b) There alternative urban mass transit projects have been proposed to increase mobility along a corridor. The following Table 1 shows the initial construction costs, annual maintenance and operating costs, useful live and the salvage values for each alternative. Assume a discount rate of 8% and determine the preferred alternative based on the appropriate economic criteria. **($13\frac{1}{3}$)**

Table 1: Costs and Benefits of different alternatives

Alternative	Capital Costs ($)	Annual Maintenance ($)	Annual User Cost ($)	Useful Life (Years)	Salvage Value ($)
I	45,000	11,000	401,000	10	14,000
II	135,000	9,000	350,000	12	11,000
III	255,000	8,000	400,000	15	5,000

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Distinguish between Robert Moses and Jane Jacobs' legacies in Urban Planning Approaches. Explain the statement - 'Transportation is an important sector of the economy in its own right'. **(4+4=8)**

(b) Write the main disadvantage of choice-based sampling and how it can be eliminated in context of urban transportation planning. Explain the system approach of Transportation planning with flow diagram. **($3+4\frac{1}{3}$)**

(c) Define Hazardous Road Location (HRL) program and its goals. Differentiate between Severity Level and Casualty Class related to accident studies. **(4+4=8)**

6. (a) "Improvement of road safety is a multi-disciplinary task and does not occur by itself' - discuss why? State the sources of accident data and the common core items related to accident recording system. **($5+6\frac{1}{3}$)**

(b) Write short note on (i) Cross classification method of trip generation (ii) Multiple linear Regression analysis of trip generation. **(7)**

(c) A zone has 275 households with car and 275 households without car and let the average trip generation rates for each groups is respectively 5.0 and 2.5 trips per day. Assuming that in the future, all household will have a car, find the growth factor and future trips from that zone, assuming that the population and income remains constant. **(5)**

Contd P/3

CE 457

7. (a) Discuss multinomial logit independence of irrelevant alternatives. Draw a qualitative diagram showing model specification error and exogenous forecast error as a function of model detail. **$(4+3\frac{1}{3})$**

(b) Differentiate between Accident prevention and Accident reduction. Write down the generalized road safety strategies. **(4+5=9)**

(c) A binary logit model can be used to describe the mode choice of a community between private automobile and bus utilization. A survey of travelers in the community regarding their travel experiences yielded the following data: **(7)**

Factor	Model Parameter	Private Automobile	Bus
Waiting Time (min)	X_1	0	10
Travel Time (min)	X_2	20	35
Parking Time (min)	X_3	5	0
Out-of-pocket Cost (Tk.)	X_4	225	100
Calibration Constant	A_k	0	-0.27

Theory calibrated utility function for both modes has the following structure:

$$U_k = A_k - 0.10X_1 - 0.13X_2 - 0.12X_3 - 0.0045X_4$$

(i) According to the survey data, what is the current mode split between private automobiles and buses?

(ii) In the following year, due to increased levels of congestion, travel time for both modes increased by 10 minutes and the parking time for private automobile users increased by 5 minutes. Determine the new mode split.

8. (a) Define 'Sustainable Transportation'. Which modes of transportation are said to be sustainable for Dhaka City and why? **(3+4=7)**

(b) Explain Haddon Matrix and Collision Diagram and their use in mitigating road safety problem. **(7)**

(c) Assign the vehicle trips shown in the following O-D trip table to the network, using the all-or-nothing assignment technique. To summarize your results, list all of the links in the network and their corresponding traffic volume after loading. **$(9\frac{1}{3})$**

Origin - Destination Trip Table

	Trips between Zones				
From/to	**1**	**2**	**3**	**4**	**5**
1	-	100	100	200	150
2	400	-	200	100	500
3	200	100	-	100	150
4	250	150	300	-	400
5	200	100	50	350	-

Highway Network: