L-4/T-2/CE Date: ~~27/04/2024~~ 18/05/2024

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2021-2022

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

Full Marks: 210 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** questions.

(Assume reasonable values for any missing data)

1. The Government of Bangladesh is implementing the Bus Rapid Transit (BRT) project for the Airport-Gazipur route under the Greater Dhaka Sustainable Urban Transport Project (GDSUTP), with the Ministry of Road Transport and Bridges as the implementing agency and financial support from the Asian Development Bank (ADB). The proposed BRT route spans 20 kilometers from the Dhaka International Airport to Gazipur, as depicted in Figure 1, aiming to develop a sustainable urban transport system in the Dhaka North City Corporation (DNCC) and Gazipur City Corporation (GCC) areas.

   Acquisition of private land and relocation of commercial vendors are necessary for the project, totaling 4.20 acres, of which 2.133 acres are private land whereas the remaining land is government land belonging to different government departments/entities. This process adheres to the Government Acquisition and Requisition of Immovable Property Ordinance 1982 (ARIPO) and ADB Safeguards Policy Statement. A survey indicates 1,535 households with 7,214 affected persons (APs) by the project, who will be compensated based on the Government of Bangladesh regulations and the ADB Safeguards Policy Statement (SPS-2009) following a detailed land acquisition and resettlement action plan study during the project's feasibility study phase.

   Answer the following questions related to the scenario mentioned for land acquisition and resettlement of the BRT project.

   (a) Suppose you are asked to identify relevant social and economic factors that should be considered 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) Propose a Resettlement policy framework for this project considering relevant Government of Bangladesh (GOB) legislation on land acquisition and Co-financier Safeguard Policies. **(20)**

2. (a) Suppose you are tasked with collecting baseline data for developing a land acquisition and resettlement action plan for the BRT project mentioned in **Question 1.** Propose baseline survey data collection methods for this project, outlining the different data you will be collecting, methods for data collection, and objectives for those data collection. **(20)**

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(b) It has been proven that a participatory approach is the most effective for addressing socio-economic issues arising from land acquisition and resettlement. How can you ensure the participatory approach for the BRT project? Your response should include your approach, methods for data collection, and how these will be incorporated into your study design and project implementation. **(15)**

3. Suppose you are tasked with proposing feasible mitigation measures for minimizing the negative impacts associated with land acquisition, relocation, and resettlement for the BRT project, described in **question 1.** Answer the following questions related to your 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 BRT project? **(15)**

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

4. One key goal of implementing various development projects by the Government of Bangladesh is to advance the realization of Sustainable Development Goals (SDGs) by 20230.

   (a) Using the Sustainable Development Goals (SDGs) framework outlined in **Table 1,** analyze the potential impact of the BRT project, described in **question 1,** 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)**

   (b) "Sound development plans require good projects; just as good projects require sound planning." What are the important considerations to be taken into account for designing a development project that could enhance sustainable development? **(15)**

SECTION – B

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

(Assume reasonable values for missing data, if any)

5. (a) Determine the Gender Development Index (GDI) for Bangladesh. Also, classify Bangladesh according to the absolute deviation from gender parity in HDI values and comment on the extent of equality in HDI achievements between women and men. Use the data provided in the following table (Table 2). **(15)**

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Table 2: Relevant Data for calculating the GDI

Name of the Country: Bangladesh				
Name of the Indicator	Female Value	Male Value	Minimum	Maximum
Life Expectancy at Birth (years)	74.3	70.6	20	85
Expected Years of Schooling (years)	13.0	11.9	0	18
Mean Years of Schooling (years)	6.8	8.0	0	15
Estimated Earned Income per Capita (2017 PPP $)	2,811	8,176	100	75,000

(b) In light of the spillover effect, explain how the apparent success of advanced countries in SDG attainment is worsening the sustainability challenges of lagging countries like Bangladesh. Also, justify the effectiveness of social safety net programs in reducing poverty and inequality in Bangladesh. **(20)**

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

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

7. (a) What are the advantages and features of the Social Impact Assessment (SIA) process? **(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 difficulties in conducting socio-economic assessments in developing countries? Explain with examples. **(20)**

   (b) Why is the Bangladesh Delta Plan 2100 deemed essential for the country's sustainable development and resilience to climate change? Also, explain the role of civil engineers in the priority investment areas of BDP 2100. **(15)**

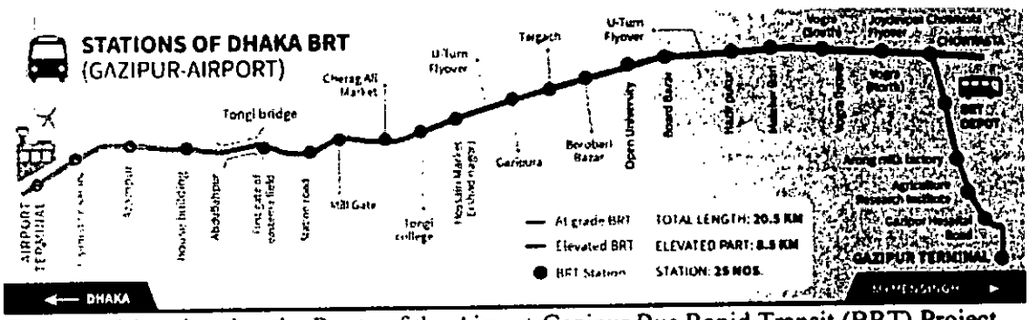

Figure 1: Map showing the Route of the Airport-Gazipur Bus Rapid Transit (BRT) Project

Table 1: 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-2/CE **Date : 24/03/2024**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2021-2022

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 composite floor system consists of formed steel deck of the type shown in Fig. 1. The beams are W21x73, and the composite deck has a total thickness of 5 in. from top of slab to bottom of deck. The effective slab width is 90 in., and the span length is 30 ft. Compute the nominal flexural strength with one 0.75 in diameter and 3.5 in long studs per rib. Use AISC-LRFD method. **(20)**

   Assume: $R_p = 0.6$, $R_g = 0.85$, and $F_u = 65$ ksi for stud 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.

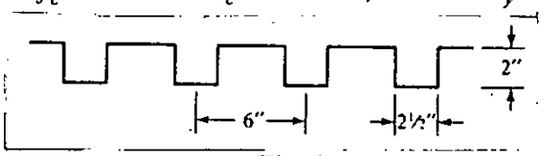

Fig. 1

   (b) Briefly describe the stages of construction to be considered during the design of composite beams in unshored construction method. **(3 1/3)**

2. (a) An interior slab panel of a composite floor is shown in Fig. 2. Determine the number and placement of 1.0 inch diameter stud type shear connectors for main beam MB (W21x57) shown in Fig.2, to develop the design moment capacity of the beam under full composite action. Show the detailing in a neat sketch. (Use AISC-ASD method). Consider shear connections between main beam and column. **(13)**

   Assume: $R_p = 0.75$, $R_g = 1.0$, and $F_u = 65$ ksi for stud shear connectors.

   Given: For concrete $f_c' = 4\,ksi$ and $E_c = 3600\,ksi$; for steel $F_y = 50\,ksi$ and $E_s = 29000\,ksi$.

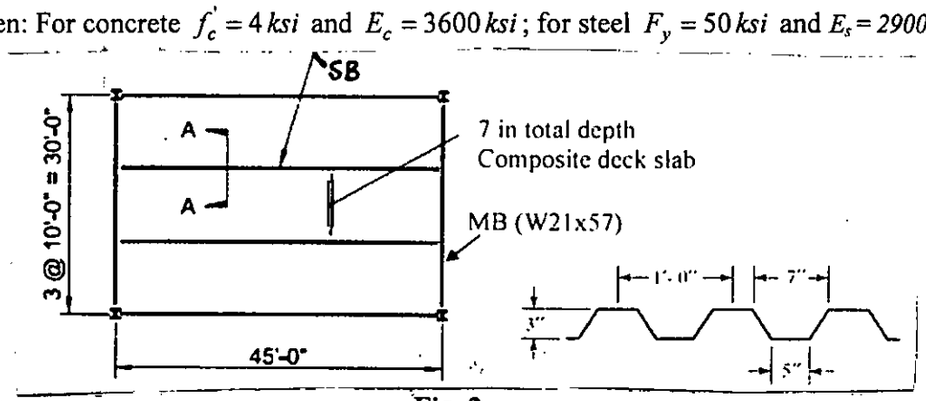

Fig. 2

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(b) Determine the design flexural strength of this beam for full composite interaction (use AISC-ASD method). **(10 1/3)**

3. (a) A composite floor system consists of 36 ft long, W18x97 secondary floor beams spaced at 7.5 ft center-to-center and supporting a 6 in. thick solid reinforced concrete floor slab. In addition to the sellf-weight of the beam and slab, there is a construction live load of 20 psf, a partition wall load of 40 psf, a floor finish of 30 psf and a service live load of 120 psf. The beam is designed with partial shear connections with 0.75 in. diameter stud connectors spaced at 12 in. c/c along the beam span. Check the design adequacy of this beam for both serviceability and ultimate limit conditions. Use AISC-LRFD method. Consider shored construction method. **(20)**

Assume: $R_p = 0.75$, $R_g = 1.0$, and $F_u = 65$ ksi for stud shear connectors.

Given: For concrete $f_c^{'} = 4\,ksi$ and $E_c = 3600\,ksi$; for steel $F_y = 50\,ksi$ and $E_s = 29000\,ksi$.

(b) Why shear connectors are required in composite floor system? **(3 1/3)**

4. (a) Calculate the service load flexural stresses in concrete and steel of the composite beam shown in Fig. 3 for unshored construction. This is an interior beam with a simply supported span of 28 ft and c/c spacing of the beam is 6 ft. 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; 0.50 k/ft for partition walls and 1.25 k/ft for floor live load. Consider the beam to be a partially composite beam with 80% composite action between steel and concrete. **(20)**

Given: For concrete $f_c^{'} = 4\,ksi$ and $E_c = 3600\,ksi$; for steel $F_y = 50\,ksi$ and $E_s = 29000\,ksi$.

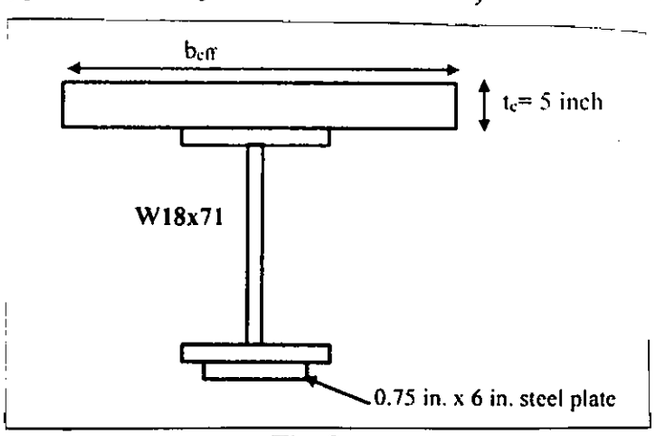

Fig. 3

(b) Show the flexural stress distribution across the depth of the beam for pre-composite and composite stages of construction. **(3 1/3)**

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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) What is a Partially Encased Composite (PEC) column? Differentiate between the two types of PEC columns commonly used. **(8)**

(b) A Partially Encased Composite (PEC) column is shown in Figure 4.

(i) Check the material and geometric properties of the given PEC column with the code-specified limits.

(ii) Determine the nominal axial compression capacity of the column.

Given f_y = 350 MPa; $f_c' = 35\,\text{MPa}$; E_s = 200 GPa; E_c = 24 GPa and effective column length = 14 ft. **(15 1/3)**

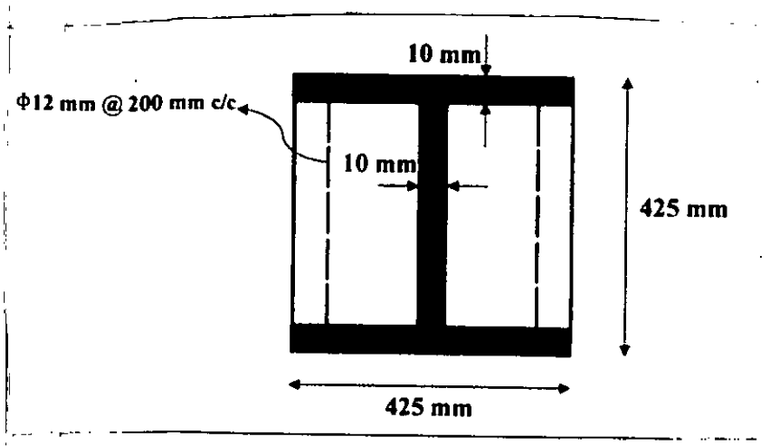

Figure 4

6. (a) A Concrete Filled Tubular (CFT) column section is shown in Figure 5. Check whether the geometric and material properties of the given section satisfy the limits specified by the AISC code. **(8)**

Given f_y = 50 ksi; f_c' = 5 ksi; E_s = 29,000 ksi; E_c = 3600 ksi.

(b) Determine the design axial capacity in compression and tension of the given CFT section. Consider the effective length of the column to be 18 ft. Use AISC-LRFD method. **(15 1/3)**

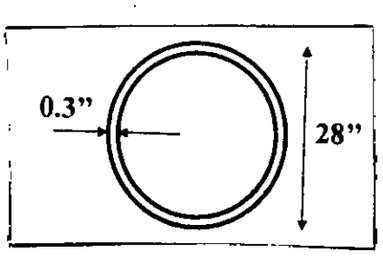

Figure 5

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7. (a) The composite compression member shown in Figure 6 only has lateral support at mid-height in the weak direction and a concrete cover of 2.5 inches to the center of the longitudinal reinforcement. Using basic principles, calculate the nominal axial load and bending moment for the five points (according to AISC 2010) in the P-M interaction diagram about the weak axis bending of the Fully Encased Composite (EFC) column. Show the diagram in a neat sketch. Follow the AISC-LRFD method. **(17 1/3)**

Given: $F_y = F_{yr} = 60$ ksi; $f_c' = 8$ ksi, $E_s = 29000$ ksi and $E_c = 3600$ ksi.

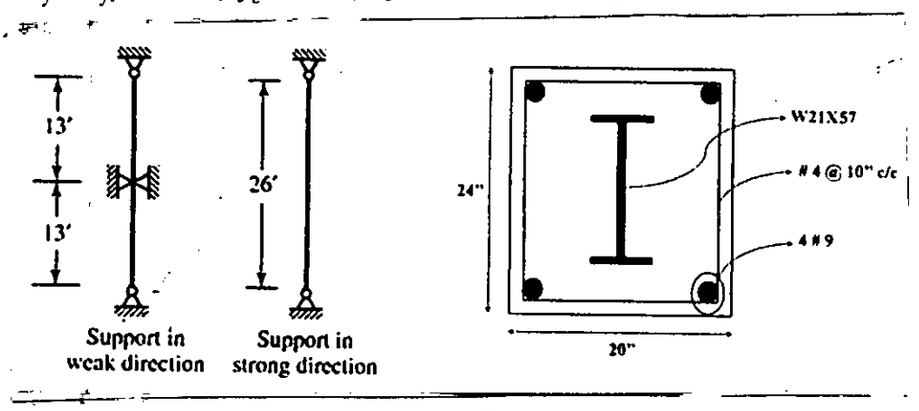


Figure 6

(b) Calculate and draw the design P-M interaction diagram for the above FEC column, including the global slenderness effect. Use AISC-LRFD method. **(8)**

8. (a) For the Concrete Filled Tabular (CFT) column section shown in Figure 7, check the design adequacy for a factored axial compressive load of 440 kips and a factored bending moment of 770 kips-ft about the weak axis using both the AISC interaction equation and simplified plastic stress distribution method. Consider the effective length of the column to be 15 ft. Use the AISC-LRFD method. **(15 1/3)**

Given: $f_y = 50$ ksi; $f_c' = 3.5$ ksi; $E_s = 29{,}000$ ksi and $E_c = 3600$ ksi.

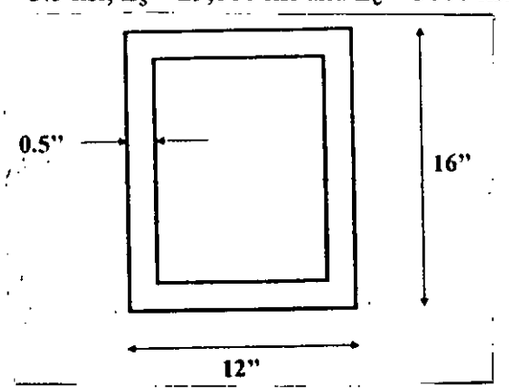


Figure 7

(b) Provide comments on the adequacy check for both methods. Slenderness effects must be considered. Follow the AISC-LRFD method. **(8)**

ANNEXURE

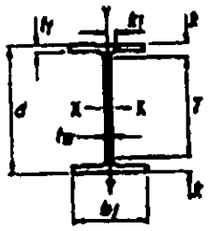


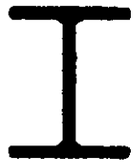
Table 1–1 (continued)
W Shapes
Dimensions

Shape	Area, A	Depth, d		Web Thickness, t_w		$\frac{t_w}{2}$	Flange Width, b_f		Flange Thickness, t_f		Distance k		k_1	T	Work-able 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 7/16	13/16	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	1/8		
×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	1/8		
×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 3/16	1/8		
×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	1/16		
×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 1/16	1/16		
×48[c,d]	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	1/16		
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 1/16	13/16	18 1/8	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 1/16	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[b]	91.8	22.3	22 3/8	1.52	1 1/2	3/4	12.0	12	2.74	2 3/4	3.24	3 1/16	1 3/8	15 1/2	5 1/2
×283[b]	83.8	21.9	21 7/8	1.40	1 3/8	11/16	11.9	11 7/8	2.59	2 1/2	3.00	2 15/16	1 5/16		
×258[b]	75.9	21.5	21 1/2	1.28	1 1/4	5/8	11.8	11 7/8	2.30	2 5/16	2.70	3	1 1/4		
×234[b]	68.8	21.1	21	1.16	1 1/16	9/16	11.7	11 7/8	2.11	2 1/8	2.51	2 1/4	1 3/16		
×211	62.1	20.7	20 5/8	1.06	1 1/16	9/16	11.8	11 1/2	1.91	1 15/16	2.31	2 5/16	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 1/16	1 1/8		
×175	51.3	20.0	20	0.890	7/8	7/16	11.4	11 3/8	1.59	1 5/8	1.99	2 1/16	1 1/16	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	1 1/16		
×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	1 15/16	1 1/16		
×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	1 13/16	1 1/16		
×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 13/16	1 1/16		
×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 1/16		
×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 1/4	1 1/16		
×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 1/16	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	1.06	1 1/16	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
×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 1/16	1 1/16		
×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 1/16	1 1/16		
×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 1/16		
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	1 1/16	15 1/2	3 1/2
×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 5/16	1 1/16		
×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		

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

ANNEXURE

Table 1–1 (continued)
W Shapes
Properties



W21 – W16

Nominal Wt.	Compact Section Criteria		Axis X-X				Axis Y-Y				r_T	A_s	Torsional Properties	
	$\frac{b}{2t}$	$\frac{h}{t_w}$	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	35.4	1830	171	8.67	196	81.4	19.5	1.83	30.5	2.21	20.6	4.34	8530
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	6780
62	6.70	46.9	1330	127	8.54	144	57.5	14.0	1.77	21.7	2.15	20.4	1.83	5980
55	7.87	50.0	1140	110	8.40	125	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	3960
57	5.04	46.3	1170	111	8.36	129	30.6	9.35	1.35	14.8	1.88	20.4	1.77	3190
50	6.10	49.4	984	94.5	8.18	110	24.9	7.64	1.30	12.2	1.84	20.3	1.14	2570
44	7.22	53.6	843	81.6	8.08	95.4	20.7	6.37	1.26	10.2	1.80	20.2	0.770	2110
311	2.19	10.4	6970	624	8.72	754	785	132	2.95	207	3.53	19.8	176	76200
283	2.36	11.3	6170	555	8.61	675	704	118	2.91	185	3.47	19.4	134	65800
258	2.58	12.5	5510	514	8.53	611	628	107	2.88	168	3.42	19.2	103	57600
234	2.76	13.8	4900	466	8.44	549	568	95.8	2.86	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	59.6	43400
192	3.27	16.7	3870	380	8.28	442	440	78.6	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
156	3.88	19.8	3090	310	8.12	358	347	61.4	2.74	94.8	3.20	18.3	25.2	29000
143	4.25	22.0	2780	282	8.09	322	311	55.5	2.72	85.4	3.17	18.2	19.2	25700
130	4.65	23.9	2480	256	8.03	290	278	49.8	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	10.8	20000
106	5.95	27.2	1910	204	7.84	230	220	39.4	2.68	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	13800
76	8.11	37.8	1330	146	7.73	163	152	27.8	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	2.06	17.7	3.49	4700
65	5.09	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	17.6	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	7.36	101	40.1	10.7	1.65	16.6	1.98	17.4	1.24	3040
48	5.01	44.8	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	7.08	53.5	510	57.6	7.04	66.5	15.3	5.12	1.22	8.05	1.52	17.3	0.506	1140

ANNEXURE

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	$\frac{0.09E}{F_y}$	$\frac{0.31E}{F_y}$	$\frac{0.31E}{F_y}$

ANNEXURE

(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

(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 11.1a

P_p is determined from Equation 12-9b

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

(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

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

ANNEXURE

The effective stiffness of the composite section, EI_{eff}, for all sections

$$EI_{eff} = E_s I_s + E_s I_{sr} + C_3 E_c I_c$$

where

C_3 = coefficient for calculation of effective rigidity of filled composite compression member

$$= 0.6 + 2\left[\frac{A_s}{A_c + A_s}\right] \leq 0.9$$

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

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

For FEC Columns:

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

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

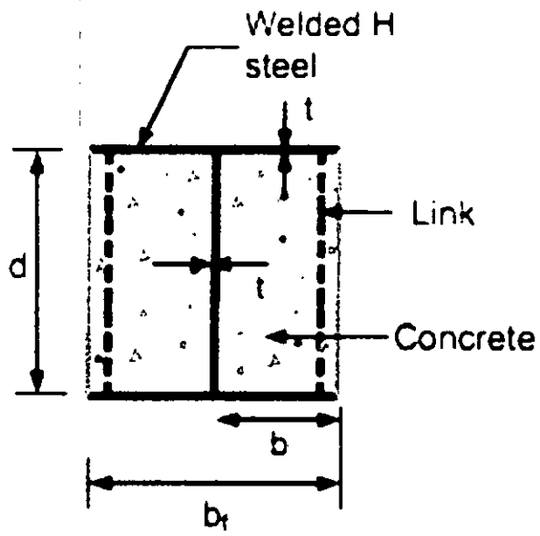
$$C_1 = 0.1 + 2\left(\frac{A_s}{A_c + A_s}\right) \leq 0.3$$

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

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

ANNEXURE

For PEC Columns with Non-compact Sections:



$$C_r = \left(A_{se}F_y + 0.85A_c f_{cd} + A_{sr}F_{yr}\right)$$

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

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

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

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

AISC 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-2/CE Date: ~~05/05/2024~~ 26/5/24

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2021-2022

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

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** questions.

---

1. (a) What are the problems of indiscriminate dumping of solid wastes in and around cities of low-income countries? State the main features of various landfill development levels in developing countries. **(10)**

   (b) What is "sanitary landfill" ? State the considerations in planning of a sanitary landfill. **($7\frac{1}{3}$)**

   (c) Calculate the required landfill capacity for a community for the year 2040 from the following data: **(6)**

   Projected population in 2040 = 12,50,000

   Per capita generation rate = 5.6 lb/cap/d

   Diversion fraction = 0.25

   Compacted waste density = 42.3 lb/ ft^3

   Assume a soil daily cover is used that accounts for 18% of the landfill volume.

   Also determine the area requirement for the depositing waste considering an average depth of 35 ft.

2. (a) List the area exclusion criteria for choosing a site of a sanitary landfill. **($8\frac{1}{3}$)**

   (b) Define leachate. Draw the typical concentration profile of leachate constituents and explain it. **(7)**

   (c) What are the common methods of estimating the quantity of leachate generated in a landfill ? **(8)**

   Estimate the percolation of leachate through a landfill 12 m deep, with a 0.75 m cover of silty clay for the following data :

   Precipitation = 2250 mm/year

   Runoff coefficient = 0.34

   Evapotranspiration = 650 mm/year

   Silty clay field capacity = 380 mm/m

   Field capacity of solid wastes = 290 mm/m

   Assume further that the soil cover has a moisture content of 340mm/m when applied, and that the incoming waste has a moisture content of 175mm/m.

Contd P/2

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3. (a) What are the 6 R's of waste management? List the responsibilities of domestic waste generators and users as per SWMR 2021 of Bangladesh. **($6\frac{1}{3}$)**

   (b) What are the important factors in the design of a leachate treatment system? Summarise the leachate treatment options. **(9)**

   (c) Draw a Fig. showing idealistic development of landfill gases. Estimate the theoretical volume of methane and carbon dioxide gases that would be expected from the anaerobic digestion of 10 ton of solid wastes having the composition $C_{43}H_{87}O_{36}N_2$. Density of CH_4 gas at STP = 0.7167 kg/m^3 and density of CO_2 gas at STP = 1.9783 kg/m^3. **(8)**

4. (a) Draw the pathways of human exposure to hazardous wastes. List the major problems of hazardous wastes management in developing countries. **(9)**

   (b) What are the advantages, disadvantages and limitations of chemical and thermal treatment processes of hazardous wastes ? **(7)**

   (c) What are the main sources of infectious or contaminated wastes in the hospitals? State the standard for deep burial of hospital wastes. **($7\frac{1}{3}$)**

SECTION – B

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

Q. # 5		MARKS
a)	"Use of volatile solids content as a measure of the biodegradability of Municipal Solid Waste may not be the most appropriate approach" – Justify this statement in light of modified approach in assessing the biodegradable fraction in MSW. Also, provide proof with example using the mathematical expression for biodegradability.	9

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b)	Because of a difference of opinion among city staff members, you have been retained as an outside consultant to evaluate the collection operation of Dhaka North City Corporation. The basic question centers around selection between Conventional HCS and Exchange Mode HCS. Following data were collected by your team. Based on these information, you need to suggest which of the two systems will enable the DNCC to provide better service. i) The average time spent driving from yard to the first container is 15 min, and no off-route activities occur. ii) The average pick-up time per container is 4 min. iii) The average time to drive between containers is 10 min. iv) The average time required to empty the container at the disposal site is 6 min. v) The average round-trip distance to the disposal site is 12 miles/trip, and the haul equation ($a + bx$) constants are a = 0.004 h/trip and b = 0.015 hr/mile. vi) The time required to redeposit a container after it has been emptied is 6 min. vii) The average time spent driving from the last container to the corporation yard is 20 min, and no off-route activities occur. viii) The collectors spent 10% of the 8hr workday on off-route activities.	$14\frac{1}{3}$

Q. = 6		
a)	Describe the different types of Transfer Stations with appropriate diagrams.	9
b)	Determine the chemical composition of the organic fraction of the Municipal Solid Waste, with or without sulfur and with or without water, with the composition shown in the following Table.	$14\frac{1}{3}$

Component	Food Waste	Plastic	Yard Waste	Tin	Ash
Wt. in lb.	135	25	32	3.0	5.0
Moisture (%)	70	2	60	3	6

Q. = 7		
a)	Draw the flow diagrams for separation of the source-separated (a) mixed papers, (b) comingled plastics & glasses and (c) aluminum and tin cans at an MRF.	9
b)	A cannery receives on a given day 15 tons of raw produce, 5 tons of cans, 0.5 tons of cartons, and 0.3 tons of miscellaneous materials. Of the 15 tons of raw produce, 12 tons become processed product, 2.2 tons end up as produce waste, which is fed to cattle, and the remainder is discharged with the wastewater from the plant. Four tons of cans are stored internally for future use, and the remainder is used to package the product. About 5 percent of cans used are damaged. Stored separately, the damaged cans are recycled. The cartons are used for packaging the canned product, except for 5 percent that are damaged and subsequently separated for recycling. Of the miscellaneous materials, 25 percent is stored internally for future use; 50 percent becomes waste paper, of which 35 percent is separated for recycling with the remainder being discharged as mixed waste; and 25 percent becomes a mixer of solid waste materials. Assume the materials separated for recycling and disposal are collected daily. Prepare a materials balance for the cannery on this day and a materials flow diagram accounting for all of the materials. Also determine the amount of waste per ton of product.	$14\frac{1}{3}$

Contd P/4

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Q. # 8		
a)	What is the relationship between intrinsic permeability and the hydraulic conductivity of compacted solid waste in a landfill? Are the intrinsic permeability values in the horizontal and vertical direction of a compacted landfill similar? If not, why? How do the intrinsic permeability values in both directions control the design of protection measures against leachate movement?	9
b)	The following average speeds (y) were obtained for various round-trip distances (x) to a disposal site. Using the graphical method to find the haul speed constants a and b for the haul speed equation represented by a rectangular hyperbola; $$y = \frac{x}{a + bx}$$	$14\frac{1}{3}$

Also, find the round-trip haul time for a site that is located 21 km away.

Round-trip Distance x (km)	Average Haul Speed y (kph)
3.2	27.4
8.0	45.1
12.9	51.5
19.3	57.9
25.7	64.4
32.2	67.6
40.2	72.4

Typical data on the ultimate analysis of the combustile components in residential MSW[a]

	Percent by weight (dry basis)					
Component	**Carbon**	**Hydrogen**	**Oxygen**	**Nitrogen**	**Sulfur**	**Ash**
Organic						
Food wastes	48.0	6.4	37.6	2.6	0.4	5.0
Paper	43.5	6.0	44.0	0.3	0.2	6.0
Cardboard	44.0	5.9	44.6	0.3	0.2	5.0
Plastics	60.0	7.2	22.8	–	–	10.0
Textiles	55.0	6.6	31.2	4.6	0.15	2.5
Rubber	78.0	10.0	–	2.0	–	10.0
Leather	60.0	8.0	11.6	10.0	0.4	10.0
Yard wastes	47.8	6.0	38.0	3.4	0.3	4.5
Wood	49.5	6.0	42.7	0.2	0.1	1.5
Inorganic						
Glass[b]	0.5	0.1	0.4	0.1	–	98.9
Metals[b]	4.5	0.6	4.3	0.1	–	90.5
Dirt, ash, etc	26.3	3.0	2.0	0.5	0.2	68.0

Table for Q 6 (b)

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L-4/T-2/CE Date: ~~05/05/2024~~

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2021-2022

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

Full Marks: 140 Time: 3 Hours

The figures in the margin indicate full marks.

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** questions.

Assume reasonable values for missing parameters.

Q # 1

(a) What do you understand by "criteria" pollutants? Why is an averaging period assigned to air quality standards of pollutants? Explain. The Air Quality Index (AQI) corresponding to SO_2 (24-hr) concentration on a particular day is 220. Determine the SO_2 (24-hr) concentration in $\mu g/m^3$. A "table" for calculation AQI is provided [Given: Temperature = 25 °C, P = 1 atm]. **9**

(b) How do catalytic converters help reduce automotive emissions? Explain. How does the air/fuel ratio affect the performance of a catalytic converter? Explain with an appropriate figure. **7**

(c) What are halocarbons? How do the halocarbons differ with respect to their effects on global warming and the stratospheric ozone layer? Explain. **7½**
How do tropospheric ozone and stratospheric ozone affect global warming? Explain.

Q # 2

(a) A power plant emits 175 g/sec of SO_2 through a stack with an effective height of 50 m. The wind speed is 2.8 m/sec (at 10 m height), and the atmosphere is "slightly unstable." Estimate: (i) ground level concentration of SO_2 at 1.75 km downwind along the center-line of the plume; and (ii) SO_2 concentration at the top of a 30 m high building located 1.75 km downwind and 0.75 km off the centerline of the plume. **10**

[Given: p = 0.20; Table for calculation of dispersion coefficient provided]

(b) What do you understand by short-lived climate pollutants (SLCP)? Why are they called "short-lived"? What are the adverse impacts of the SLCPs? **7**

(c) What are "coarse," "fine," and "ultrafine" particulate matters? Why are the PM of anthropogenic origin considered more harmful than the PM of natural origin? Explain. **6½**

Q # 3

(a) What do you understand by stoichiometric ratio, rich mixture and lean mixture? **9**
With an appropriate figure, explain the effects of air/fuel ratio on automotive emissions of HC, CO, and NO_x. Is it possible to reduce emissions of these three pollutants simultaneously by adjusting the air/fuel ratio? Explain.

(b) What do you understand by stable, unstable, and neutral atmosphere? What are "ambient" and "adiabatic" lapse rates? Define atmospheric stability in terms of ambient and adiabatic lapse rates. **8**
Determine the nature of atmospheric stability for each of the following situations of ambient atmosphere:
(i) $dT/dz = 0$; (ii) $dT/dz = \Gamma$; (iii) $dT/dz = -1.5\Gamma$

(c) Identify five primary indicators of climate change. What do you understand by the "Global Warming Potential (GWP)" of a greenhouse gas? For methane, 20-year and 100-yr GWP are 62 and 23, respectively. Why does the GWP for methane decrease over a longer time period? Explain. **6½**

Contd P/2

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Q # 4

(a) In the context of air quality modeling, what do you understand by a "line source"? Give examples. **10**

On a long and straight section of a highway, 500 vehicles pass a given spot per hour. Each vehicle, on average, emits 14.7 g/km of carbon monoxide (CO). Wind speed is 2.2 m/sec perpendicular to the highway. Estimate CO concentrations at ground level and the roof of a 30 m high building located 200 m down-wind of the road. Consider the atmosphere to be "neutral".

[Note: Table for calculation of dispersion coefficient provided]

(b) What are the adverse effects of tropospheric ozone? How do hydrocarbons affect the NO-NO_2-O_3 photochemical reaction sequence, and help produce O_3 and other secondary pollutants? Explain with appropriate equations. **7**

(c) In Bangladesh, what are the major sources of lead in the air?
How does carbon monoxide affect the oxygen-carrying capacity of blood? Explain. **6½**

Table for calculation of AQI [for Question No. 4(a)]

Breakpoints							AQI
O_3 (ppm) 8-hr	O_3(ppm) 1-hr (i)	$PM_{2.5}$ (µg/m³) 24-hr	PM_{10} (µg/m³) 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 1(a) and 3(a)]

Stability	a	$x \le 1$ km			$x \ge 1$ km		
		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.

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

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

Contd P/3

CE 435

SECTION – B

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

Assume reasonable values for any missing data.

No.	Questions	Marks
5.	a) Discuss the sources of thermal pollution in a river. What are the major problems associated with thermal discharge in a river?	5
	b) How does productivity level of a lake affect its DO level during Summer and Winter stratification? Explain with neat sketches.	5
	c) With neat sketch show the effect of retardation on contaminant flow in groundwater.	3+10½
	A cubic meter of a gravel-and-sand aquifer has been contaminated with 20 L of tetrachloroethylene. The amount of tetrachloroethylene dissolved in aquifer water is 20 percent of its aqueous solubility. i) How much tetrachloroethylene is dissolved? ii) How much remains as undissolved DNAPL mass? iii) If the aquifer has a gradient of 0.001, use porosity and hydraulic conductivity data for gravel-and-sand aquifers to estimate the average linear velocity of the groundwater. iv) How long would it take to remove the tetrachloroethylene? Specific gravity of tetrachloroethylene is 1.63 and solubility is 150 mg/L.	

No.	Questions	Marks
6.	a) Water from a tubewell contains 150 ppb of arsenic and 5 mg/L of iron. Identify a treatment method that can remove arsenic from this water. Explain the reason for selecting the method along with the basic principle of the method.	5
	b) Suppose the only source of BOD in a river is untreated wastewater discharged from a food processing plant. The resulting oxygen sag curve has a minimum value of DO, somewhere downstream, equal to 3.0 mg/L. Just below the discharge point, the DO of the stream is equal to the saturation value of 10.0 mg/L. i) If the stream flows at 90 km per day, has a reaeration coefficient equal to 0.80/day, and has a deoxygenation coefficient of 0.20/day, how far downstream (kms) would the lowest DO occur? ii) A treatment plant is to be installed to treat the wastewater. By what percent should the BOD of the wastewater be reduced to assure a healthy stream with at least 5.0 mg/L of DO everywhere? iii) What would be the maximum allowable ultimate BOD of wastewater to ensure minimum DO does not fall below 5.0 mg/L? The flow of the river is 1 m^3/s and the wastewater is 0.2 m^3/s. Assume ultimate BOD of the river upstream of the discharge point to be negligible. iv) Sketch the oxygen sag curve before and after the installation of the treatment plant recommended in (ii), labeling critical points (location and value). Assume complete and instantaneous mixing of sewage and river water.	18½

Contd P/4

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No.	Questions	Marks
7.	a) Briefly explain the role of "reduction" and "phosphate" in arsenic mobilization.	5
	b) With neat sketches describe the effect of temperature and NBOD on DO sag curve.	5
	c) Differentiate between oligotrophic and eutrophic lake.	3+10½
	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. An untreated municipal sewer pipe discharges wastewater with phosphorus concentration of 15 mg/L into the lake at a flow rate of 0.4 m^3/s. 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) A treatment plant is being installed to remove phosphorus from the wastewater. After the installation of the plant, phosphorus concentration of the effluent discharging into the lake comes down to 1 mg/L. Is this treatment plant capable of keeping the concentration of phosphorus in the lake below 0.01 mg/L?	
	iii) If the treatment plant mentioned in (ii) fails to keep the phosphorous concentration within 0.01 mg/L, what is the level of additional phosphorus removal required at the treatment plant to keep the concentration of phosphorus in the lake below 0.01 mg/L?	

No.	Questions	Marks
8.	a) Define "forever chemical" with examples. List the properties and health effects of "Forever Chemicals".	5
	b) An industry discharges chemical waste into a waste lagoon. A particular contaminant, with concentration 40 mg/L, infiltrates into the ground from the lagoon.	10½
	i) Estimate the time required for the contaminant concentration to reach 10 mg/L at a depth of 1 m from the bottom of the lagoon. Seepage velocity is 0.5 m/d and dispersivity is 0.1 m. Assume the contaminant as conservative and ignore the molecular diffusion.	
	ii) What would be the time required for the contaminant to reach the same concentration at the same position, if there is a 1 m thick clay layer at the bottom of the lagoon. Assume coefficient of molecular diffusion for the clay layer as 8.5×10^{-6} m^2/d.	
	c) A test bottle containing just seeded dilution water has its DO level drop by 1.0 mg/L in a five-day test. A 300-mL BOD bottle filled with 15 mL of wastewater and the rest seeded dilution water experiences a 7.2 mg/L drop in DO level in a five-day test.	8
	i) Calculate the five-day BOD of the wastewater.	
	ii) If the wastewater contains only 100 mg/L of ethanol, calculate the proportion of ultimate BOD and theoretical oxygen demand (ThOD) of the wastewater. Assume the BOD rate constant of the wastewater as 0.3 d^{-1}.	

CE 435 (Section B)

Relevant Equations for Section B:

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

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

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

$$C(x,t) = \frac{C_0}{2}\left[erfc\left(\frac{x-\bar{v}_x t}{2\sqrt{D_x t}}\right) + \exp\left(\frac{\bar{v}_x X}{D_x}\right) * erfc\left(\frac{x+\bar{v}_x t}{2\sqrt{D_x t}}\right)\right];$$

$$D_x = \alpha \bar{v}_x + D^*$$

$$C(x,t) = C_0\left[erfc\left(\frac{x}{2\sqrt{D^* t}}\right)\right]$$

$$C(x,t) = \frac{C_0}{2}\left[erfc\left(\frac{x - \bar{v}_x t}{2\sqrt{D_x t}}\right)\right]$$

The complementary error function table

x	erfc(x)	x	erfc(x)
0	1.0		
0.05	0.943628	1.1	0.119795
0.1	0.887537	1.2	0.089686
0.15	0.832004	1.3	0.065992
0.2	0.777297	1.4	0.047715
0.25	0.723674	1.5	0.033895
0.3	0.671373	1.6	0.023652
0.35	0.620618	1.7	0.016210
0.4	0.571608	1.8	0.010909
0.45	0.524518	1.9	0.007210
0.5	0.479500	2.0	0.004678
0.55	0.436677	2.1	0.002979
0.6	0.396144	2.2	0.001863
0.65	0.357971	2.3	0.001143
0.7	0.322199	2.4	0.000689
0.75	0.288844	2.5	0.000407
0.8	0.257899	2.6	0.000236
0.85	0.229332	2.7	0.000134
0.9	0.203092	2.8	0.000075
0.95	0.179109	2.9	0.000041
1.0	0.157299	3.0	0.000022

$$\text{erfc}(x) = 1 - (2/\sqrt{\pi})\int_0^x e^{-\epsilon^2} d\epsilon$$

$$\text{erfc}(-x) = 2 - \text{erfc}(x)$$

[a] Adapted from Freeze and Cherry (1979).

L-4/T-2/CE **Date: 22/04/2024**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations 2021-2022

Sub: **CE 443 (Earth Retaining 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** questions.

Assume reasonable values for any missing data only if necessary. Symbols carry their usual meanings.

1. (a) Discuss the importance of slurry trench wall construction in the context of Bangladesh. Comment on the desirable properties of slurry. **(9 1/3)**

(b) Why is construction dewatering so important? "Choice of method for dewatering depends on soil type"- explain **(5)**

(c) Design a system of well points arranged in a circle around an excavation 28m x 26m in sandy soil overlying clay stratum. Thickness of sand stratum is 8m. Excavation is 5m deep and ground water table is at a depth of 2m. Permeability of sand is 0.05 cm/sec. Given: $nq = \frac{\pi K\left(H^2 - h^2\right)}{log_e\left(R/r\right)}$, $R = 3000s\sqrt{K}$ **(9)**

$$q = 2\pi r_0 h_0 \frac{\sqrt{K}}{15}$$

2. (a) Briefly describe the use of different types of sections of steel sheet piles. Comment also on the joints between sections. Present neat sketches. **(7 1/3)**

(b) Using Broms method, determine the allowable lateral load on a 0.5 m dia 15m long free standing pile in a sandy soil subjected to a horizontal load 0.5m above ground level. Soil properties are: Angle of internal friction= 33^0, Unit weight (below GWT) = 19 kN/m^3, Unit weight (above GWT) = 17 kN/m^3. Assume yield moment of pile = 110 kN-m. Consider worst case scenario regarding Ground Water Table (GWT). **(7)**

(c) Fig. 1 shows the section of a braced excavation in clay. Given: Undrained shear strength = 75 kPa, Unit weight = 19 kN/m^3. Draw the earth pressure envelope and determine the design strut load. Also determine the maximum moment developed in the wales, assuming struts are placed at a spacing of 4 m centre to centre. Calculate the factor of safety against base heave. **(9)**

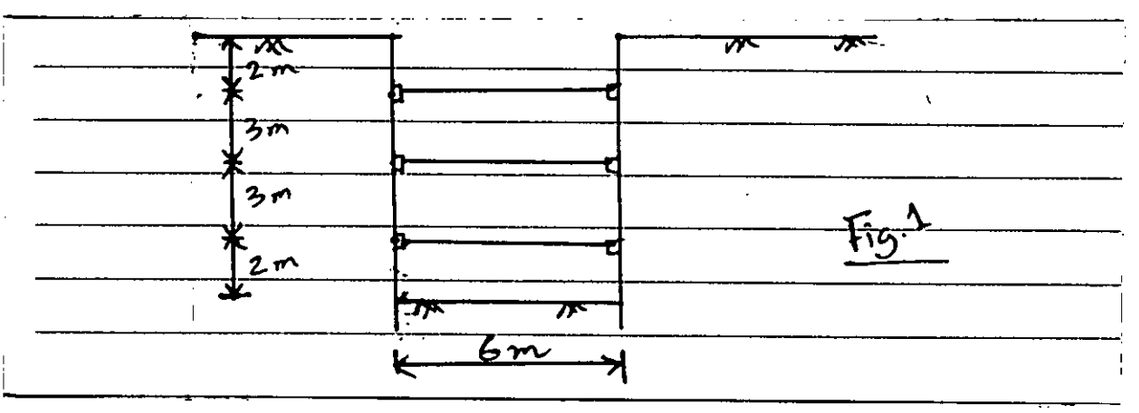

Fig. 1

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3. (a) A cantilever sheet pile is required to retain an excavation in cohesive soil as shown in Fig. 2. Consider uniform surcharge load of 20 kPa. Determine the required depth of penetration of the sheet pile. Ground water table is at a great depth. **(13)**

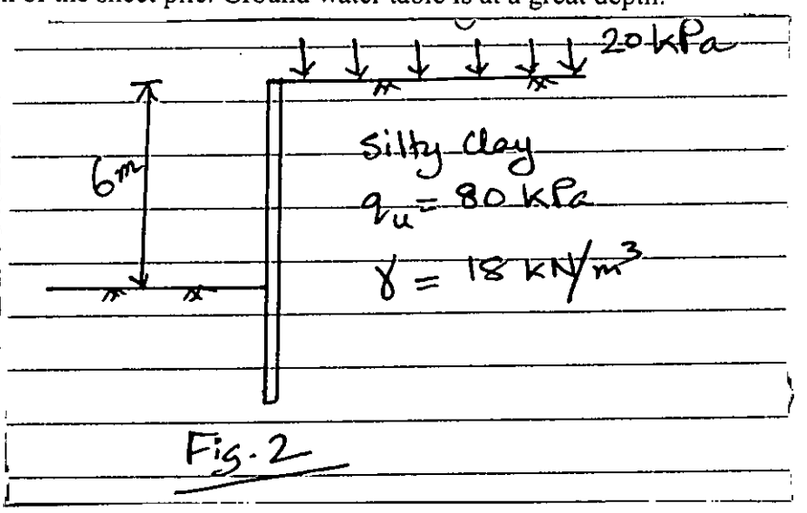

Fig. 2

Present neat sketches of the pressure diagrams, considering short term analysis.

(b) If a heavy truck stands at a distance of 1 m form the sheet pile, explain how you would determine the effect of truck load on the pressure diagram. Present neat sketches and relevant equations. **(4)**

(c) Describe the computational procedure you would employ for analyzing the response of a laterally loaded pile in a layered soil. Discuss advantages and limitations of your procedure. **(6 1/3)**

4. (a) Determine the required embedment of an anchored sheet pile retaining 7.5 m of backfill as shown in Fig. 3. Also determine the dimensions and location of the anchor rods and anchorage block (deadman). Ground water table is at a depth of 4m. **(20)**

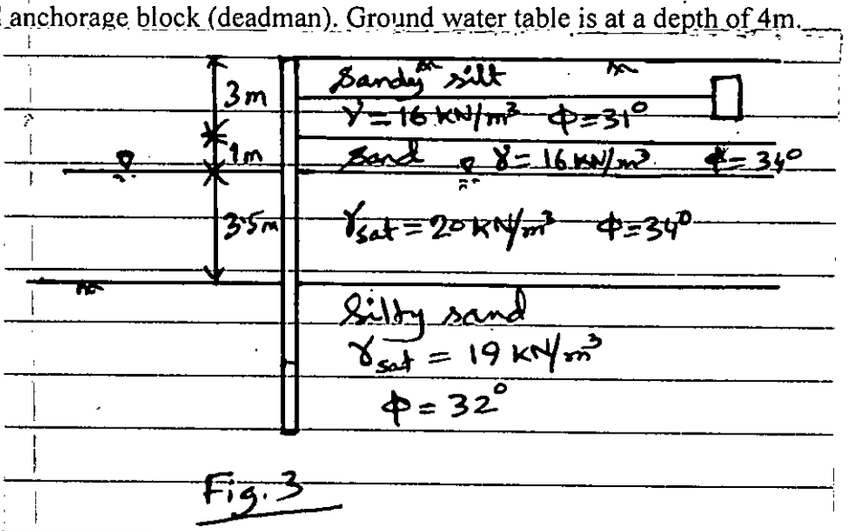

Fig. 3

(b) Write short notes on moment reduction for anchored sheet pile system. **(3 1/3)**

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SECTION – B

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

5. (a) The following figure shows the foundation system (piles and pile cap) of a bridge pier. Determine the maximum compression and tension forces exerted on the piles due to the self-weight of the pier and external loads as shown in the figure. What will be the soil pressure if piles are omitted? **(15 1/3)**

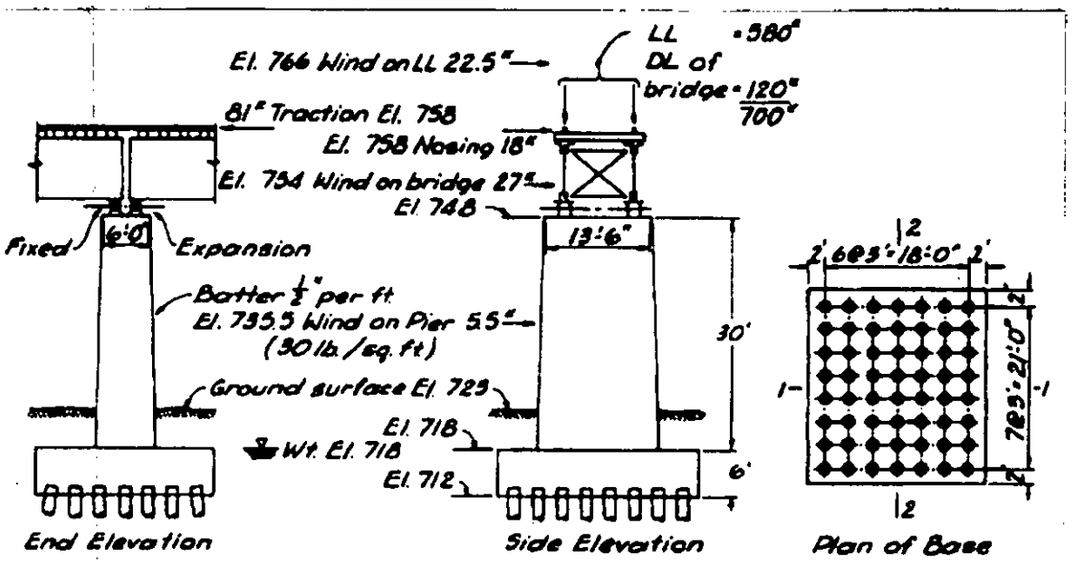


Figure for Question 5(a)

(b) State 5 causes of failure of a cofferdam as highlighted by ArcelorMittal Pilling Handbook. **(5)**

(c) What is the main difference between a cofferdam and a caisson? **(3)**

6. (a) The following figure shows a section of a retaining wall with geotextile reinforcement. A woven slit-film geotextile with warp (machine) direction ultimate wide-width strength of 50 kN/m and having $\delta = 24^0$ is intended to be used in its construction. The orientation of the geotextile is perpendicular to the wall face and the edges are to be overlapped to handle the weft direction. A factor of safety of 1.4 is to be used along with site-specific reduction factors of $RF_{ID} = 1.2$, $RF_{CR} = 2.5$, $RF_{CD} = 1.15$, and $RF_{BD} = 1.1$. Determine the spacing of individual layers of geotextile and the length of the fabric layers as shown in the figure. Also, calculate the required overlap length and check for external stability. The backfill surface carries a uniform surcharge dead load of 10 kN/M^2. **(18)**

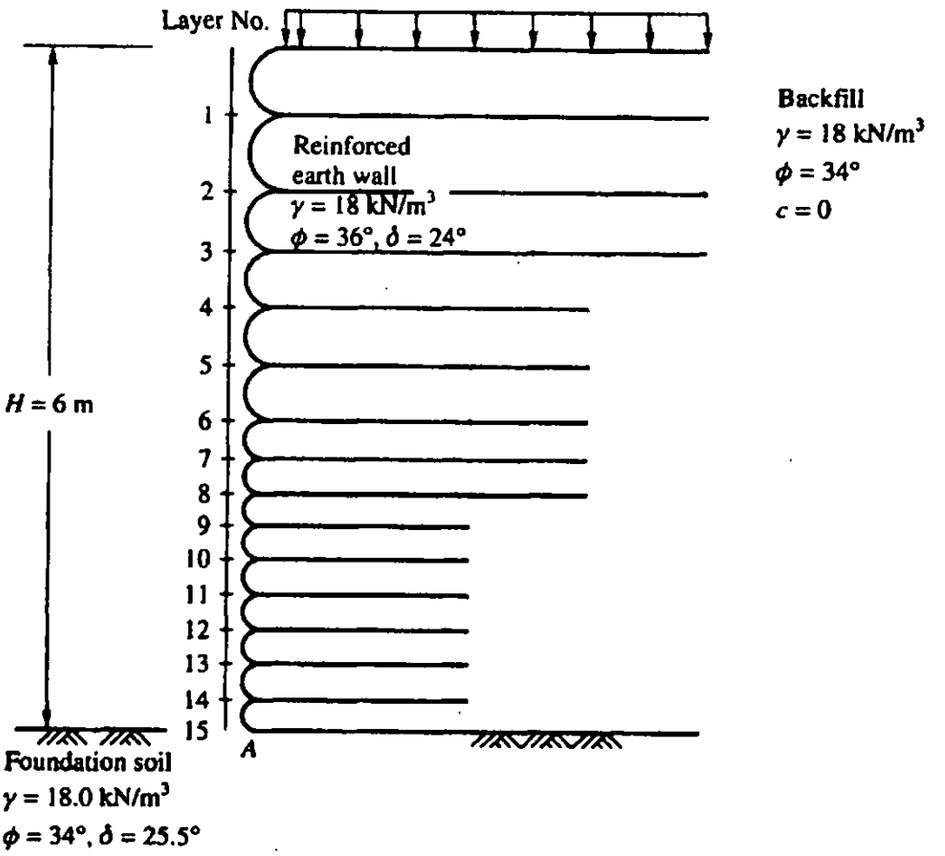


Figure for Question 6

(b) Write a short note on drainage provision for retaining walls. (5 1/3)

7. (a) Briefly describe with proper illustrations the general construction procedures for using geotextiles in fabric wall construction. **(8)**

(b) Design a circular, cellular cofferdam of total height 15 m resting on rock as shown in the figure below. Use the TVA method. Consider allowable interlock tension of 1500 kN/m, $\phi = 30^0$, $\delta = 25^0$, K = 0.60, and f = 0.30. Assume D = 12.H, b = 0.875D, and 90^0 - Tees for ring tension. Also, consider perfectly draining fill in your design. (15 1/3)

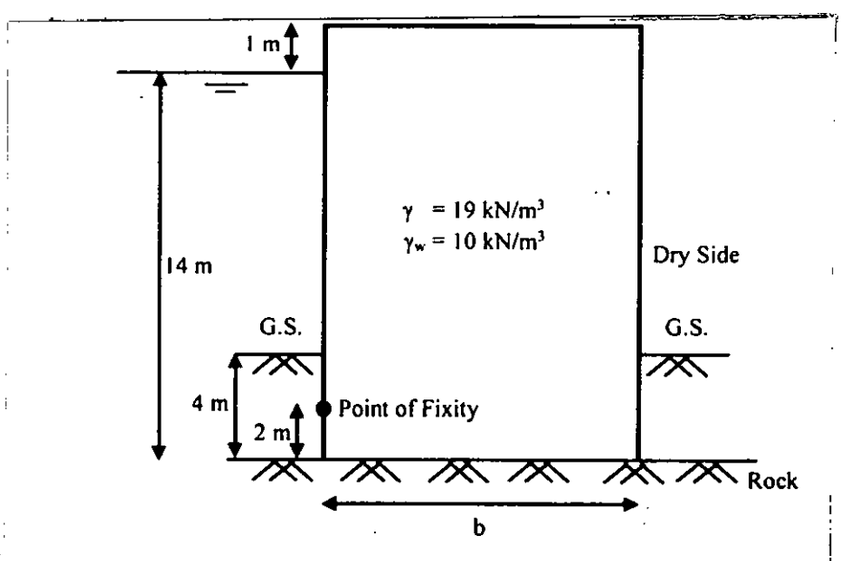


Figure for Question 7(b)

Contd..... Page/5

CE 443

8. The cross-section of a cantilever retaining wall is shown in the figure below. Calculate the factors of safety with respect to overturning, sliding, and bearing capacity. Use Tables 1, 2, and 3 for necessary calculations. Use Rankine's theory of active and passive earth pressures. **(23 1/3)**

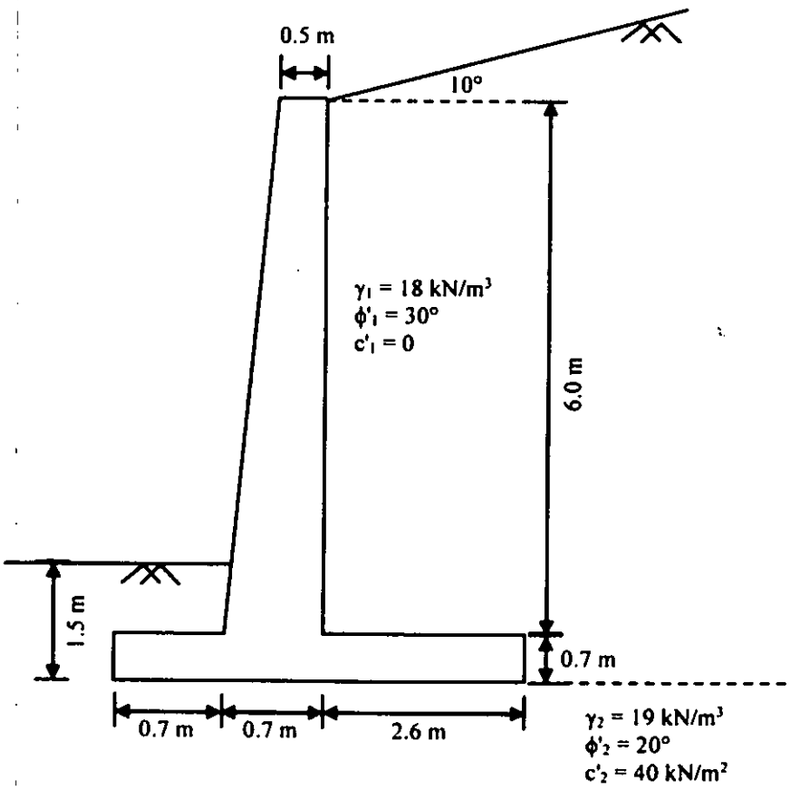
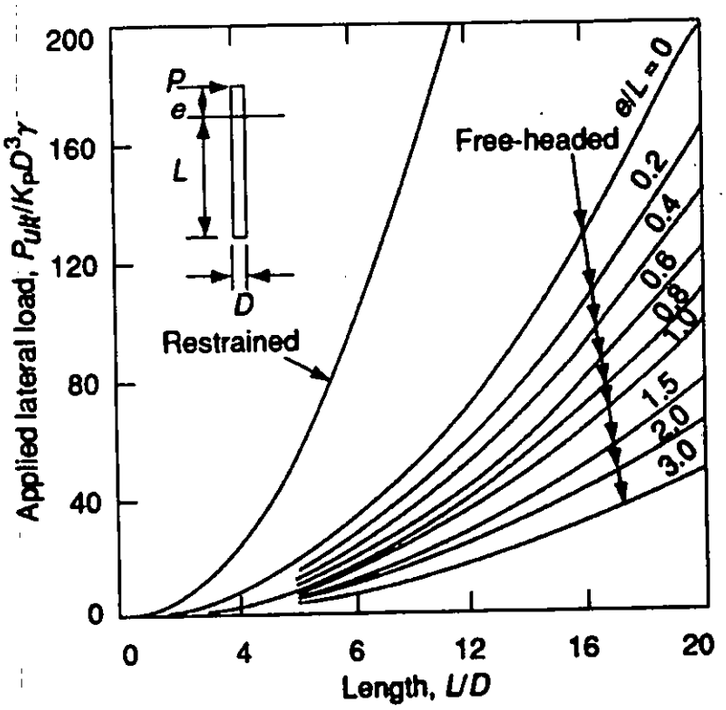


Figure for Question 8


Applied lateral load, $P_{ult}/K_pD^3\gamma$
200
160
120
80
40
0
0
4
6
12
16
20
Length, L/D
P
e
L
D
Restrained
Free-headed
e/L = 0
0.2
0.4
0.6
0.8
1.0
1.5
2.0
3.0

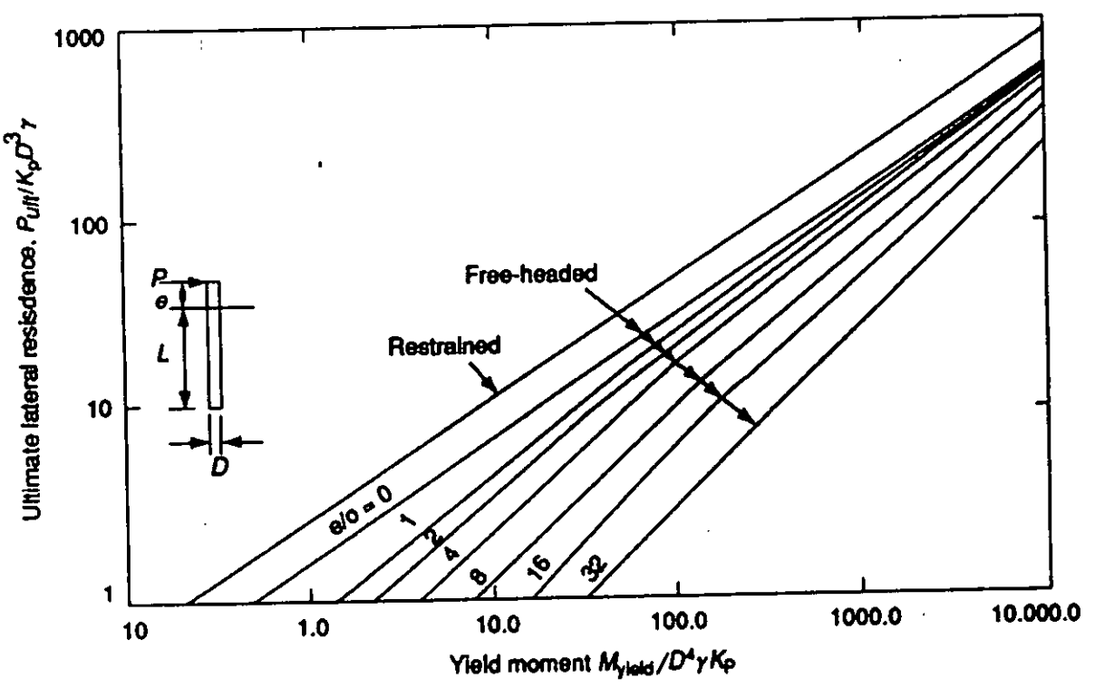

Ultimate lateral resistance, $P_{ult}/K_pD^3\gamma$
1000
100
10
1
10
1.0
10.0
100.0
1000.0
10.000.0
Yield moment $M_{yield}/D^4\gamma K_p$
P
e
L
D
Free-headed
Restrained
e/D = 0
1
2
4
8
16
32

Table 1: Bearing capacity factors

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				

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

α (deg)	θ (deg)	$K_{a(R)}$, ϕ' (deg)						
		28	30	32	34	36	38	40
0	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
	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
5	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
	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
10	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
	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
15	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
	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
20	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
	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

Table 3: 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	$\frac{D_f}{B} \le 1$ 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)

L-4/T-2/CE

Date : 28/03/2024

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Examinations 2021-2022

Sub: **CE 445** (Elementary 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** questions.

1. (a) Expand on the various types of vibratory motions. Also, define resonance. **(4 ⅓)**

   (b) Derive the equation of motion for a one-storied structure subjected to earthquake excitation, starting with the dynamic equilibrium equation. Assume that the structure behaves elastically. **(9)**

   (c) A free vibration test is conducted on an empty elevated water tank. A cable attached to the tank applies a lateral (horizontal) force of 40 kip and pulls the tank horizontally by 4 in. The cable is suddenly cut and resulting free vibration is recorded. At the end of four cycles, the time is 2.0 sec and the amplitude is 1 inch. From these data, compute the following: (i) damping ratio; (ii) natural period of undamped vibration; (iii) effective stiffness; (iv) effective weight; (v) damping coefficient; and (vi) number of cycles required for the displacement amplitude to decrease to 0.2 in. **(10)**

2. (a) Derive the equation of motion of the free longitudinal vibration using the Energy method. **(4 ⅓)**

   (b) Show the relationship between magnification factor (M) and frequency ratio (ω/ω_n) in a plot. Also, write down the necessary inferences from the plot. **(9)**

   (c) A bungee jumper weighing 200 lb ties one end of an elastic rope of length 250 ft and stiffness 12 lb/in to bridge and the other to himself and jumps from the bridge. Assuming the bridge to be rigid, determine the vibratory motion of the jumper about his static equilibrium position. **(10)**

3. (a) What do you mean by critical damping co-efficient? Also, differentiate between oscillatory and non-oscillatory motion. **(4 ⅓)**

   (b) Derive the following expression of logarithmic decrement (denoted by δ) **(9)**

$$\delta = \ln\frac{u_i}{u_{i+1}} = \frac{2\pi\zeta}{\sqrt{1-\zeta^2}}$$

   (c) Briefly explain the factors affecting modulus reduction and damping characteristics. **(10)**

4. (a) Define elastic stored energy and dissipation of energy with neat sketch. **(4 ⅓)**

   (b) Show graphically the relation between shear modulus ratio (G/G_0) and amplitude of shear strain (γ_a) for Toyoura Sand by Kokusho (1980). Also, explain the effect of confining stress on the strain dependent shear modulus. **(9)**

(c) Compare between seismic reflection and seismic refraction test in light of fundamental principle, measured properties, advantages, disadvantages and limitations. **(10)**

SECTION – B

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

Use attached chart where necessary.

5. (a) Describe different types of magnitude scales. **(13)**

   (b) Estimate the probability of seismic hazard for a bridge for a return period of (i) 50 yr, (ii) 150 yr, (iii) 450 yr, and (iv) 950 yr. **(10 ⅓)**

6. (a) Write short notes on: **(12)**

   (i) Earthquake Source Models

   (ii) Attenuation Laws

   (b) Write down the salient features of an Intensity Scale. **(4)**

   (c) What are the collateral effects of an earthquake? Explain one of them. **(3+4 ⅓)**

7. (a) Differentiate between Zonation and Microzonation with neat sketches. **(9 ⅓)**

   (b) For the following data, shown in Table 1, estimate Liquefaction Resistance Factor and Liquefaction Potential Index for a_{max} = 0.26g for M = 8.5, Ground Water Table is located at a depth of 1.75m from the EGL. **(14)**

Table 1

Soil Layer Thickness (m)	Soil Profile	d_{50}(mm)	SPT-N Value
0-8	Coarse Sand	0.65	6
8-14	Medium Sand	0.55	9
14-21	Fine Sand	0.15	12

8. (a) Write short notes on: **(12)**

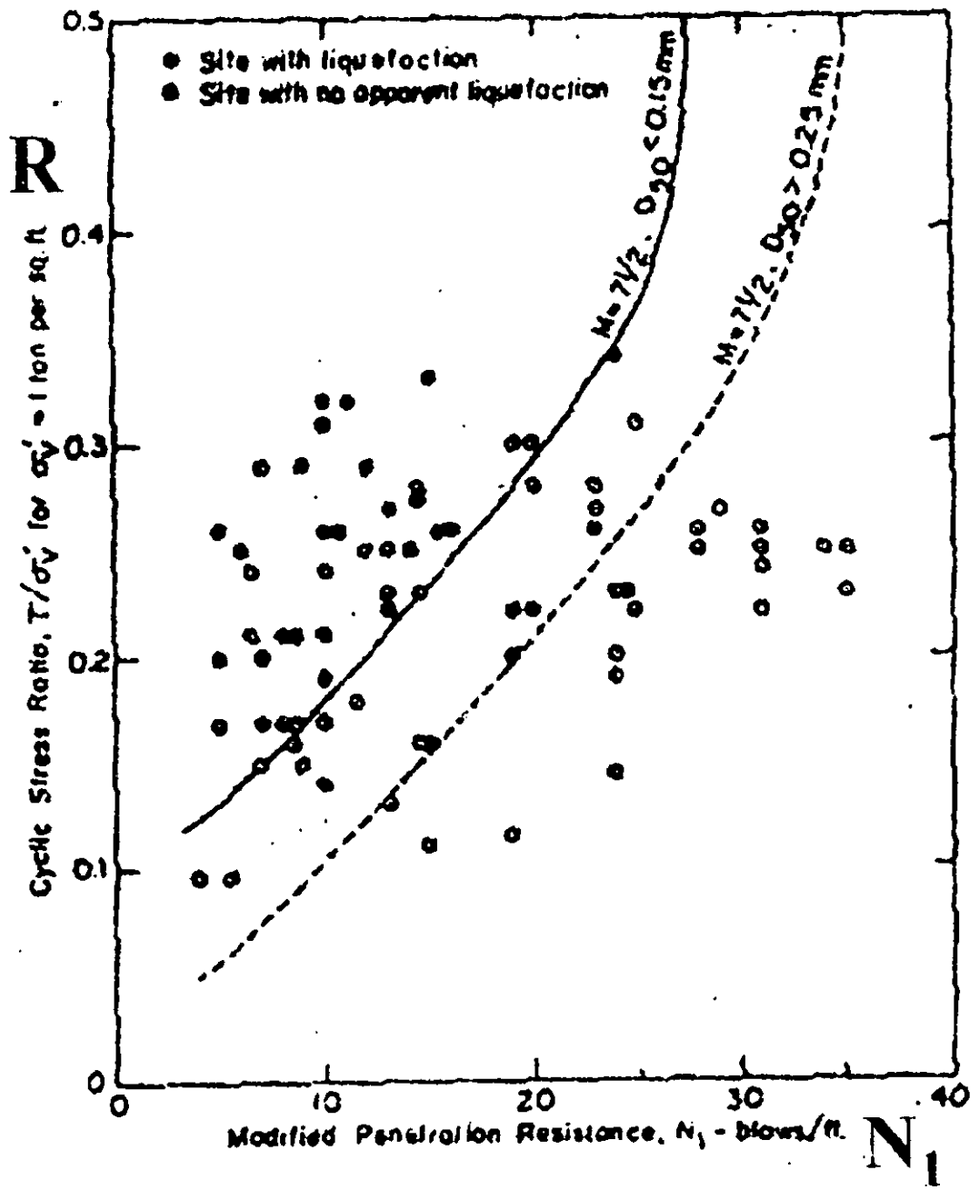
   (i) Data Completeness

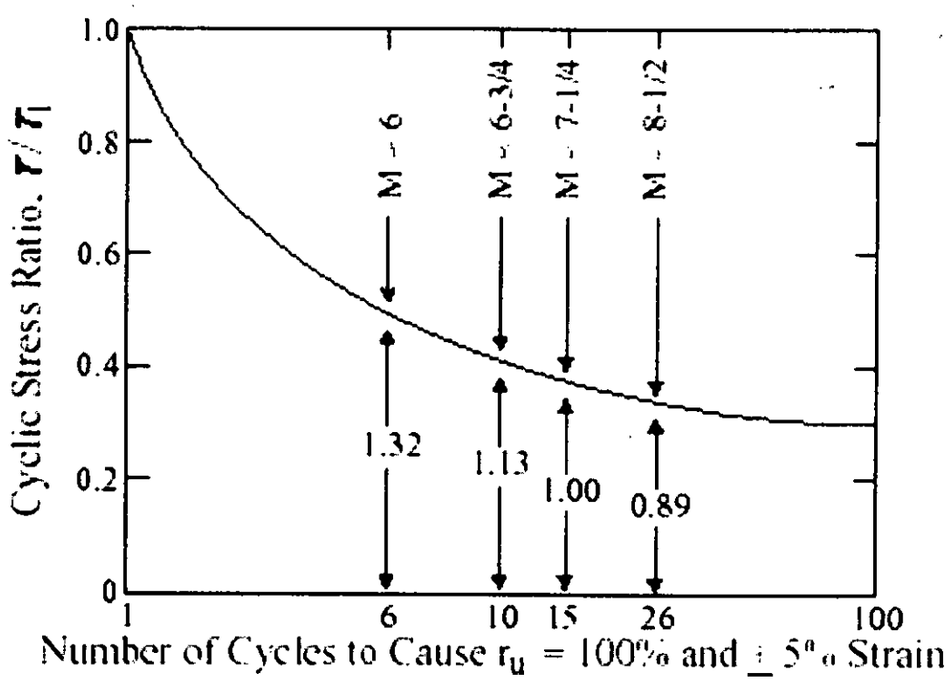
   (ii) Surface Waves & Normal Faults

   (b) There are four Seismoactive zones (Table 2) in and around a nuclear power plant site. Estimate SDE and SSE on the basis of cumulative intensity-frequency relation. **(11 ⅓)**

Table 2

Zones	a	b	I_{max}	Attenuation Value
1	1.07	0.77	X	1.2
2	0.47	0.66	XI	0.9
3	0.79	0.37	VIII	1.5
4	1.37	0.85	IX	2.2


Site with liquefaction
Site with no apparent liquefaction
R
M = 7½, a_{max} < 0.15 g
M = 7½, a_{max} > 0.25 g
Cyclic Stress Ratio, τ/σ_v' for σ_v' = 1 ton per sq. ft.
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
Modified Penetration Resistance, N_1 - blows/ft.
N_1


Cyclic Stress Ratio, τ/σ_1
1.0
0.8
0.6
0.4
0.2
0
M = 6
M = 6-3/4
M = 7-1/4
M = 8-1/2
1.32
1.13
1.00
0.89
1
6
10
15
26
100
Number of Cycles to Cause r_u = 100% and ± 5% Strain

L-4/T-2/CE **Date : 28/03/2024**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2021-2022

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** questions.

1. (a) With appropriate sketch, discuss the mechanism of water related stability problems that may occur to a slope. **(9)**

   (b) Discuss the factors that need to be evaluated to select appropriate ground modification methods for improvement of hydraulic fills. **(8⅓)**

   (c) Explain why the values of various properties of geotextiles as obtained from laboratory tests cannot be directly used in design. Also explain how these values are modified to be used in design. **(6)**

2. (a) Explain transmissivity for a geotextile along with its mathematical expression. Laboratory test for determination of transmissivity was conducted on a 20 cm × 10 cm specimen of a geotextile. Under a water head of 30 cm and with flow along the long direction of the specimen, a flow volume of 250 cc in 4 minute 10 seconds was recorded. The thickness of the specimen is 3.57 mm under 2 kPa pressure at which the test was conducted. Calculate the transmissivity and in-plane permeability of the geotextile at the test temperature. **(5+5=10)**

   (b) Discuss the initial states and properties of a hydraulic fill made with- **(6)**

   (i) Clean sand (ii) Clayey sand (iii) Soft cohesive soil

   (c) Explain the use of granular filters when the seepage quantity is 'small' and 'large'? **(7⅓)**

3. (a) Name various process and agents that cause degradation of geotextiles. **(6)**

   (b) With neat sketch show various type/arrangements of granular filters used in the design and construction of earthen embankments. **(8)**

   (c) Results of grain size analysis of in-situ soil samples on a slope is shown in the following Table. For protection of the slope, a two-layer filter was considered. Results of grain size analyses of a coarse sand considered as fine filter and those of stone aggregate considered as coarse filter are also presented in the Table. Analyze and comment on the appropriateness of the coarse sand and stone aggregates as filter layers. **(9⅓)**

Contd P/2

CE 447 Contd... Q. No. 3(c)

Particle size, mm		0.08	0.15	0.25	0.30	0.42	0.60	0.84	1.18	2.00	2.36	4.75	12.00	19.00	25.00	37.00	51.00	67.00	75.00	100.00
% Finer	In-situ soil	5	62	85	94	100	100													
	Coarse Sand		5	8	12	24	34	55	80	98	100	100								
	Brick aggregate												4	8	40	87	98	100	100	100

4. (a) State the criteria for granular filter design. Are these criteria applicable for medium to high plastic clays? If not, what can be done to protect such clays? **(9)**

   (b) Show with sketches, the use of granular filter behind a retaining wall and below a road pavement. **(7⅓)**

   (c) State the principle, applicability, equipment, advantage and limitations of various methods of improvement of hydraulic fills that fall in the category 'deep densification by vibration'. **(7)**

SECTION – B

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

Assume any reasonable value of missing data.

5. (a) Three layers of soil are shown in a tube 100mm × 100mm in cross section in the figure given below (Fig.1). A constant head difference of 300 mm is maintained across the entry and exit points of the multilayered soil sample. The hydraulic conductivities of the layered soil in the direction of flow are as follows: **(13)**

$$k_A = 10^{-2} cm/s,\ k_B = 3\times10^{-3} cm/s,\ k_C = 4.9\times10^{-4} cm/s$$

Compute the equivalent permeability of the three soil layers in the direction of flow. If the flow of water through the three layered soil system is 291.2 cm^3/hour, determine the magnitude of h_A and h_B in millimeters.

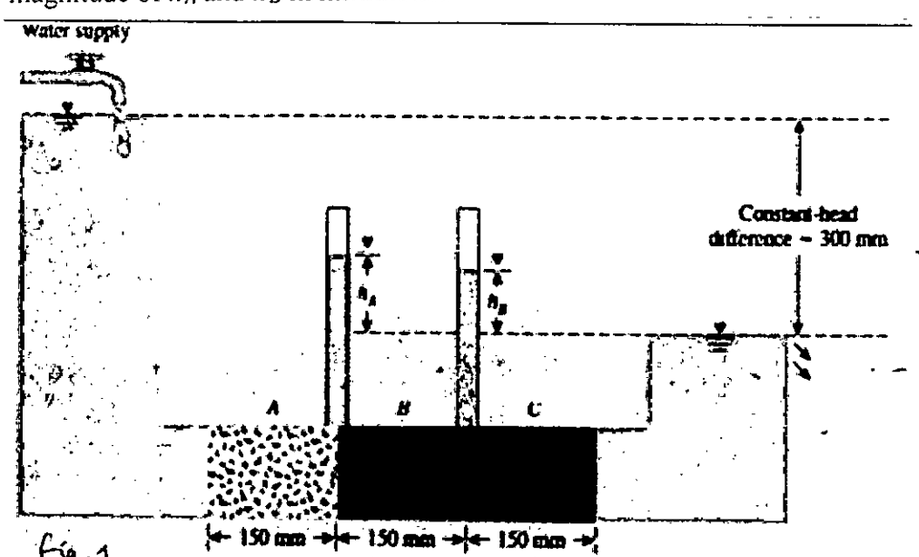


Fig. 1

Fig. 1

Figure 1.21 Three layers of soil in a tube 100 mm × 100 mm in cross section

Contd P/3

CE 447

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

(b) Find the flow rate along the direction of flow in m^3/s per meter of length normal to the section through the permeable soil layer for the problem shown in the Fig. 2. The following data is given for the problem: H = 8m, H_1= 3m, h = 4m, S = 50m, α = 8°, and k = 0.08 cm/s. If the soil has an average void ratio of 0.7, also compute the seepage velocity through the soil. (NOTE: The soil cross section will be perpendicular to the direction of flow) **(10⅓)**

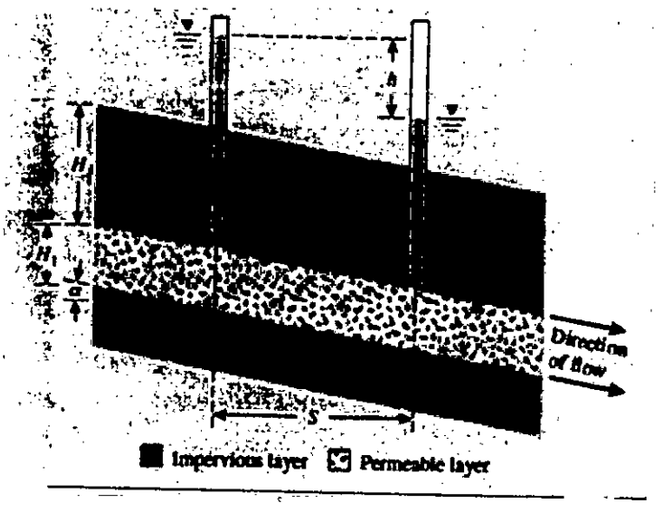


Fig. 2

6. (a) A stiff clay layer underlies a 12m thick silty sand deposit with permeability k = 8.6 $\times 10^{-6} m/s$. A sheet pile is driven into the sand to a depth of 7m. The difference between the upstream and downstream water levels is 3m as shown in the Fig. 3. The equipotential lines represent equal intervals of drop in the head and the flow lines and corresponding flow channels represent paths of equal flow. All flow lines and equipotential lines drawn below intersect at right angles to each other. Compute the seepage beneath the sheet pile in m^3/day per meter of length normal to the section shown below. Also compute the total head, pressure head and pore pressure at the bottom tip of the sheet pile (at A) using the bottom of the silty sand soil layer as the reference DATUM to measure all heads. NOTE: There will be loss of head during seepage flow. **(13)**

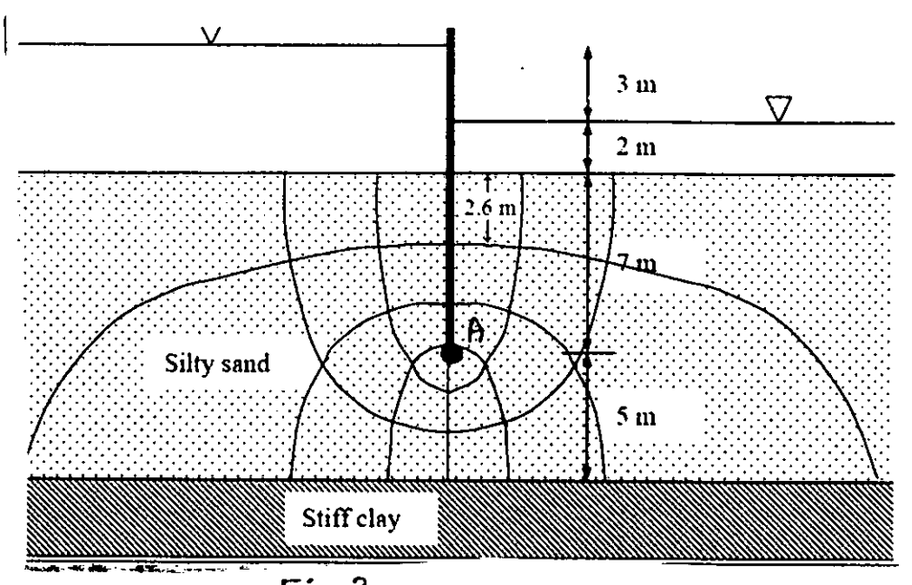


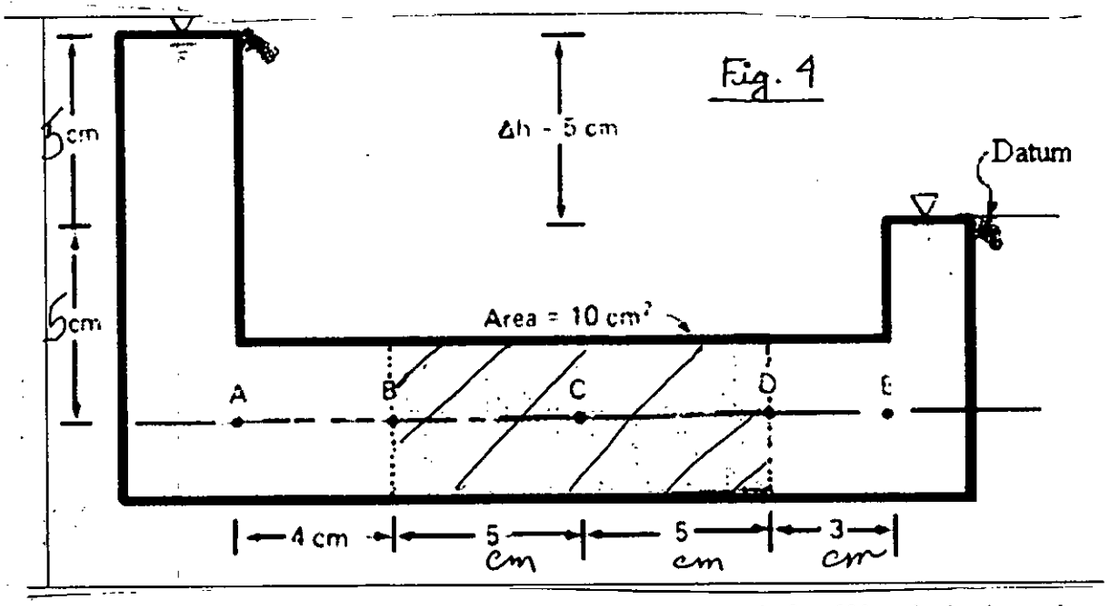
Fig. 3

Contd P/4

CE 447

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

(b) For the Fig. 4, draw a flow net with four flow channels of equal area and equipotential lines representing eight equal intervals of head loss from entry of water into the samples BCD at B to the point of exit from it at D. Assuming the permeability of soil sample to be 0.01 cm/s, compute the flow of water through the sample in cm^3/s per cm of width of sample normal to the section. If the width of the sample normal to the section is 2cm, what would be the total flow through the soil sample. Use Darcy's equation to compute the flow and verify the flow computed using flow net. Use the line ABCDE as the reference datum to measure all heads. **(10⅓)**



7. (a) A cut has to be made in a soil. The cut slope will make an angle $\beta = 60°$ to the horizontal. The soil has the following properties: γ = 18 kN/m^3, c' = 25 kN/m^2 and $\varphi' = 25°$. For a factor of safety of three use Culmann's method of analysis of finite slopes assuming plane failure surfaces to compute the following: **(13)**

(i) the critical height of the slope using full values of c' and φ'. Then use the factor safety to determine the design slope height.

(ii) the design height of the slope using mobilized values c'_m and φ_m' obtained using the desired factor of safety. Then use the factor safety again to determine the critical slope height.

(b) For the same problem as described in question 7(a), determine the design height and critical height of the slope using the Taylor's stability chart Fig. 5 for a factor of safety three assuming the hard stratum is at large depths compared to the height of the cut slope. Consider first the case when the excavation is completely empty. Next determine the design height of the slope if the excavation is filled with water to its maximum height. Taylors Stability chart is given below. **(10⅓)**

CE 447

Contd...Q. No. 7(b)

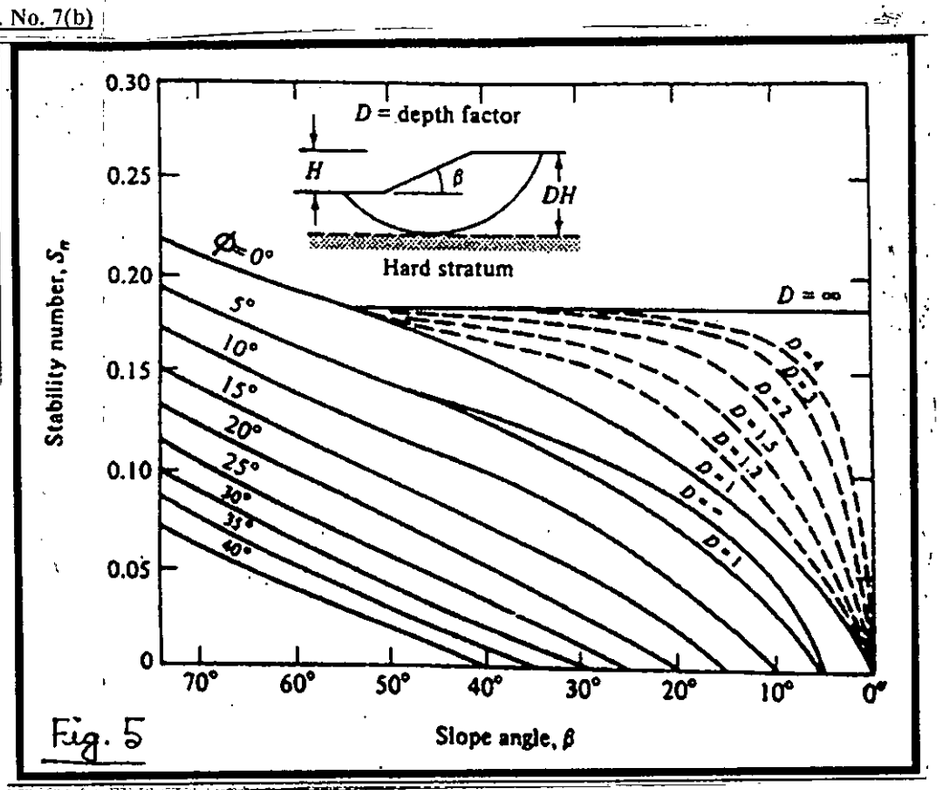


Fig. 5

8. (a) A homogeneous earth embankment of height 15m was built on an impervious foundation with side slopes 2: 1 (horizontal to vertical). The embankment retains water to a height of 10m. The crest width of the embankment is 5 m. The average coefficient of permeability of the embankment soil is 5×10^{-4} m/s. Draw a neat qualitative sketch of the embankment identifying the dimensions as given above. Compute the y coordinate of the phreatic line at x=20m from the origin which is assumed to be the intersection point of the downstream slope with the impervious base. Also, compute the rate of seepage through the embankment using Schaffernak and Van Iteration's method. **(13)**

(b) A uniform sand has a void ratio of 0.5 and effective grain diameter D_{10}= 0.03 mm. Use Hazen's empirical formula $h_c = \frac{C}{eD_{10}}$ to compute the height of capillary rise in the uniform sand. The value of C varies between 0.1 cm^2 to 0.5 cm^2 for sand. Choose a value of C that will give the maximum height of capillary rise for the given sand. Compute the suction pressure on the surface of the capillary column in kPa and in pF. Assuming effective diameter of the capillary column to be equal to 20% of the effective diameter of sand and taking surface tension of water T = 73×10^{-6} kN/m, recompute the capillary rise in sand using $h_c = \frac{4T}{d\gamma_w}$. **(10⅓)**

L-4/T-2/CE Date: ~~02/05/2024~~ 23/5/24

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2021-2022

Sub: **CE 457** (Transportation Engineering V: Urban Transportation Planning and Management)

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** questions.

1. (a) "The urban environment is particularly suitable for transit"— discuss why? **(3+3+6)**

Briefly explain the interrelation between congestion and parking. Discuss the following factors in relation to urban traffic congestion:

(i) Longer commuting;

(ii) Accidents and Safety; and

(iii) Public transport inadequacy.

(b) Why is it necessary to consider urban freight movement separately in the transportation planning process? "Truck stops" can help improve safety of highways in Bangladesh — elaborate. Mention the traffic engineering and design issues and problems related to urban goods movement. **(4+3+4⅓)**

2. (a) Briefly discuss the factors related to automobile dependency. Explain in brief two negative consequences of automobile dependency. Elaborate the most difficult challenges facing urban transit. **(3+3+6)**

(b) State the problems associated with truck movement and loading/unloading facilities in Bangladesh. Discuss three strategies to limit automobile circulation. How the introduction of self-driving vehicles may affect urban transit operations and safety. **(4+4+3⅓)**

3. (a) Mention three most relevant indicators of automobile dependency. Explain different urban transport development paths. Also, identify those development paths in an ownership of passenger modes versus urban mobility level diagram. **(2+8+2)**

(b) Explain the different components of an urban transit system along with a neat sketch. Write down the negative impacts of truck terminals in an urban setting. **(8+3⅓)**

4. (a) Explain the two major forms of congestion. Explain how alternate work schedule and ride sharing can contribute to reducing peak period traffic congestion. Elaborate the project evaluation and decision-making procedure. **(5+3+6)**

(b) Discuss the concerns of different parties involved in UGM process. Write a short note on intermodal freight terminals. **(5+4⅓)**

Contd P/2

CE 457

SECTION – B

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

Assume reasonable values for any missing data.

5. (a) The peak hour demand of a bus operating between Shahbag to Jatrabari reduced from 400 to 300 passengers due to a fare increase of 10 takas. Calculate the fare elasticity of the Shahbag to Jatrabari bus route if the initial fare for the route was 20 takas. **(7⅓)**

(b) Define flat, and variable fare structure of public transport system. What do you understand by telescopic fare? Which fare system is most appropriate for metro rail ling 6 operating between Uttara and Motijheel in Dhaka according to you and why? **(4+2+2)**

(c) Define the following operational and financial performance indicators for public transportation systems. How do these indicators for Dhaka's bus system compare against the standard values to the best of your knowledge? **(6+2)**

Operational Indicators		**Financial Indicators**	
(i)	Occupancy ratio	(ii)	Operational ratio
(iii)	Fleet utilization	(iv)	Fair box ratio

6. (a) Calculate the fleet size requirement for public buses for a city of 15 million population. Assume a per capita trip rate of 1.8. The modal share for bus and the average trip distance can be assumed to be 65% and 6 km respectively. You can assume the following properties for the bus service. **(8⅓)**

Distance traveled by bus per day	130 km	Average occupancy	0.85
Capacity of bus	80 including Standees	Expected fleet utilization	95%

(b) Draw schematic diagram of the three most popular type of public transit routes. Which type of route(s) do you think would be most suitable for Dhaka South City Corporation area and why? **(6+2)**

(c) What is the most common method for calculating pollutant emissions from transportation systems? What do you know about activity factor and emission rate with respect to the calculation of pollutant emissions? Explain with appropriate example(s). **(2+3+2)**

7. (a) Regression equation (1) was developed for estimating the trip generation rate from retail shops. Calculate the total number of trips generated during the peak hour from the retail shops provided in Table 1. **(6⅓)**

$T = 9.24 * A$ .....(1)

Contd P/3

CE 457

Contd... Q. No. 7(a)

In equation (1) T represents the trip count during the peak hour and A represents the gross floor area of the shopping mall in 1000 square feet (sft).

Table 1 (for question 7(a))

Shop	**Gross Floor Area in sft**
Anam Rangs Plaza	4,600
Unimart	46,000
A. R. A. Center Shopping Mall	20,000

(b) The number of trips produced in and attracted to the three zones 1, 2, and 3 are tabulated in table 2. The travel impedance or friction factor values between the various zones can be taken from the matrix provided in table 3. **(9)**

Table 2 for question 7(b)

Zone	1	2	3	Total
Trips Produced (P_i)	140	330	280	750
Trips Attracted (A_j)	330	280	140	750

Table 3 for question 7(b)

O/D	**1**	**2**	**3**
1	13	82	41
2	50	26	39
3	52	20	41

Distribute the trips between various zones using a **single iteration** of the **gravity model**. Assume the socio-economic adjustment factor to be 1.

(c) What do you understand by highway performance function? Compare the linear and the exponential performance functions with appropriate qualitative diagram(s). Which type of function do you think is more representative of Dhaka's traffic situation? **(2+2+2+2)**

8. (a) Write down the objective function of the system equilibrium approach to traffic assignment along with the appropriate constraints. Clearly identify the variables of the equations. What is the principal difference between the system and the user equilibrium approach? **(3+2+2)**

Contd P/4

CE 457

Contd... Q. No. 8

(b) A mode choice model is developed to quantify the modal share between car, bus and rickshaw on Satmasjid Road. The utility equation of the three modes is provided below where 'tt' represents travel time in minute and 'tc' represents travel cost in taka. **(6+4)**

$$U_{car} = 2.5 - 0.3 * tt_{car} - 0.2 * tc_{car}$$
$$U_{bus} = -0.15 * tt_{bus} - 0.2 * tc_{bus}$$
$$U_{ricksahw} = -0.1 - 0.1 * tt_{rickshaw} - 0.2 * tc_{rickshaw}$$

(i) What will be the modal share under the prevailing condition given the travel time and cost values provided in Table 4?

(ii) How will the modal share change if the Rickshaw is banned from Satmasjid Road during Ramadan?

Table 4 for question 8(b)

Mode	Travel Time (min)	Travel Cost (Taka)
Car	30	40
Bus	50	20
Rickshaw	60	30

(c) What are the major differences in the road crash patterns between the high income country (HIC) and low-middle income countries (LMIC)? Discuss specifically with reference to the following points: **(6⅓)**

(i) Urban versus rural population share

(ii) Traffic mix, and

(iii) Left versus right hand driving.
