L-4/T-2/CE **Date : 01/10/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations 2017-2018

Sub : **CE 457** (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) Justify the statement- 'Urban traffic congestion is particularly linked with motorization and the diffusion of the automobile'. **(4 1/3)**

   (b) Discuss the following factors in relation to urban traffic congestion: (i) Longer commuting; (ii) High infrastructure maintenance costs; and (iii) Public transport inadequacy. **(3×4)**

   (c) Draw the vicious circle of congestion. Write the different measures that can help alleviate congestion in automobile dependent cities **(3+4)**

2. (a) What are the factors contributing to growth of driving? Elaborate two major factors contributing to automobile dependency. **(2+4)**

   (b) Write the negative consequences of car dependency. Briefly discuss the strategies to limit automobile circulation. **(2+5)**

   Explain different urban transport development paths. Also, identify those development paths in an ownership of passenger modes verses urban mobility level diagram. **(6+4 1/3)**

3. (a) Explain with diagram different components of hypothetical urban transit system. **(10)**

   (b) "Public transit systems are challenged to remain relevant to urban mobility or to increase its market share"- elaborate. **(8)**

   (c) Write down the different approaches used for evaluating urban transportation alternatives. **(5 1/3)**

4. (a) Why transportation planners and traffic engineers in many cases are not concerned and aware about UGM problems? State the issues and problems related to UGM. **(4+4)**

   (b) Discuss the concerns of different parties involved in UGM process. **(10)**

   (c) Write the strategies that may be useful to solve truck loading/unloading in CBD locations. **(5 1/3)**

Contd P/2

CE 457

SECTION - B

There are **FOUR** questions in this section. Answer **Q. No. 5** and any **TWO** from the rest.
Assume reasonable value for any missing data.

5. (a) A 3-by-3 trip table representing a total of 2500 trips is shown in the following table, which is for the base year 2018. **(20)**

Dest.j / *Orig.i*	1	2	3	Total (in hundreds)
1	1	4	2	7
2	6	2	3	11
3	4	1	2	7
Total	11	7	7	25

The next table indicates the origin and destination growth factors for the horizon year.

Zone	1	2	3
Origin Factor (production)	2	3	4
Destination Factor (attraction)	3	4	2

Use the Fratar technique to distribute the trips in the horizon year. (**Minimum 2 iterations**).

6. (a) Draw a flow-chart showing the factors affecting the choice of public transport mode. Also, describe the following terms related to transit capacity: (i) Maximum Load Point, (ii) Productive Capacity; (iii) Crush Capacity, and (iv) Dwell and Clearance Time. **(10)**

(b) A bus system needs to be set up between the Bangladesh University of Engineering and Technology Campus and the North-South University Campus, distance of 9.5 miles. The operating time is 30 minutes. It has been estimated that the peak hour demand is 450 passengers/hour and 45-seater buses are available, which can safely accommodate 20 standees. Design the basic system and determine the fleet size assuming that the minimum terminal time is 7.5 minute, which may be revised if necessary. **(15)**

7. (a) Explain system approach of transportation planning. **(5)**

(b) State advantages and limitations of "Saturation System". **(5)**

(c) Explain the different types of Road patterns used for highway planning with their advantages and disadvantages. **(5)**

Contd P/3

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Contd... Q. No. 7

(d) A wide range of data regarding number of trips per household size by auto ownership which was obtained from Mirpur zone in Dhaka city, is shown in Table 1. **(10)**

Table 1

Household Size	Auto Ownership					
	0		1		2+	
	HH	Trips	HH	Trips	HH	Trips
1	1,200	2,520	2,560	6,144	54	130
2	874	2,098	3,456	9,676	5,921	20,165
3+	421	1,137	2,589	8,026	8,642	33,704

Table 2 shows the forecasted number of households in the study zone by auto ownership and size.

Table 2

Household Size	Auto Ownership		
	0	1	2+
1	25	125	3
2	32	175	254
3+	10	89	512

By Cross Classification Analysis, forecast the number of trips in that zone.

8. (a) State the generalized road safety strategies. **(5)**

(b) Define Hazardous Road Location (HRL) Program and its goal. **(5)**

(c) State the main principles of Safer Road Environment. **(5)**

(d) Explain Haddon Matrix and Collision Diagram and their use in mitigating road safety problem. **(10)**

L-4/T-2/CE **Date: 01/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2017-2018

Sub: **CE 405** (Business and Career Development)

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**.

1. (a) What is the purpose of using four frames for understanding organization's behavior? According to each of these frames, what do you think an organization means? **(17½)**

   (b) What are the assumptions and basic leadership challenges under the structural frame? **(17½)**

2. (a) What is "opportunity cost" for supplier? What are four routes of adding positive value? **(17½)**

   (b) According to Ham brick and Fredrickson, one can develop strategy by finding answers of five fundamental questions. What are these five questions? Also, correlate them with Ham brick and Fredrickson strategy diamond. **(17½)**

3. (a) What are the three types of innovations? The development of smart phone falls under which kind of innovation compared with existing computer market and how it will eventually can dent into the computer market? **(17½)**

   (b) What do you understand by the principle of "customer job to be done" and how it can help you against disruption? **(17½)**

4. (a) What are the 9 components of a business model development canvas? Explain. **(17½)**

   (b) How a value map should fit with the customer profile? (in accordance with the value proposition canvas) **(17½)**

Contd P/2

CE 405

SECTION – B

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

5. (a) What is career development? Design a model towards successful career development. **(15)**

   (b) Define the five stages of a career. Describe, in brief, the five stages of a career with a graphical representation of the performance variation of an individual with each phase. **(20)**

6. (a) Describe the skills gained from an internship program for an undergraduate student. **(10)**

   (b) Explain the significance of 5Cs in analyzing a situation from market research. **(10)**

   (c) What is the role of a resume in a successful career development? Describe, in brief, the different formats of resume. **(15)**

7. (a) Briefly state the internal and external dimensions of mid-career stage of a career. **(10)**

   (b) Describe the market strategies to ensure a successful connection with customers. **(15)**

   (c) State the different steps for ensuring an ideal job search in today's job market. **(10)**

8. (a) Describe, in brief, the different types of interviews. **(12)**

   (b) Describe the brand development stages in building a strong brand in the market. **(13)**

   (c) Define Marketing. State the tasks required for an ideal marketing management. **(10)**

L-4/T-2/CE **Date: 01/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2017-2018

Sub: **CE 403** (Socio Economic Aspects of 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**.

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

   (b) What can socio economic assessment accomplish in the context of water supply for rural areas of Bangladesh? Explain. **(15)**

2. (a) How does one identify and evaluate socio economic impacts for development projects? Explain. **(20)**

   (b) Explain the various levels of "community participation" with examples. **(15)**

3. (a) What are the consequences of socio economic changes associated with new developments? **(20)**

   (b) What are the key strategic issues of Water Supply and Sanitation (WSS) projects for Bangladesh? **(15)**

4. (a) Describe the development scenarios in the WSS sectors in the rural areas of Bangladesh. How can the success be achieved? **(15)**

   (b) Explain the methodologies in practice to ensure community participation. **(20)**

SECTION – B

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

5. (a) What is Human Development Index (HDI)? The following information are available for a particular country for the year 2017. Calculate HDI for the country. **(18)**

   Life expectancy at birth : 73 years
   Mean year of schooling : 5.3 years
   Expected year of schooling : 10.5 years
   GNI per capita (PPP USD) : 3,500

   If this country would like to attain the ranking of "high human development" (minimum HDI 0.700) just by increasing the GNI per capita (other parameters remaining the same), what GNI per capita the country needs to attain?

   [Assume reasonable values for parameters not given]

Contd P/2

CE 403

Contd... Q. No. 5(a)

(b) State SDG 6, and Targets 6.1. In the context of water supply service, what do you understand by "safely managed water", "basic service" and "limited service"? Discuss the major challenges Bangladesh is facing in achieving SDG Target 6.1. **(17)**

6. (a) Define and differentiate between "economic growth" and "economic development". What do you understand by "human development"? Discuss the four major elements in the concept of human development. **(17)**

(b)Briefly discuss the concept of "sustainable development". What do you understand by "equity" in the context of sustainable development" **(8)**

(c) How many goals were there in the MDGs? Discuss the major achievements of Bangladesh during the MDG period. **(10)**

7. (a) Define GNI, GDP and GNI per capita. Why, despite many weaknesses, GNI/GDP is still the most widely used development indicator? Briefly discuss the weaknesses of GNI as a development indicator. **(18)**

(b) Discuss the policy considerations that should be taken into account in early stages of project preparation for "involuntary resettlement". **(17)**

8. (a) State SDG Target 6.2. In the context of sanitation service, what do you understand by "safely managed sanitation" and "basic sanitation"? Discuss the present sanitation coverage in Bangladesh and identify the challenges the country is facing in achieving SDG Target 6.2. How is the SDG Target 6.3 related to SDG Target 6.2? Explain. **(18)**

(b) What are the typical socio-economic impacts of major infrastructure development projects? Why is land acquisition and resettlement one of the most sensitive issues in major development projects? Explain. **(17)**

L-4/T-2/CE **Date : 04/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations 2016-2017

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

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) Name three instruments and explain their uses, which are used for measuring vibrations. **(8 2/3)**

   (b) Write short notes on: **(15)**

   (i) Sand Compaction Pile
   (ii) Vibroflotation
   (iii) Intensity Scales

2. (a) Explain different types of earthquake waves with neat sketches. **(13 2/3)**

   (b) Estimate the probability of earthquake hazard for a bridge for a return period of (i) 100 yr; (ii) 200 yr; (iii) 475 yr; and (iv) 950 yr. **(10)**

3. (a) Explain data completeness and its use for seismic hazard analysis. **(10)**

   (b) Explain V_{S30} and provide necessary values. **(3 2/3)**

   (c) For the following data, how many storied building may not be suitable and why? **(10)**

Soil Type	Layer Thickness (m)	Density (kg/m^3)	V_S (m/s)
Silty Soft Clay	12	1400	130
Medium Stiff Clay	13	1600	190
Dense Sand	17	1800	350

4. (a) What are the countermeasures for building foundation against liquefaction? Explain with figures. **(8 2/3)**

   (b) There are three seismoactive zones (Table 1) in and around a nuclear power plant site. Estimate SDE and SSE on the basis of cumulative intensity- frequency relation. **(15)**

Table 1: Parameters of seismoactive zones

Zone	a	b	I_{max}	Attenuation Value
1	0.53	0.37	XII	2.3
2	1.05	0.64	X	1.9
3	0.98	0.58	XI	2.1

Contd P/2

CE 445

SECTION-B

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

5. (a) Prove that the natural frequency, ω_n, of a mass-spring is: $\omega_n = (k/m)^{1/2}$. Also, explain how it varies with the damping ratio of the vibrating system? How does it vary with external forcing system? **(10 1/3)**

(b) A machine foundation is subjected to a maximum vertical force Q_0 = 2500 kg. Given: weight of machine + foundation = 18,000 kg; spring constant, k = 70×10^3 kg/cm; Operating frequency of the machine, ω = 40 rad/sec. Assuming that the foundation can be idealized as a mass-spring system, determine: **(8)**

(i) the maximum amplitude,
(ii) inertia force vector,
(iii) viscous force vector , and
(iv) spring force vector.

(c) Show graphically the effects of the magnitude of damping ratio on vibration amplitude in an SDOF system free vibration. **(5)**

6. (a) Derive for a damped-free vibration: **(10 1/3)**

$$z = Z_0 e^{\frac{-\omega_n D t}{\sqrt{1-D^2}}} \sin(\omega_{nd} t + \Phi)$$

where, the symbols have their usual meanings.

(b) Definer over-tuned and under-turned foundations. Which foundation system is more vulnerable to the vibration even if operating frequency is far away from natural frequency of vibrating system which can be considered safe in dynamic analysis? How is this vulnerability minimized? **(8)**

(c) Define cyclic triaxial strength of soil. State various forms of its representation in the liquefaction potential analysis. Show graphically, how does cyclic triaxial stress vary with the number of stress cycles. **(5)**

7. (a) Define soil liquefaction. How do you incorporate the phenomenal behavior of a soil deposit that liquefies in the definition of liquefaction? **(10 1/3)**

(b) A body weighing 65 kg is suspended from a spring which deflects 1.57 cm under the load. Important is subjected to a damping effect adjusted to a value 0.25 times that required for critical damping. Find the natural frequency of the un-damped 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 to 0.75 times the natural frequency, find the amplitude of forced vibrations and the phase difference with respect to the disturbing force? **(8)**

(c) Write at least 5 possible measures that you can undertake if analysis shows the subsoil of a proposed industrial site is vulnerable to liquefaction against an anticipated earthquake? **(5)**

Contd P/3

CE 445

8. (a) Evaluate: $M_{max} = \frac{1}{2D\sqrt{1-D^2}}$, for forced vibration acting on a viscous damping system , where D is the damping ratio. **(10 1/3)**

Explain what will happen if the supporting foundation system possesses an equivalent damping ratio of $1/\sqrt{2}$.

(b) For the system represented by the following equation: **(8)**

$$m\frac{d^2z}{dt^2} + c\frac{dz}{dt} + kz = m_e e\omega^2 \sin \omega t$$

State the various forces acting in the system given by the above expression.

(c) What is logarithmic decrement? Show that logarithmic decrement can be estimated with reasonable accuracy by $2\mu D$. D is the damping ratio of the vibrating system. **(5)**

L-4/T-2/CE **Date : 04/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations 2016-2017

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

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**.

Use the attached Charts and Table where necessary. Assume reasonable value of missing data, if any.

1. (a) Mention the principal reasons for non-Darcy behavior in soils. Also with neat sketches define permeability parameters n and C. **(6 ½)**

   (b) Derive Kozeny – Carman equation to predict coefficient of permeability of soil. **(6 ½)**

   (c) What are the basic requirements to be fulfilled for drawing of flow net in an earth dam? Also with neat sketches mention the possible boundary conditions for construction of flow net in an earth dam. **(6 ⅓)**

   (d) A homogenous earth embankment of height 14 m was built on an impervious foundation with side slopes 3:1 (horizontal : vertical). The embankment retains water to a height of 12 m. The crest width of the embankment is 3 m. The coefficient of permeability of the embankment soil is 4×10^{-5} m/s. Calculate the rate of seepage through the embankment using Schaffernak and Van Iterson's method. **(4)**

2. (a) Derive equation of continuity and Laplace's equation in two dimensions. Also show that both potential function and stream function satisfy Laplace's equation while stream function satisfies equation of continuity. **(7 ⅓)**

   (b) With neat sketch briefly describe a direct method of determining soil suction. **(4)**

   (c) A test well, 0.5 m diameter, was drilled through an aquifer of 8 m thick up to the underlying impermeable stratum. The original water table is at the ground surface. At the steady state, the discharge from the well is 5×10^{-2} m^3/s at a drawdown of 3 m. Determine the coefficient of permeability of the aquifer if the observed radius of influence is 120 m. **(4)**

   (d) A homogenous earth embankment of height 12 m was built on an impervious foundation with side slopes 0.5 : 1 (horizontal : vertical). The embankment retains water to a height of 10 m. The crest width of the embankment is 3 m. Plot the line of seepage (phreatic line) using A. Casagrandi's method (use plain graph paper for plotting). **(8)**

Contd P/2

CE 447

3. (a) Mention the assumptions for determining permeability by pumping test. With neat diagrams briefly describe the variable head borehole permeability tests for the following cases: **(10)**

(i) Uncased borehole

(ii) Cased borehole with column of soil inside the casing to a certain depth

(iii) Cased borehole with soil flush with the bottom of the borehole.

(b) Derive an expression for determining the rate of seepage through an earth dam resting on an impervious base using Leo Casagrand's method. Also state the procedure for plotting the line of seepage (phreatic line) using this method. **(7 1/3)**

(c) A dry cohesive deposit of clay of height 3 m exists in an infinite slope. The slope angle is 60°. The values of effective cohesion (c′) and effective angle of internal friction (ϕ′) of the clay are 20 KN/m^2 and 15°, respectively. Dry unit weight of the clay is 17 KN/m^3. Find r following: **(6)**

(i) Factor of safety of the slope with respect to sliding.

(ii) Factor of safety of the slope with respect to cohesion assuming friction has been fully mobilized.

(iii) Critical height of the slope.

4. (a) What general criteria should be considered during design of a revetment structure? **(3 1/3)**

(b) With neat sketch briefly describe the procedure for determining th coefficient of permeability in the laboratory by horizontal capillarity test. **(6)**

(c) The upstream slope of an earth embankment of height 6 m was constructed at an angle of 65°. The values of saturated unit weight, cohesion and angle of internal friction of the embankment soil are 20 KN/m^3, 25 KN/m^2 and 10°, respectively. Calculate the factor of safety of the upstream slope of the embankment for the following cases: **(6)**

(i) When the reservoir is full to the top level of the upstream slope

(ii) When a sudden drawdown occurs.

(d) The following data have been obtained for the design of bank revetment using CC blocks for a site on the Meghna river: **(8)**

- Average flow velocity = 3 m/s
- Specific gravity of CC block = 2.4
- Mass density of CC block = 2400 kg/m^3
- Angle of repose of CC block = 30°
- Ratio of water depth and revetment size = 5
- Slope of bank = 2: 1(horizontal : vertical)
- Shield's constant = 0.04
- Strength coefficient = 5
- Damage coefficient = 6.5
- Wind speed = 30 m/s
- Minimum wind duration = 0.75 hour
- Fetch length =5 km.

Characteristics of the waves are shown in Table 1. Determine the thickness of CC blocks capable of withstanding the action of currents and waves.

Contd P/3

CE 447

SECTION-B

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

5. (a) Discuss the adverse effects of water on earth slopes and dams. Also discuss one beneficial effect of water in geotechnical field. **(8)**

(b) State the chemical and physical processes by which water influences the engineering behavior of soils. **(6 1/3)**

(c) Discuss measures, with appropriate sketch, that may be adopted to minimize the adverse effects of water to basements and foundations. Also discuss the ways to make the design of a retaining structure safe and economic in consideration to the water pressure. **(9)**

6. (a) Draw the cross-section of a river bank slope with revetment work and show its different components. **(8)**

(b) "A granular filter may be completely unsatisfactory even if the theoretical piping ratio is satisfied."- Under what situation can important happen? How to design a granular filter in such a case? **(7 1/3)**

(c) What is meant by hydraulic segregation relevant to a hydraulic fill? What measures are taken to avoid hydraulic segregation? **(8)**

7. (a) Discuss two methods of ground improvement for hydraulic fills with clean sand. **(8)**

(b) Discuss the use of factor of safety as applied to laboratory test properties in designing with geotextiles. **(7 1/3)**

(c) State factors that given the selection of an appropriate method for a hydraulic fill. **(8)**

8. (a) Differentiate between permittivity and transmissivity properties of geotextile. **(8)**

(b) Discuss the depositional process and characteristics of various sub-aqueous hydraulic fills. **(7 1/3)**

(c) Revetment work is to be done on a river bank with cement concrete (CC) blocks. It is considered that a two stage granular filter: a sand layer and a course aggregate layer will be provided beneath the CC blocks for protection of the in-situ soil. **(8)**

Fig. 1 shows the diagram curves of proposed materials for sand layer and course aggregate layer along with that of in-situ soil. Analyze and comment on the suitability of the proposed sand and course aggregates as filter layer.

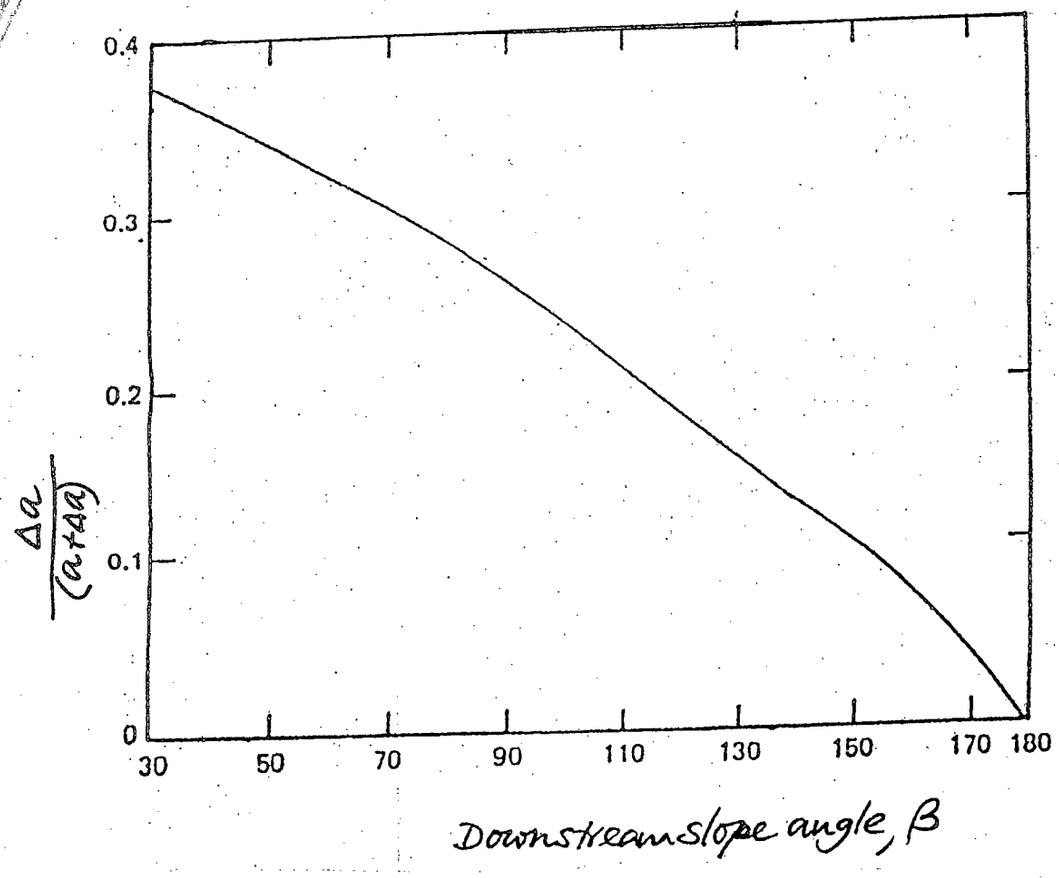


Chart 1

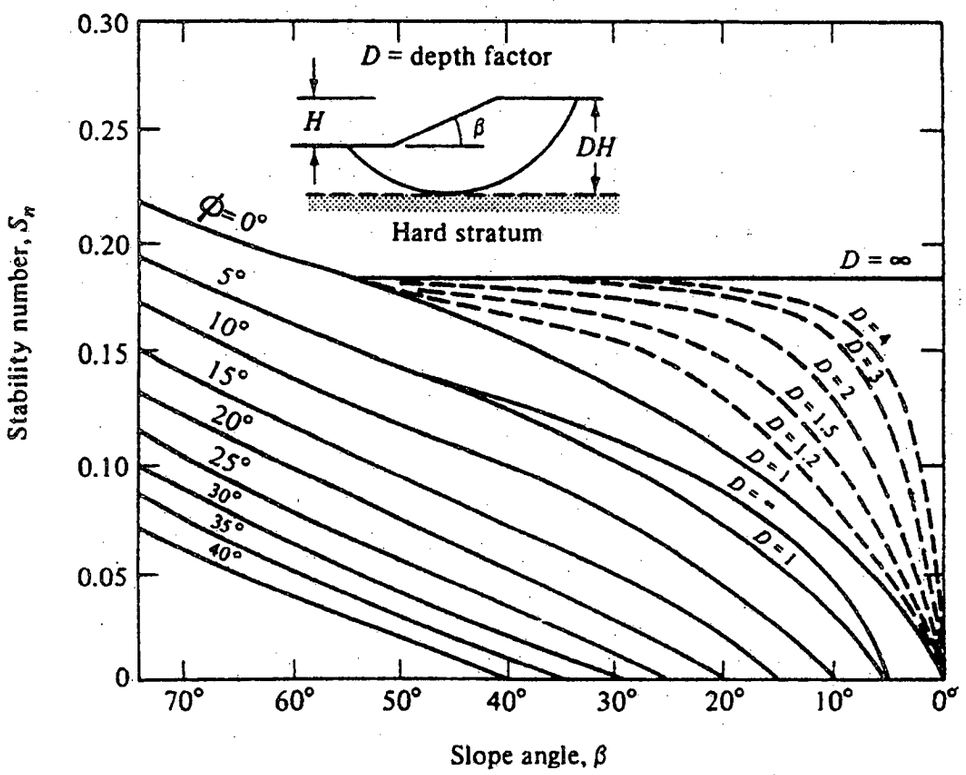


Chart 2

Table 1 Characteristics of Waves

Wind speed (m/sec)	Minimum duration of wind (hour)	Fetch length (km)	Wave height (m)	Wave period (sec)
15	1.00	5.0	0.7	2.8
	1.75	10.0	0.9	3.3
	2.25	15.0	1.2	3.8
30	0.75	5.0	1.3	3.5
	1.50	10.0	1.8	4.5
	2.00	15.0	2.0	5.0

CE447

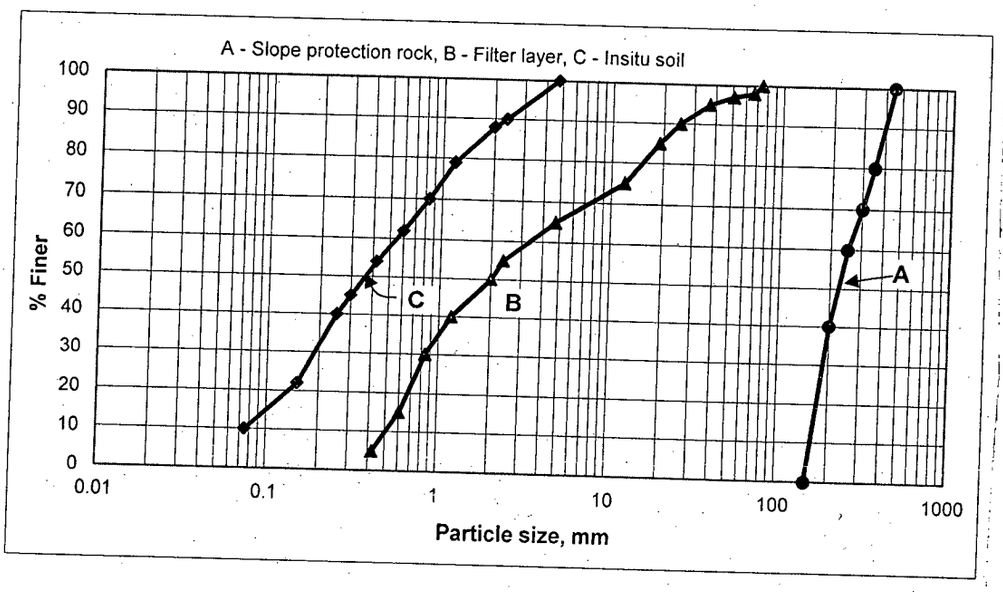

A - Slope protection rock, B - Filter layer, C - Insitu soil
% Finer
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
Particle size, mm
A
B
C

Fig. 1

L-4/T-2/CE **Date : 11/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2016-2017

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 375-ft-long concrete, box-girder bridge on four supports - two abutments and two symmetrically located bents, is shown in Fig. 1(b). The cross-sectional area of the bridge deck is 123 ft^2. The weight of the bridge is idealized as lumped at the deck level; the unit weight of concrete is 150 lb/ft^2. The weight of the bents may be neglected. Each bent consists of three 25-ft-tall columns of rectangular cross section with $I_y' = 12\ ft^4$ and $I_z' = 14\ ft^4$ (Fig. 1(a)). Determine the natural frequency of the bridge in the longitudinal and transverse directions. The elastic modulus of concrete is E = 3000 ksi. Consider the deck to be rigid (EI = ∞) and the columns to be clamped at the footings. **(15)**

   (b) Determine the equations of motion of the following two DOF spring-mass-damper system as shown in Fig. 2. **$(8\frac{1}{3})$**

2. (a) Express the periodic loading shown in Fig. 3 as a Fourier series. Determine only the first four terms of the Fourier coefficients a_o, a_n and b_n. **(15)**

   If the above loading is applied to an undamped SDOF system, which has the time period of $0.5T_0$, determine the steady state response of the system.

   (b) Draw the dynamic magnification factor vs frequency ratio curve of a damped dynamic system subjected to harmonic excitation and briefly explain about it. **$(8\frac{1}{3})$**

3. (a) The SDOF frame subjected to the blast loading history is shown in Fig. 4. Determine the response time history of this system by the Newmark's Beta method (constant average acceleration method) using h = Δt = 0.12 sec. Given, initial displacement, $v_0 = 0$ and initial velocity , $\dot{v}_0 = 0$. Use equation 1 to 4 given herewith. **(16)**

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

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

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

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

Contd P/2

CE 421

(b) Describe briefly about the Eigenvalue problem, Eigenvalues ad Eigenvectors. $(7\frac{1}{3})$

4. (a) What are the basic differences between static and dynamic problems? $(3\frac{1}{3})$

(b) Determine the natural frequency and mode shape of the two DOF shear frame as shown in Fig. 5. Draw the mode shapes also. Given EI_c = 5184 k-in^2, h = 10 ft, m = 3 kip/in/sec^2 **(20)**

SECTION – B

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

5. (a) Derive the expression for free vibration response of an under-damped SDOF system. $(7\frac{1}{3})$

(b) Write short note on logarithmic decrement. **(6)**

(c) A single storey reinforced concrete (RC) building idealized as a massless frame as shown in Fig. 6. supporting a dead load of, W = 10 kip at the roof level. Each column is 10″×10″ in cross-section. The beam is assumed to be rigid ($EI_b = \infty$). Assume Young's modulus of concrete, E = 3 × 10^{3}ksi. Determine the natural frequency of the frame. Mass, m = W/g, where g = 386 in/sec^2. **(10)**

6. (a) Describe briefly the different types of dynamic loads. **(4)**

(b) Derive the response of an un-damped SDF system subjected to a cosine force, P(t) = $P_0 \cos \omega t$; $(7\frac{1}{3})$

(c) The un-damped spring-mass system has a mass of 5.0 kg and a spring stiffness of 4000 N/m. It is excited b y a harmonic force having and amplitude P_0 = 200N and an excitation frequency of ω = 8 rad/s. The initial conditions are u(0) = 0.015 m and $\dot{u}(0) = 0.15$ m/s. Determine (a) the frequency ratio (b) the amplitude of the forced response (c) the displacement of the mass at time t = 2 s. and (d) the velocity of mass at time t = 4 s. **(12)**

7. (a) Derive the response of an un-damped SDOF dynamic system under ideal step loading. Given, initial condition, $u(0) = \dot{u}(0) = 0$. $(7\frac{1}{3})$

(b) Describe about the bandwidth method to evaluate the damping in a SDOF dynamic system. **(6)**

Contd P/3

CE 421

(c) A weight attached to a spring of stiffness 500 N/m and undergoes viscous damping and the weight was displaced and released. The period of vibration was found to be 2.4 seconds. The ratio of consecutive amplitudes was found to be 4.2/1. Determine the steady state vibration amplitude and phase angle when a force of P(t) = 100 sin 4t acts on the system. **(10)**

8. (a) What is the unit-impulse response function? **(6)**

(b) Write short notes on Duhamel's integrals. **(6)**

(c) The SDOF system has a spring stiffness k = 40 k/in., and the mass weighs 38.6 kip. If the system is initially at rest, that is $u(0)=\dot{u}(0)=0$, when an excitation p(t) = 20 cos(10t) kip begins, determine an expression for the resulting motion. Assume damping ratio, ρ = 0.20. **($11\frac{1}{3}$)**

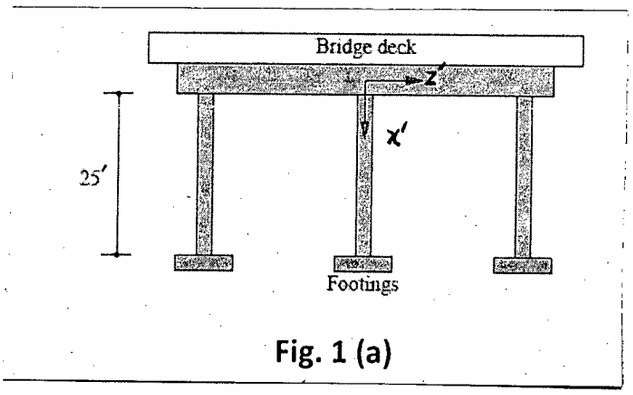


Fig. 1 (a)

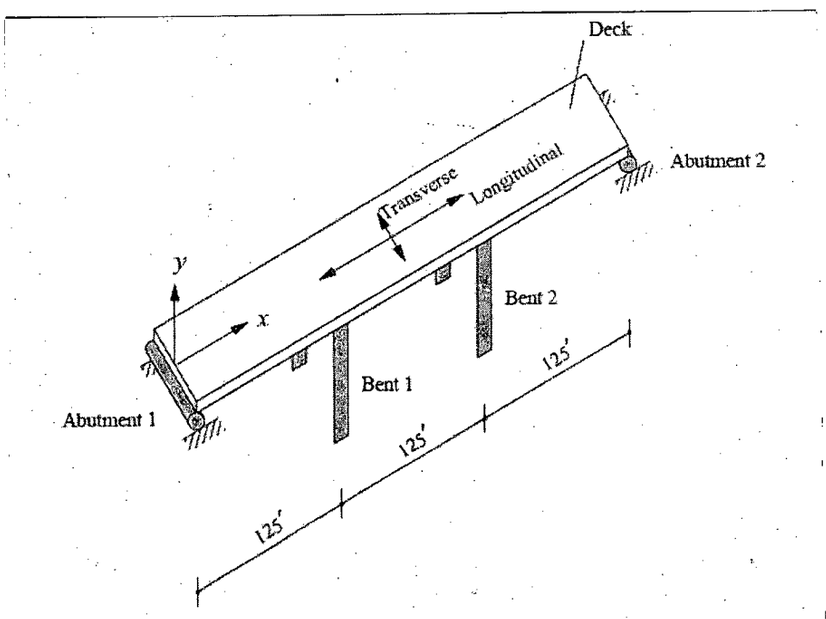


Fig. 1 (b)

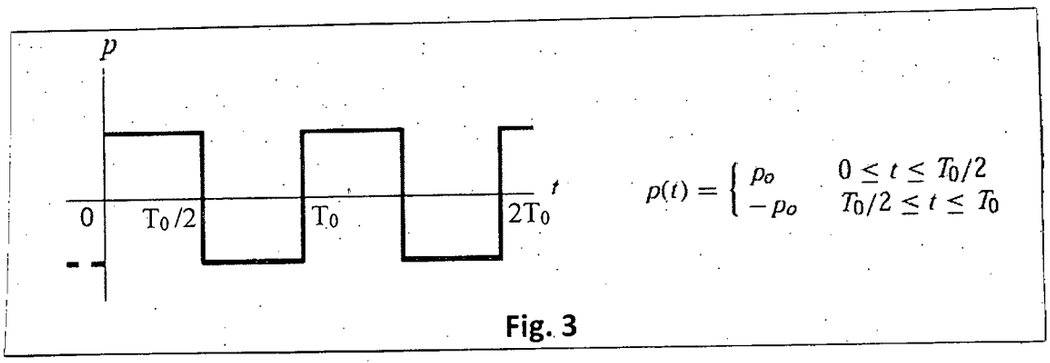


Fig. 3

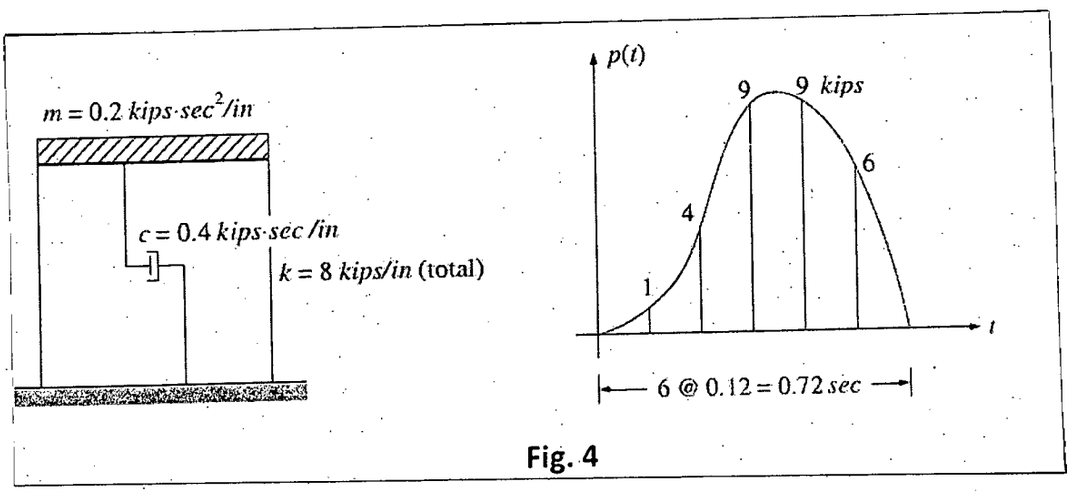


Fig. 4

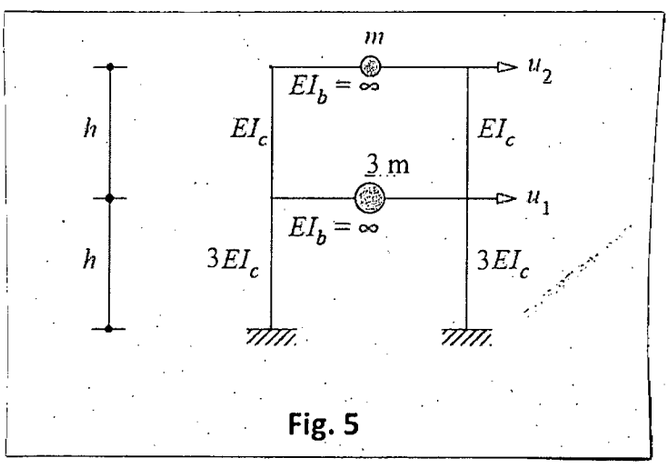


Fig. 5

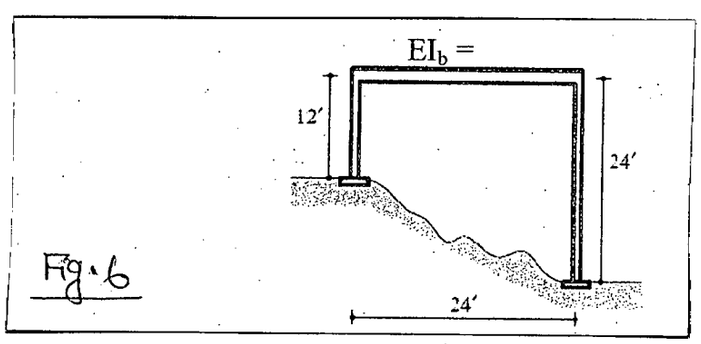


Fig. 6

L-4/T-2/CE **Date : 11/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2016-2017

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 any **THREE**.

Symbols have their usual meaning. Assume reasonable values for missing data, if any.

1. (a) Explain the term "Shape Functions". Why polynomial terms are preferred for shape functions in finite element method? **(4+5=9)**

   (b) Determine shape functions for 4-noded rectangular elements. Use natural coordinate system. **($14\frac{1}{3}$)**

   In this process show that shape function for i_{th} node can be written generally as:
   $N_i = \frac{1}{4}(1+\xi\xi_i)(1+\eta\eta_i)$ for i = 1, 2, 3 and 4.

2. (a) Define isoparametric element. Why isoparametric element performs better than super parametric element. **(4+5)**

   (b) Discuss convergence criteria for isoparametric elements. **($6\frac{1}{3}$)**

   (c) Give two examples to show that natural coordinate system performs better than cartessian coordinate system in a finite element formulation. **(8)**

3. (a) The beam shown in Figure-1 is clamped at the two ends and acted upon by a force P and moment M in the mid-span. Fine the deflection and rotation at the centre node and reaction forces at the two ends. **($16\frac{1}{3}$)**

   (b) Why Gauss quadrate formula is preferred in finite element analysis? Write down the expression that Gauss method suggests to compute a function at predetermined sampling points **(7)**

4. (a) Describe the sequence of development of front in terms of letters used for nodes as the front creeps forward one element after another as shown in Figure 2. **(12)**

   (b) Explain the situations when band solution becomes more expensive than frontal solution technique in terms of memory requirements and storage time. **(8)**

   (c) Explain skyline technique with an example. **($3\frac{1}{3}$)**

Contd P/2

SECTION – B

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

The notation carry their usual meaning

5. (a) Is FEM an exact method of analysis? Explain the reasons behind your statement. **($5\frac{1}{3}$)**

   (b) What are the assumptions of linear static problem? **(6)**

   (c) What do you understand by "Transformation Matrix? Explain the instances the matrix is needed in a standard finite element procedure. **(12)**

6. (a) What is a Constitutive relation? Write down the relation for a linear isotropic material. **($6\frac{1}{3}$)**

   (b) "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 assumption for this derivation. **(6)**

   (c) The bar element shown in Figure -3 is subjected to axial forces, f_i and f_j at node 1 and node 2. Assume necessary shape functions for node i and node j, respectively. Show that element stiffness for the element can be expressed as: **(11)**

$$\underline{\underline{k}} = \int_V \underline{\underline{B}}^T \underline{\underline{E}} \underline{\underline{B}} \, dV$$

7. (a) List and explain the types of discontinuities that may occur in a finite element mesh? What are the ways to minimize the discontinuities in finite element procedure? **($6+5\frac{1}{3}$)**

   (b) "In a displacement based finite element formulation with inadequately defined mesh, a lower bound solution is expected" - Explain **(6)**

   (c) Write a short note on the effect of element aspect ratio on the accuracy of a numerical solution **(6)**

8. (a) Summarize the basic procedural steps that are followed in analyzing a structure using finite element method. **(6)**

   (b) Find the stresses in the two bar assembly as shown in Figure 4. The bar is loaded with force, P and constrained at two ends. Use 1-D bar elements. **($11\frac{1}{3}$)**

   (c) If the two bars in Figure-4 are tapered in cross-sectional area along the lengths, how will you address the problem in your finite element model? Discuss the limitations, if any, in your considerations. **(4+2)**

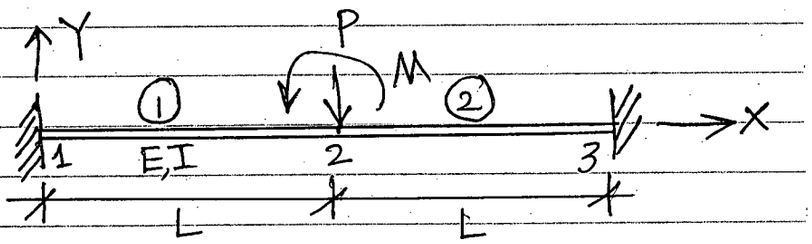


Figure 1.

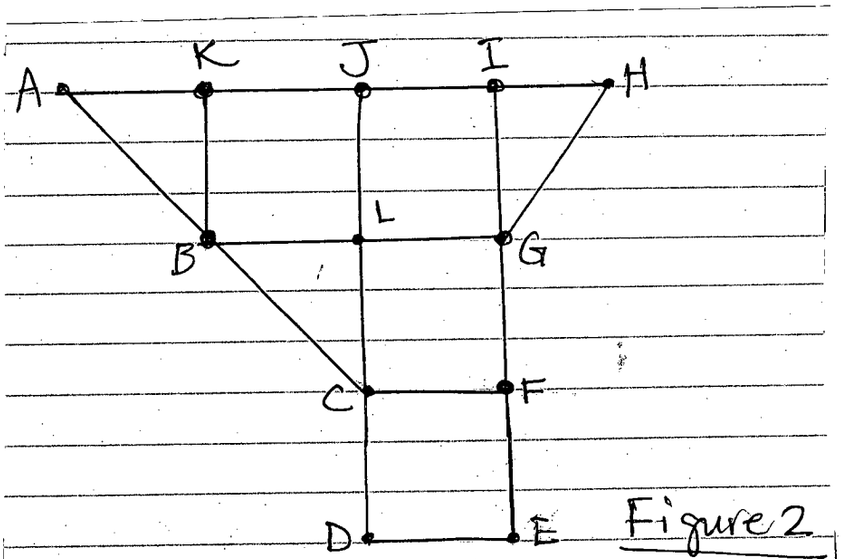


Figure 2

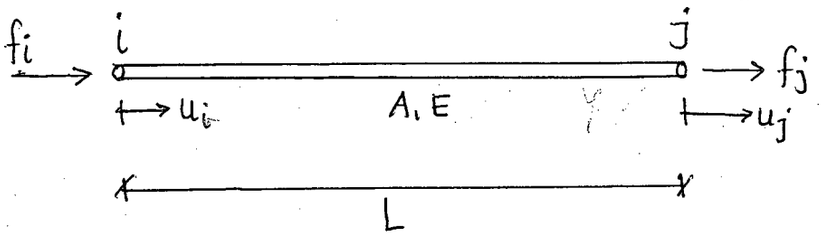


Figure 3

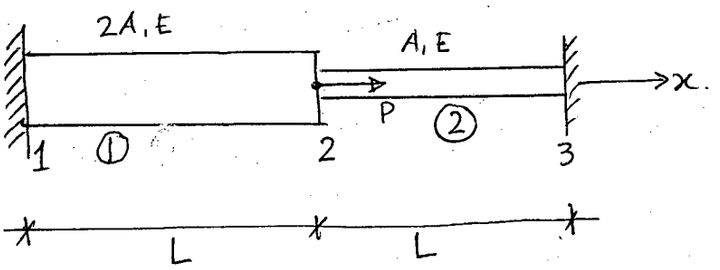


Figure 4

L-4/T-2/CE **Date : 15/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations 2016-2017

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

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) Briefly describe the analyses methods for foundations of structures subjected to lateral loads. How does lateral load affect the bearing capacity of foundation? **(5)**

   (b) What are the primary uses of geo-textiles in foundation engineering? What are the main components of a retaining wall with metallic strip reinforcement? Draw necessary diagram. **(5)**

   (c) Determine the factor of safety against sliding for the square footing (2.2 m× 2.2m) shown in Fig. 1. Is the footing safe against sliding? If the factor of safety against sliding is not sufficient what can be done? Is there any effect of the water table on the stability against sliding? **(13 1/3)**

2. (a) List the common uses of retaining walls. Compare between buttressed wall and counterfort wall. **(5)**

   (b) Show in neat sketches the ultimate limit states of external instabilityfor mechanically stabilized retaining wall. **(5)**

   (c) Determine the factors of safety against sliding and overturning failure for the retaining wall shown in Fig. 2. Consider the passive resistance in front of the wall. Comment on the safety against overturning and sliding. Unit weight of concrete, $\gamma_{conc} = 22.5$ kN/m^3. **(13 1/3)**

3. (a) What is a cofferdam? Show the main components of a cofferdam in a neat sketch. Mention the force /stress that is necessary to consider for designing each component of the cofferdam. **(5)**

   (b) Compare the phenomenon of earth pressure on braced cofferdam in 'soft clay' and 'stiff clay'. **(5)**

   (c) A braced excavation system for an open cut is shown in Fig. 3. Determine the force in the struts **A, B** and **C**. The struts are spaced 2 m center to centre horizontally. **(13 1/3)**

4. (a) Compare the advantages of pneumatic caissons and box caissons. List the factors that influence the selection of size and shape of the caissons. **(5)**

   (b) List the types of load that are necessary for designing a caisson. Describe briefly the permanent loads for designing caissons. **(5)**

   (c) Will the caisson shown in Fig. 4 be self sinking? If not determine: (a) the required amount of ballast and (b) the thickness for self sinking. Calculate the allowable load capacity (Factor of safety, FOLLOWS = 3.0) of the caisson. Given, for $\phi = 30°$, $N_q = 22.5$, $N_\gamma = 19.7$, $S_\gamma = 0.6$. **(13 1/3)**

Contd P/2

CE 443

SECTION-B

There are **FOUR** questions in this section. Answer any **THREE**.
Assume reasonable value of missing data only if necessary .

5. (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 1/3)**

(b) Briefly describe the different techniques available for construction dewatering (no need to present diagram). Discuss how soil permeability affects the choice of each method. **(11)**

6. (a) Write short notes (Answer any three): **(4×3=12)**

(i) Moment reduction for anchored sheet pile

(ii) Effect of wall movement on the lateral earth pressure acting on a retaining wall.

(iii) Raymond's (1997) criteria for underpinning of structures adjacent to a braced excavation.

(iv) Modulus of horizontal subgrade reaction.

(b) 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 1/3)**

(c) Using Broms' method, determine the ultimate capacity of fixed-head (restrained) pile subjected to a horizontal load. Assume the following: Cohesive soil, unit weight = 110 lb/ft^3, undrained shear strength = 700 psf, pile diameter = 18 inch, pile length = 20 ft, yield moment = 80 kip-ft. **(6)**

7. (a) A cantilever sheet pile needs to retain 3 m of sandy backfill material. It is embedded in cohesive soil as shown in the Figure. 5. Ground water table acts on both sides of the sheet pile according to a depth of 1 m from top of backfill material. Determine the required depth of penetration of the sheet pile into the cohesive soil. **(14)**

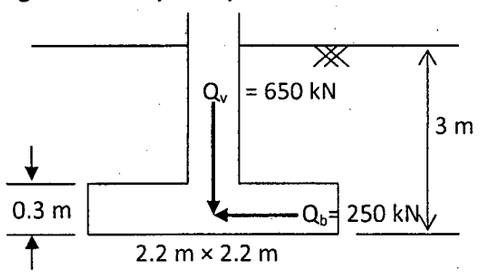
(b) If the water table infront of the retaining wall of Figure. 5 falls by 1 m, while the water table in the backfill remains unchanged, show the change in lateral pressure on the wall. Also indicate how you will consider the effect of upward seepage caused by this sudden drop of water table. **(5 1/3)**

(c) Show Broms' earth pressure distribution and failure modes for laterally loaded piles in cohesive soils for short and long piles. **(4)**

8. (a) Briefly discuss the use of stability number in the context of sheetpile walls. **(3 1/3)**

(b) Determine the required embedment of an anchored sheet pile, shown in Figure. 6, retaining sandy backfill material and embedded in silty sand. Assume an additional surcharge load of 10 kN/m^2 on the backfill. Determine the spacing and size of mild steel tie-rods to be used for anchor. Also show the distance of the anchor block from the sheet pile wall. **(20)**

CE 443: Earth Retaining Structures (Sec. A)



Uniform soil layer
γ=17.0 kN/m^3
ϕ=28°
c=35 kPa

Fig. 1. for Q. 1(c)

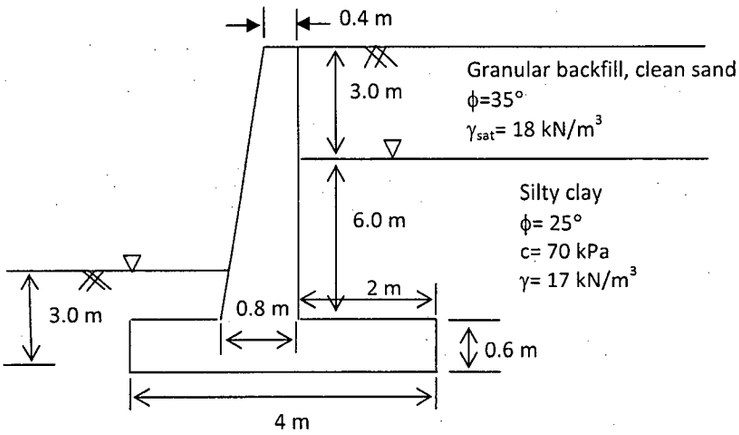
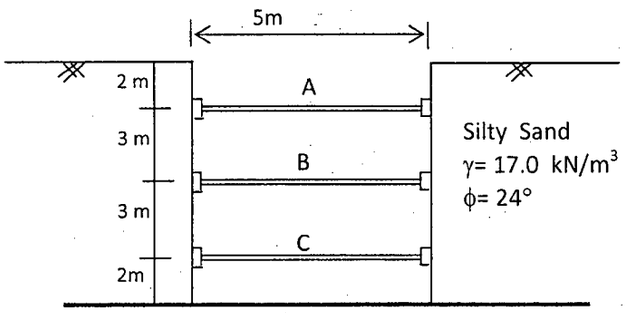
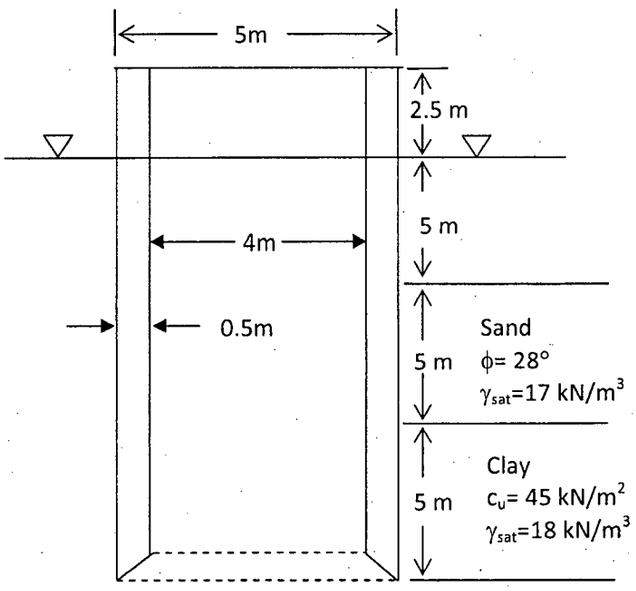


Fig. 2. for Q. 2(c)



Bottom of excavation, Water table is greater depth

Fig. 3. for Q. 3(c)



Sand ϕ= 30°, γ_{sat}=19 kN/m^3

Fig. 4. for Q. 4(c)

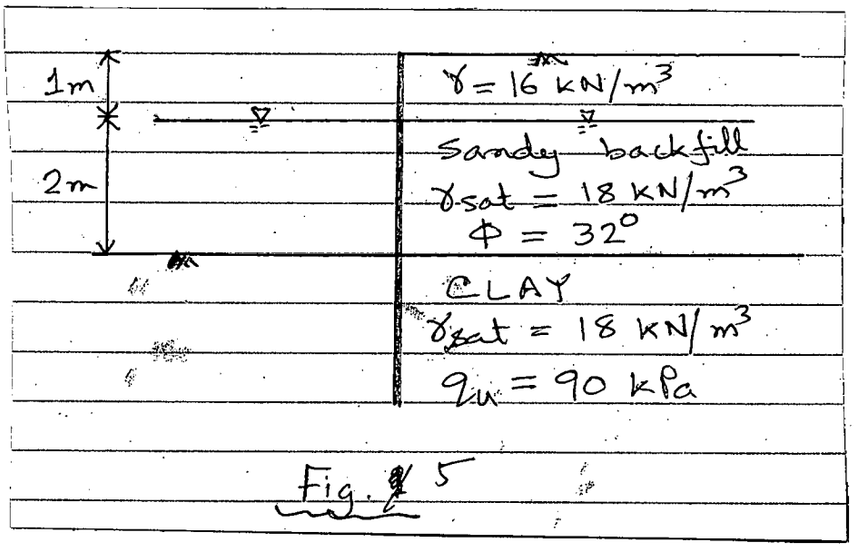

1m
2m
γ = 16 kN/m³
Sandy backfill
γsat = 18 kN/m³
Φ = 32°
CLAY
γsat = 18 kN/m³
qu = 90 kPa

Fig. 5

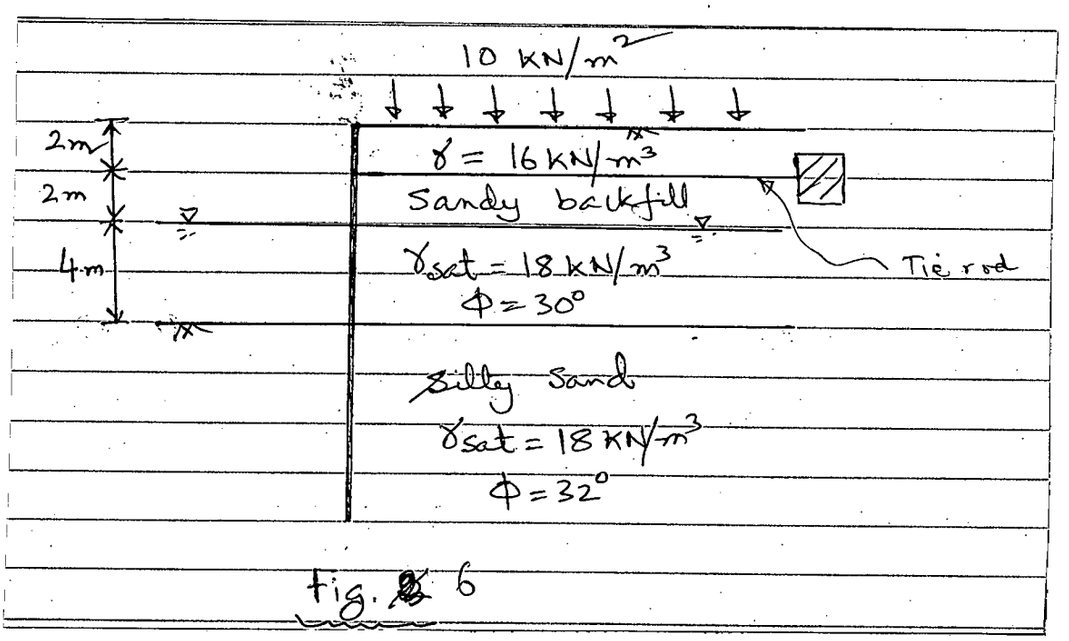
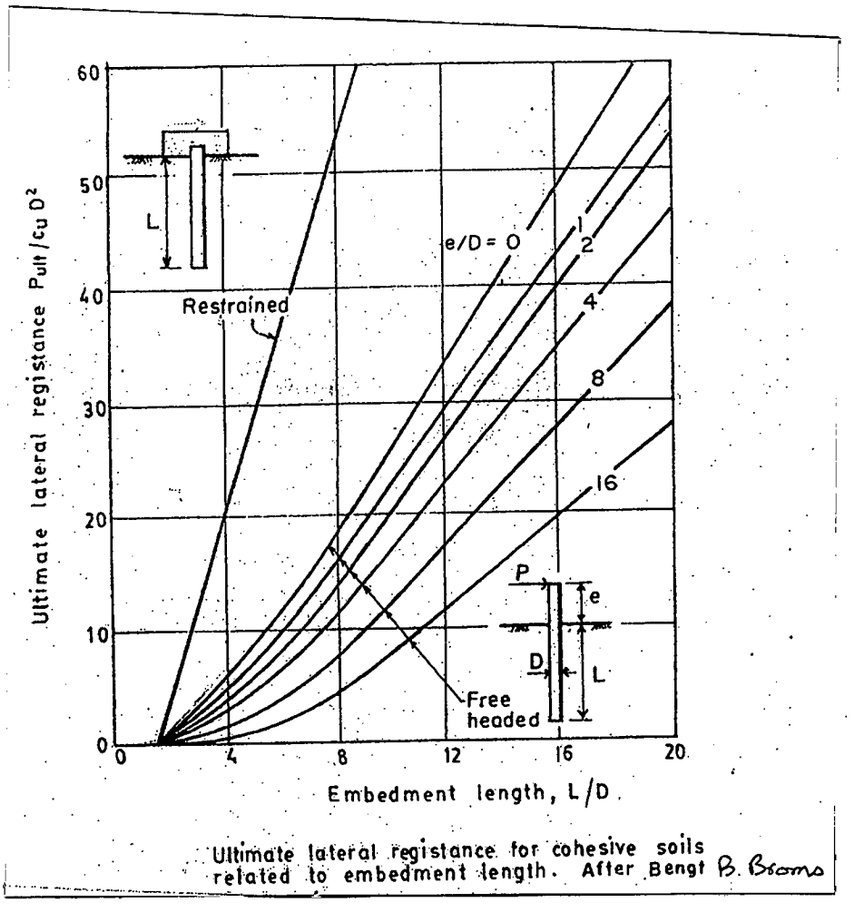
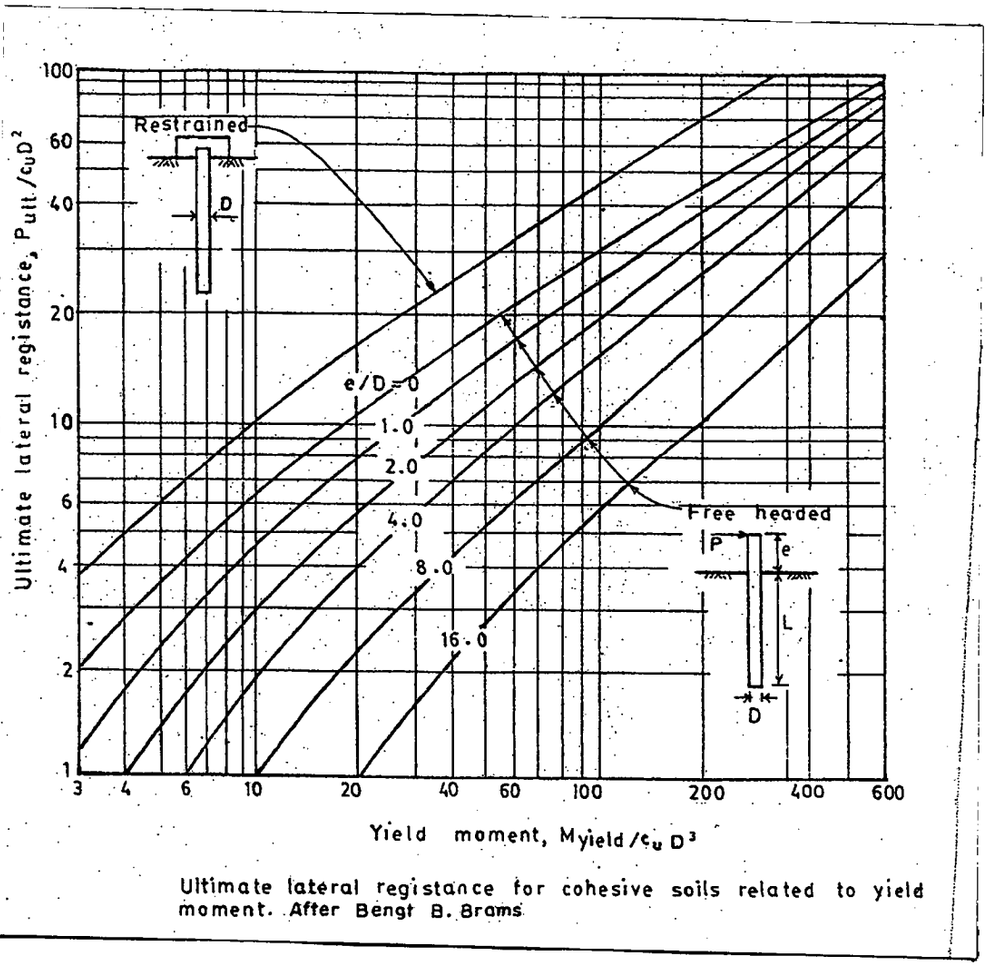

10 kN/m²
2m
2m
4m
γ = 16 kN/m³
Sandy backfill
γsat = 18 kN/m³
Φ = 30°
Tie rod
Silty Sand
γsat = 18 kN/m³
Φ = 32°

fig. 6



Ultimate lateral registance for cohesive soils related to embedment length. After Bengt B. Broms



Ultimate lateral registance for cohesive soils related to yield moment. After Bengt B. Broms

L-4/T-2/CE **Date : 17/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2016-2017

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**.

1. (a) Explain Pavement Management System. Describe the Effects of Maintenance and Rehabilitation on Pavement Conditions. **($7\frac{1}{3}$)**

   (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 Base course. **($9\frac{1}{3}$)**

   (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 200 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 540 meter. The velocity of flow in the side drain may be assumed 0.55 ms so that silting and erosion are prevented. Estimate the design quantity of flow on the side drain for 25 years period of frequency of occurrence of the storm. Use figure 1 and 2 of required. **($9\frac{1}{3}$)**

   (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)**

Contd P/2

CE 455

4. (a)The maximum quantity of water expected in on open longitudinal drains on clayey soil is 1.0m^3/sec. Design the X-section and longitudinal slope of Trapezoidal drain assuming the bottom width to be 1.0 meter and cross slope to be 1V:1.5H. Allowable velocity of flow in the drain is 1.2 m/sec. and Manning's roughness co-efficient is 0.02. Assume a free board = 0.14m. **(10)**

   (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) What is efficient Transportation System? Write the advantages and problems of air transportation. **(2+5)**

   (b) Discuss the trend of air travel demand in Bangladesh with qualitative diagrams. **(7)**

   (c) State the factors to be considered for the site selection of an airport. Show with a diagram the components of an airport system for a large airport. **(3+6$\frac{1}{3}$)**

6. (a) Write the functions and need of ATC. **(4)**

   (b) Mention the types of airport planning studies. Write the factors that affect runway orientation. Explain with diagrams different runway configurations. **(3+3+8)**

   (c) Explain how the size of aircraft and type of aircraft parking affect the size of the gate. **(5$\frac{1}{3}$)**

7. (a) Explain with diagrams the different concepts of planning the terminal building. **(7$\frac{1}{3}$)**

   (b) Write short notes on : (i) Bypass taxiway; (ii) Holding fix; (iii) Victor routes:; and (iv) Displaced threshold marking. **(3×4)**

   (c) Show in a single diagram the different types of aircraft parking. **(4)**

8. (a) Explain with diagram the narrow-gauge pattern for runway lighting. **(5$\frac{1}{3}$)**

   (b) What is "Black Hole Effect"? Explain culvert and ICAO systems of runway approach lighting. **(2+8)**

   (c) Define airway Beacon. Explain ILS. Differentiate between VFR and IFR conditions. **(2+2+4)**

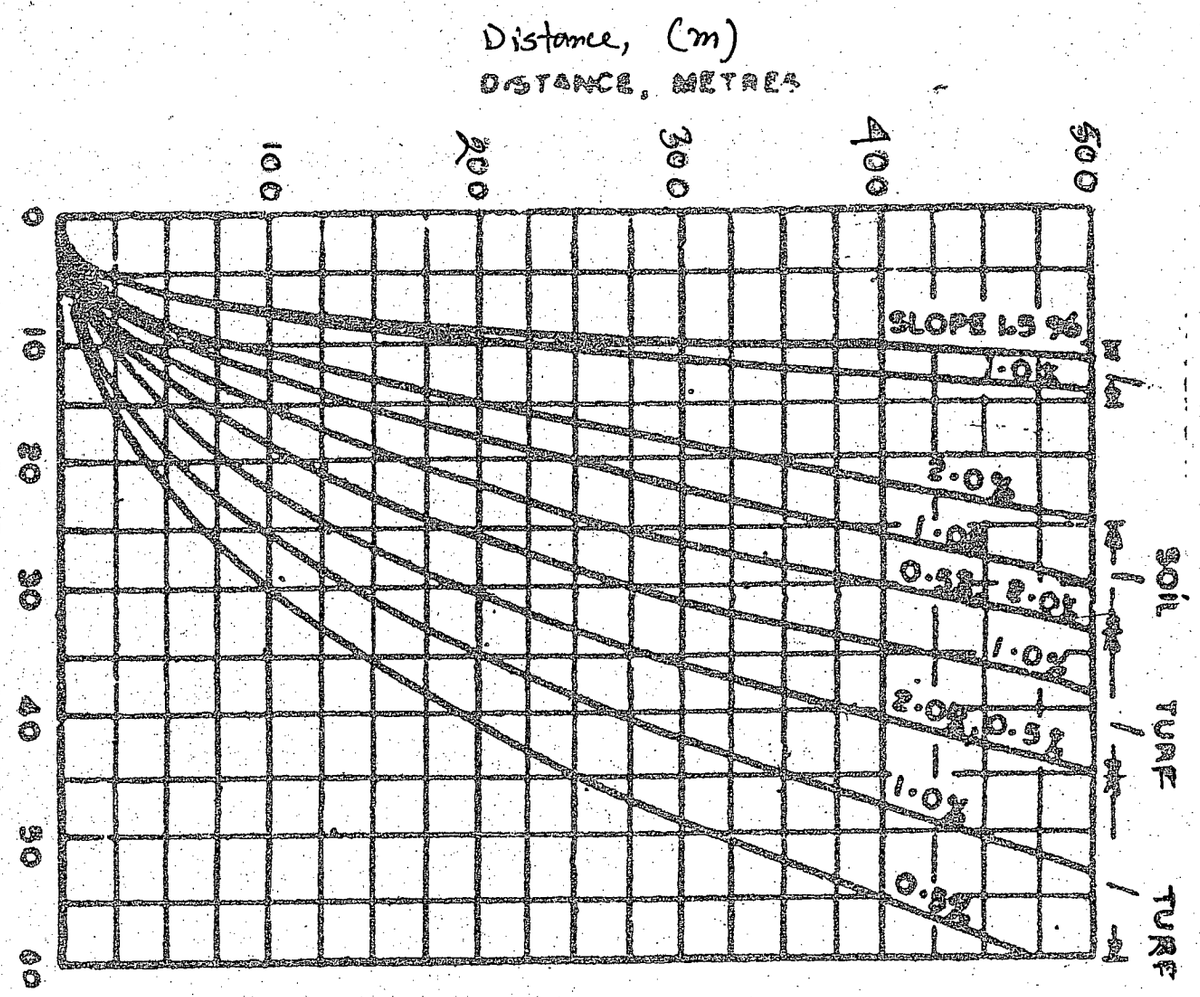


Fig. 1 Time of Flow to Inlet

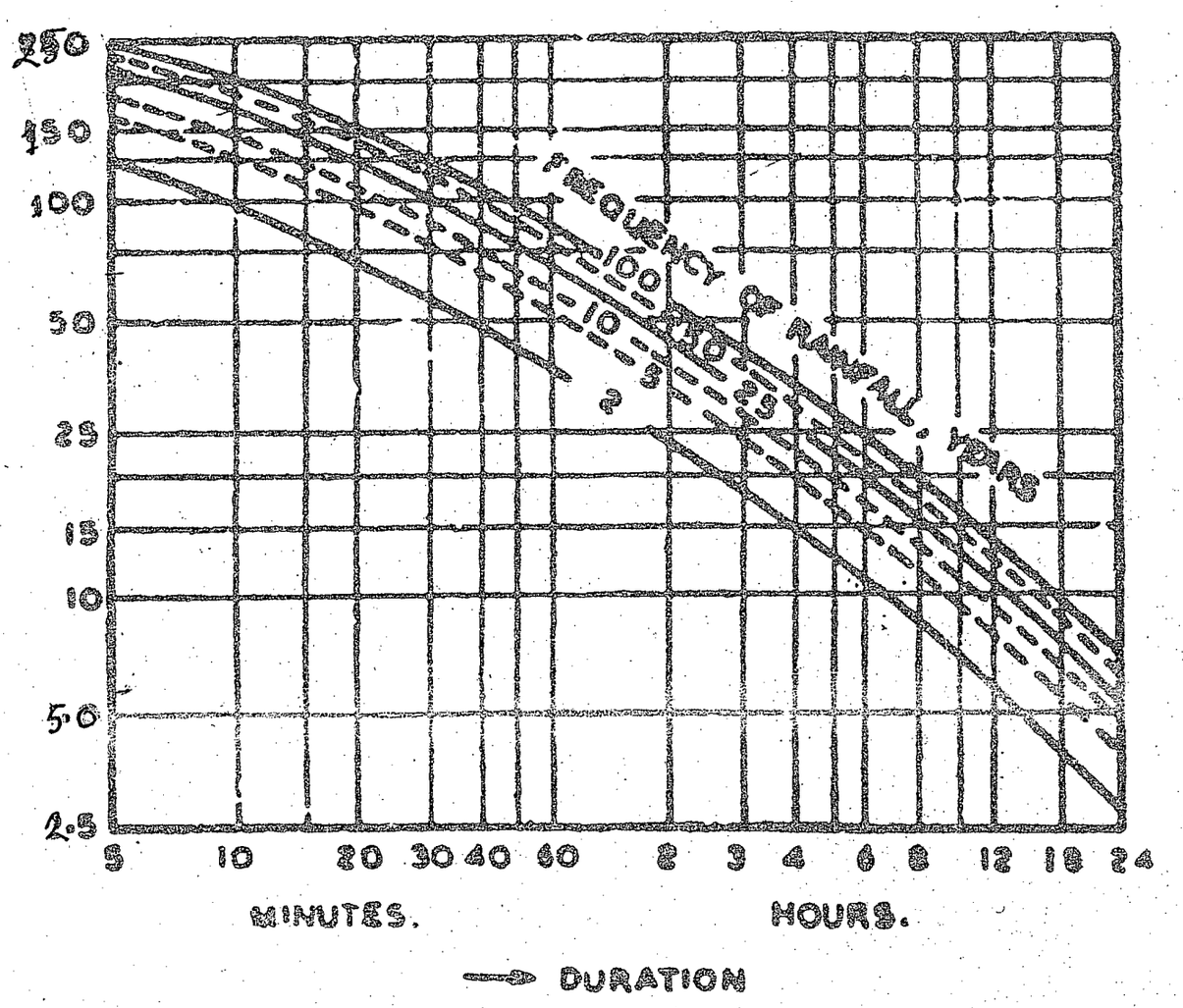


Fig. 2. Typical Rainfall Intensity Duration Curve

L-4/T-2/CE **Date : 19/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations 2016-2017

Sub : **CE 435** (Environmental Pollution 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) What do you understand by aerodynamic diameter of particulate matter (PM)? On a particular day, air quality index (AQI) for Dhaka city is 250, and the Critical Pollutant is $PM_{2.5}$. Determine the concentration of $PM_{2.5}$ on that particular day. [Table for calculating AQI provided] **(6)**

(b) Explain the effects of atmospheric aerosols (including black carbon) on global warming, distinguishing between positive and negative, and direct and indirect forcings. **(7 1/3)**

(c) A gravitational setting chamber is to be designed with a height of 1.65 m, where flow velocity will be maintained at 0.35 m/sec. The Chamber shall be designed such that all particles with size ≥ 40 μm are removed with 100% theoretical efficiency. Estimate the length of the chamber, and the settling velocity of a 40 μm particle. Also estimate the removal efficiency of 25 μm particle in the designed settling chamber [$\mu = 2.0 \times 10^{-5}$ kg/m.sec; Specific gravity of particle = 2]. **(10)**

2. (a) A power plant emits fine particulate matter (PM) at a rate of 28.5 g/sec through a stack that has an effective height of 40 m. Wind speed at instrument height (10 m) is 4.5 m/sec and the atmosphere is "neutral". Calculate: **(12)**

(i) Ground concentration of particulate (PM) matter 1.8 km down-wind of the power plant, along the center-line of the plume.

(ii) Concentration of (PM) 1.8 km down-wind, at a height of 20 m above the ground and 100 m off the center-line of the plume.

[Given: p = 0.25 for neutral atmosphere; Table for calculation of dispersion coefficient provided]

(b) What do you understand by "thermal NO_x" and "fuel NO_x"? What are the adverse impacts of NO_x? **(7)**

(c) What do you understand by stable, unstable and neutral atmosphere? Determine the nature of atmospheric stability for each of the following situation of ambient atmosphere: **(4 1/3)**

(i) $dT/dz = 0$; (ii) $dT/dz = \Gamma$; (iii) $dT/dz = -1.2\Gamma$

The symbols have their usual meanings.

Contd P/2

CE 435

3. (a) A road has 450 vehicles passing a given spot per hour. Each vehicle on an average emit 16.0 g/km of Carbon Monoxide (CO). If wind speed is 2.0 m/sec perpendicular to the road, estimate CO concentration at the ground-level and at roof-level of a building 26 m high, located 150 m down-wind of the road. Consider the atmosphere to be "slightly unstable". [Note: Table for calculation of dispersion coefficient provided] **(10)**

(b) How do catalytic converters help to reduce automotive emissions? How does air/fuel ratio affect performance to catalytic converters? Explain with the help of an appropriate Figure. **(6 1/3)**

(c) What do you understand by halocarbons? How do different categories of halocarbons affect stratospheric ozone layer? Explain the "positive" and "negative" radiative forcings of halocarbons. **(7)**

4. (a) Suppose the ambient atmospheric temperature profile for a particular day is given by the following equations: **(9)**

$$\Lambda = 32 - 0.004z \quad ; z \le 500\text{m}$$
$$= 30 + 0.015(z - 500) \quad ; z > 500\text{m}$$

where, z = altitude in m.

Plumes are emitted at 35 °C from the top of a smoke stack with a height of 70 m. Estimate how high the plume is expected to rise under the given condition. Also calculate the ventilation coefficient assuming an average wind speed of 3.0 m/sec, and comment on the pollution potential of the area.

(b) Describe the $NO\text{-}NO_2\text{-}O_3$ photochemical reaction sequence. Explain how hydrocarbons affect this reaction sequence and help to produce ozone and aldehyde. Can carbon monoxide (CO) promote formation of photochemical smog? Explain with appropriate equations. **(8 1/3)**

(c) If 9.5 moles of O_2 are required for complete combustion of one mole of the fuel hexane (C_6H_{14}), calculate the stoichiometric ratio for the fuel. With respect to air-fuel mixture, what do you understand by "lean mixture" and "rich mixture"? **(6)**

SECTION – B

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

5. (a) Wastewater from an industry is being discharged into a river. The characteristics of the wastewater and river water (just upstream of the point of discharge) are as follows: **(13)**

Wastewater	River water
Flow rate = 12,550 m^3/day	Flow rate = 0.7 m^3/sec
Ultimate BOD = 100 mg/l	Ultimate BOD = 5 mg/l
DO = 1.0 mg/l	DO = 6.0 mg/l
T = 30 °C	T = 23 °C

Contd P/3

CE 435

Contd... Q. No. 5(a)

Laboratory-determined BOD rate constant for the mixture of wastewater and river water at 20 °C is 0.22/day (base e). The saturation value of DO for the mixture of wastewater and river water is 8.6 mg/l. Average depth of the river is 3.5 m and average speed of water is 0.30 m/sec. Assuming complete and instantaneous mixing of wastewater and river water, calculate:

(i) Time and distance to reach minimum DO,

(ii) The minimum DO, and

(iii) Expected DO at 25 km downstream of the discharge point.

(b) What do you understand by "point source" and "non-point source" of pollution? Explain with examples. What are biologically accumulative pollutants? Explain the terms: Bioconcentration; Bioaccumulation; Biomagnification. **(6 1/3)**

(c) In the context of solute transport through a porous media, what do you understand by "advection" and "hydrodynamic dispersion"? Explain briefly. **(4)**

6. (a) Consider a lake with a surface area of 75×10^6 m^2 that is fed by a stream having a flow rate of 9.5 m^3/sec and average total phosphorous (P) concentration of 0.03 mg/l. The lake also receives phosphorous from two other sources: (i) treated effluent from an industry with a flow rate of 0.35 m^3/sec and phosphorous concentration of 1.5 mg/l, and (ii) untreated domestic sewage with a flow rate of 2.0 m^3/sec and phosphorous concentration of 4.0 mg/l. The phosphorous settling rate in the lake is 10 m/year. Estimate average phosphorous concentration in the lake. If one wishes to maintain average phosphorous concentration in the lake at 0.04 mg/l by treating the domestic sewage, how much phosphorous removal efficiency is required for the sewage treatment plant? **(10)**

(b) What are the principle chemical forms of arsenic in water? In which chemical forms arsenic is likely to exist in groundwater? Briefly discuss the principles of removal of arsenic from water. **(7)**

(c) What do you understand by "eutrophication"? What are the adverse impacts of eutrophication? Briefly discuss the common methods/approaches for controlling eutrophication. **(6 1/3)**

7. (a) An industry discharge wastewater into a pond, from where it seeps into the underlying aquifer. Concentration of a particular contaminant in the wastewater is 30.31 mg/l. Estimate the time required for the contaminant concentration to reach 1.0 mg/l at a depth of 5m below the bottom of the pond. The seepage velocity is 0.40 m/day and dispersivity of the aquifer media is 0.08 m. Consider conservative transport and ignore molecular diffusion. [Note: Error function chart provided] **(12)**

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

Breakpoints							AQI
O_3 (ppm) 8-hr	O_3(ppm) 1-hr (i)	$PM_{2.5}$ (µg/m^3) 24-hr	PM_{10} (µg/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(a) 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.

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

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

Complementary Error Function Table (Q-7(a))

TABLE 3-4 The Complementary Error Function[a]

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 : 19/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations 2016-2017

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. Answer any **THREE**.

1. (a) What is the difference between cooperative and confrontational approach of environmental laws? What are the powers and functions of the DG, DoE according to Environment Conservation Act 1995? What are the limitations of the Environment Court? **(16)**

   (b) What are the differences in the information required and procedures for environmental clearance between "Orange A" and "Red" category projects according to ECR 1997? What is the difference between guidelines and standards? Give Examples. **(7 1/3)**

2. (a) What are the merits and demerits of public consultation? What are the considerations in planning an effective public consultation? **(13)**

   (b) Summarize the mitigation measures suggested for the following environmental impacts for the implementation of the Jamuna Multipurpose Bridge Project: **(10 1/3)**

   (i) Disruption of river navigation
   (ii) Deterioration of surface water quality
   (iii) Noise pollution
   (iv) Safety of workers
   (v) Contamination of drinking water

3. (a) Write short notes on (i) Equimarginal Principle; (ii) Public Interest Litigation; (iii) Socially efficient rate of output. **(9)**

   (b) What is the difference between IEE and EIA? How do you decide when to do an IEE or an EIA? How is IEE or EIA linked with the project cycle? **(6 1/3)**

   (c) What is the purpose of environmental monitoring? What are the typical contents of an EMP report? Construct a typical environmental monitoring table format. **(8)**

4. (a) From the data given below determine how much emission each plant has to reduce, if the total emission of (i) 10 tonnes/week and (ii) 16 tonnes/week is to be achieved at the minimum possible total cost. **(7)**

Contd P/2

CE 437

Contd... Q. No. 4(a)

Emission (tones/week)	Marginal Abatement Cost (lakh BDT/week)		
	Plant A	Plant B	Plant C
10	0	0	0
9	1	2	3
8	2	3	4
7	3	4	5
6	4	6	6
5	5	10	10
4	6	12	12
3	10	25	25
2	12	40	45
1	25	90	120
0	50	180	240

(b) Explain efficient level of emissions' using Marginal Damage (MD) and Marginal Abatement Cost (MAC) curves. Show graphically what would be the effect on the 'efficient level of emissions' if there is (i) an increase in population and (ii) adoption of improved technology in reducing emissions. Explain why the 'socially efficient rate of output' cannot practically be achieved? **(9 1/3)**

(c) Write down the answers to the following questions regarding various provisions of the Environment Court Act 2000 and Environment Conservation Act 1995: **(7)**

(i) What is the rank of the judge and Public Prosecutor?

(ii) What is meant by 'power to make Rules'?

(iii) Who can carry out investigation and conduct search/examination?

(iv) What are the guiding legislations for trial and disposal of cases related to compensation and offence?

(v) What is meant by 'actions taken in good faith'?

SECTION – B

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

5. (a) Explain with figure the ecosystem carrying capacity with respect to time. **(7)**

(b) "It appears that the magnitude of Ecological Foot Print varies proportionately with the level of development of a country" – discuss the validity of the statement with example and appropriate reasoning. **(8)**

(c) In the Hollywood movie "Erin Brockovich", what pollutant was the primary reason for the environmental disaster? What was the source of pollution? Is there any example of pollution caused by the same pollutant in Bangladesh? If so, what is the source and location the contamination? **(8 1/3)**

Contd P/3

CE 437

6. (a) What is "Eco-dynamics"? Explain, with diagram, the inter-relationship among the different systems those constitutes the Eco-dynamics. **(7)**

(b) What is Aggregate Capital Stock? Define the three components of Aggregate Capital Stock. Write the Pierce & Atkinson's equation of Sustainability Index and the condition for Sustainability. **(8)**

(c) In the Hollywood movie "A Civil Action", what pollutant was the primary reason for the environmental disaster? What was the source of pollution? Is there any example of pollution caused by the same pollutant in Bangladesh? If so, what is the source and location the contamination? **(8 1/3)**

7. (a) List the consequences of Biodiversity Loss. **(7)**

(b) List the different EIA methods. State the reasons for need of EIA Methodologies. **(8)**

(c) Explain the different steps of the Design and Implementation phases of a Project Cycle for environmental and natural resources planning and management. **(8 1/3)**

8. (a) List the causes of Ozone layer depletion and its effect. **(7)**

(b) Define SMOG. List the causes of formation of SMOG and its effects. **(8)**

(c) Explain, with diagram, the conceptual framework for Environmental Impact Studies and the inter-relationship among different stages of the framework. **(8 1/3)**

L-4/T-2/CE **Date : 19/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations 2016-2017

Sub : **WRE 409** (River Engineering)

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) Classify different river training works according to its purposes. **(6 1/3)**

   (b) Explain why seepage analysis is important in designing an earthen embankment. Describe briefly how seepage analysis is done. **(7)**

   (c) Describe different structural measures to control river flood. **(10)**

2. (a) Describe how length and spacing of groynes are estimated. **(6 1/3)**

   (b) Describe different temporary measures to control river bed. **(7)**

   (c) Calculate the total volume of stone required in per unit width for the shank and nose portions of a revetment for the following given idea. Maximum discharge of the river is 5000 cumec and the corresponding water depth is 10.0 m. Mean diameter of sediment particle is 15 mm. Assume any other data if needed. **(10)**

3. (a) Explain why average width of the Jamuna river is increasing every year. **(6 1/3)**

   (b) Describe different types of measures for sediment control in a watershed. **(7)**

   (c) Describe different types of protection elements that are used in river bank protections. **(10)**

4. (a) Explain with graphs how bed forms affect bed roughness and water surface elevation in a river. **(6 1/3)**

   (b) Classify different types of bed forms according to their flow regime and describe them with neat sketches. **(8)**

   (c) Calculate bed sediment load using Duboy's bed load formula for the following given data. The channel depth is 10 m and the channel slope is 7.0×10^{-4}. Mean diameter of sediment particles is 0.15 mm. Assume any other data if needed. **(9)**

SECTION – B

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

5. (a) Define (i) Cutoff (ii) Perennial Stream (iii) Thalweg. **(3×1=3)**

   (b) Compare salient characteristics between confluence and bifurcations. Give examples in case of river of Bangladesh. **(6 1/3)**

Contd P/2

WRE 409/CE

Contd... Q. No. 5

(c) What are the different meander parameters? Show the relationship between various meander parameters. A meandering river channel of radius of curvature 3 km has a bankfull flow area of 1000 m^2 and longitudinal water surface slope is 1 m in 3 km. Calculate **(3+3+8=14)**

(i) Bankfull Discharge

(ii) Meander ratio

Assume the reasonable value of any other data if not given.

6. (a) Classify with sketches the different plan form patterns of river. **(6)**

(b) Briefly describe the behavior of a river in alluvial stage. **(6 1/3)**

(c) What do you mean by hydraulic geometry? A river flows with a discharge 48000 m^3/s. Estimate the water surface width, mean depth and mean velocity using the concept of at a station hydraulic geometry. Assume reasonable value if not given. **(2+9=11)**

7. (a) Briefly explain the basic hydraulic mechanism of formation of scour around bridge pier. **(5 1/3)**

(b) Show with clear sketches, how to estimate dominant discharge for any river section. **(6)**

(c) Draw a figure showing different types of bridge scour. A bridge is going to be built over the Boral River where the section is 100 m wide. There will be 4 cylindrical piers of 10 m height and 2 m diameter each. Before the starting of construction following survey data were found at the bridge site: **(4+8=12)**

Depth of flow = 4 m

Velocity of flow = 1.25 m/s

Sediment size, d_{50} = 0.12 mm

Angle of attack = 10°.

Compute local scour at piers using CSU equation which is given by

$$y_s = 2.0 * K_1 * K_2 * K_3 * K_4 * a^{0.65} * y_1^{0.35} * Fr_1^{0.43}$$

Use the attached table 3-1 and 3-2 factors for K_1, K_2, K_3 and K_4.

8. (a) Define critical shear stress in terms of sediment transport. Sketch a typical Shield's diagram and mention its salient features. **(2+5 1/3 =7 1/3)**

(b) Write down the causes and effects of degradation in a river. **(6)**

(c) Calculate the depth of flow at which the bed particle of size 0.2 mm just starts to move for a wide channel with longitudinal gradient 0.3 m per 3 km. Given the dimensionless shear stress to be 0.043 and the specific gravity of bed material to be 2.65. **(10)**

Tables for question no 7.(c)

Table 3-1 Correction Factor K_1, K_2 and K_3

Correction Factor	Value or Equation
K_1: Pier-nose shape	
Square nose	1.1
Round nose	1.0
Circular cylinder	1.0
Group of cylinders	1.0
Sharp nose	.9
K_2: Angle of attack of flow (θ)	$[\cos\theta + (L/a)\sin\theta]^{0.65}$, where θ = angle of attack of flow. If $L/a > 12$, use 12 as a maximum
K_3: Bed condition	
Clear-water scour	1.1
Live-bed scour:	
Plane-bed and antidune bedform	1.1
Small dunes, 3 ft > dune height ≥ 0.6 ft	1.1
Medium dunes, 9 ft > dune height ≥ 3 ft	1.1 to 1.2
Large dunes, dune height > 9 ft	1.3

Table 3-2 Correction Factor K_4

Factor	Minimum Bed Material Size	Minimum K4 Value
K4	D50 ≥ 0.006 ft (0.002 m) D95≥0.06 ft (0.02 m)	0.4

L-4/T-2/CE **Date: 23/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2016-2017

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

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**.

1. (a) Draw and explain the load deflection curve of a prestressed concrete beam under different stages of loading. **(8⅓)**

   (b) A prestressed concrete beam is shown in Fig. 1 is posttensioned with 780 mm^2 of high tensile steel to an initial prestress of 1100 MPa immediately after prestressing. Compute the initial deflection at midspan due to prestress and the beam's own weight, assuming $E_c = 30 \times 10^3$ MPa. Estimate the deflection after two months, assuming a creep coefficient $C_c = 2.0$ and an effective prestress of 850 MPa at that time. **(15)**

2. (a) Explain the importance of transfer bond in a pretensioned prestressed concrete member. **(4)**

   (b) Describe briefly the importance of transverse tension in the anchorage zone of a posttensioned concrete beam. **(4)**

   (c) Determine the bearing plate required for a tendon consisting of 19-12.7 mm dia. 7-wire strands anchored at the end of a beam as shown in Fig. 2. The tendon forces for design are 2000 kN due to maximum Jacking force and 1600 kN at service load. Use $f'_{ci} = 28$ MPa and $f'_c = 35$ MPa. Follow the specification of the Post Tensioning Institute (PTI) for allowable bearing stresses on the concrete. **(15⅓)**

3. Design a composite prestressed concrete structural system for a simply supported 30.0 m span. The beam will be type IV standard AASHTO-PCI section (Fig. 3), with a 150 mm thick composite slab. Design loads for the structure are: dead load of the composite system (for normal weight concrete), W_G; additional dead load, $W_D = 1200$ Pa; live load, $W_L = 2500$ Pa, consider $f'_{ci} = 30$ MPa, $f'_c = 40$ MPa and for the slab, $f'_c = 28$ MPa. Design for unshored beams in construction following the ACI Code for the critical section at midspan. Assume total loss of prestress is 20% for this section and the initial force for 12.7 mm diameter 7-wire strand is 130 kN. Consider $f_{pu} = 1860$ MPa. **(23⅓)**

Contd P/2

CE 415

Contd... Q. No. 3

(i) Determine the pretensioned strand-arrangement to fully utilize the precast beams.

(ii) Find the maximum spacing of the beams for this structural system based on allowable stress at service load.

Section properties for precast beam (Type-IV) are given below:

$A = 509 \times 10^3$ mm^2, $I = 1085 \times 10^8$ mm^4, $W_{cr} = 12.22$ kN/m and $C_b = 628$ mm

4. (a) Describe the procedure for the evaluation of web shear cracking stress (V_{cw}) and inclined flexural cracking stress (V_{ci}) for a prestressed concrete beam subjected to uniformly distributed load (UDL). **(8⅓)**

(b) Check shear strength for the beam shown in Fig. 4 at section 1-1 and 2-2 respectively. Given that the section is adequate for $W_u = 70$ kN/m on the basis of its flexural strength. Given: Effective prestress = 1000 MPa, Initial prestress = 1250 MPa and $f'_c = 40$ MPa. Use ACI equations. **(15)**

SECTION – B

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

5. (a) A post tensioned simple beam on a span of 14 m is shown in Fig. 5. It carries superimposed load of 9.0 kN/m in addition to its own weight. The initial prestress in the steel is 980 MPa reducing to 840 MPa after deducing all losses but assuming no bending of the beam. Compute the stress in the steel at midspan, assuming steel to be bonded by grouting. Assume, $n = 6$, $A_{ps} = 1400$ mm^2, and $\gamma_{con} = 25$ kN/m^3. **(8⅓)**

(b) For the above problem [5(a)], determine the total uniform load that can be supported by the beam without causing any tension at bottom fibre. Also determine the cracking moment for this beam section if modulus of rupture of concrete is 4.5 MPa. **(15)**

6. (a) Show the stress distribution in a prestressed concrete beam section for different locations of compressive force 'c' according to elastic theory. **(5⅓)**

(b) Describe briefly the prestress transfer bond in pretensioned concrete member. **(8)**

(c) Determine the ultimate moment capacity of the rectangular section shown in Fig. 6. It contains mild steel rebass in addition to prestressing steel. Use $f'_c = 40$ MPa, $E_s = E_p = 2 \times 10^5$ MPa, $E_c = 3 \times 10^4$ MPa, $f_{pu} = 1860$ MPa, $f_y = 415$ MPa, $\varepsilon_{cu} = 0.003$ and effective prestress, $f_{se} = 1100$ MPa. Follow any method of calculation. **(10)**

Contd P/3

CE 415

7. (a) Briefly describe the loses of prestress in pretensioned and posttensined members from each individual source. Hence explain which type of member will undergo greater loss of prestress. **(8⅓)**

(b) An overhanging beam (Fig. 7) is to be posttensioned from the Anchor end 'A'. Compute the percentage loss of prestress due to friction from support 'A' to the free end. Solve using (i) simple approximate method and (ii) more exact friction formula method. **(15)**

Given: Friction co-efficient (μ) = 0.40 and wooble effect (k) = 0.0033/m.

8. (a) Make an initial design for section of a prestressed beam to resist a total moment of 750 kN-m of which M_G = 300 kN-m. Assume f_c = 15 MPa, f_{se} = 980 MPa, and a trial depth of $41\sqrt{M_T}$ (mm) where M_T is in kN-m. **(10)**

(b) Make the final design from the initial section obtained above. Given: f_b = –18 MPa, f_t = -16 MPa, f_{so} = 1080 MPa and allow no tension. **(13⅓)**

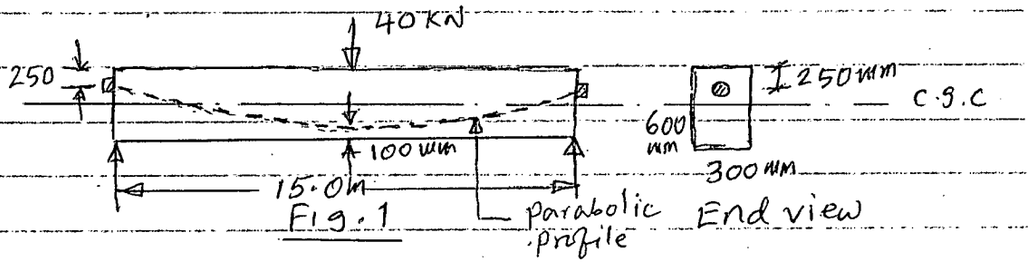


Fig. 1

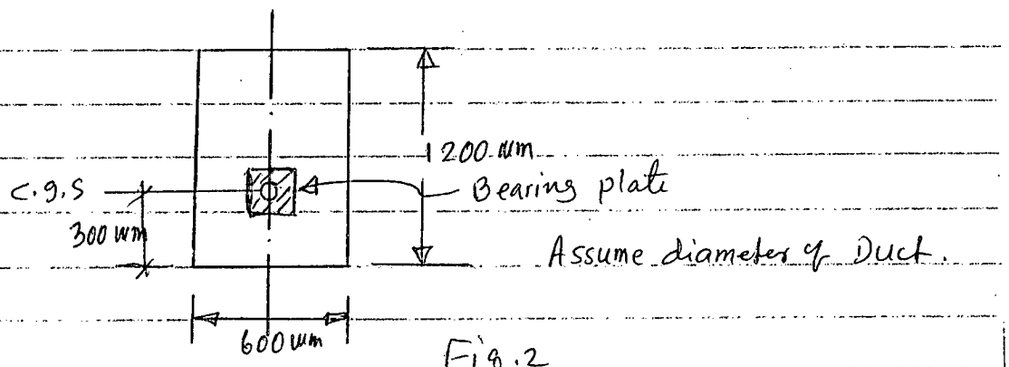
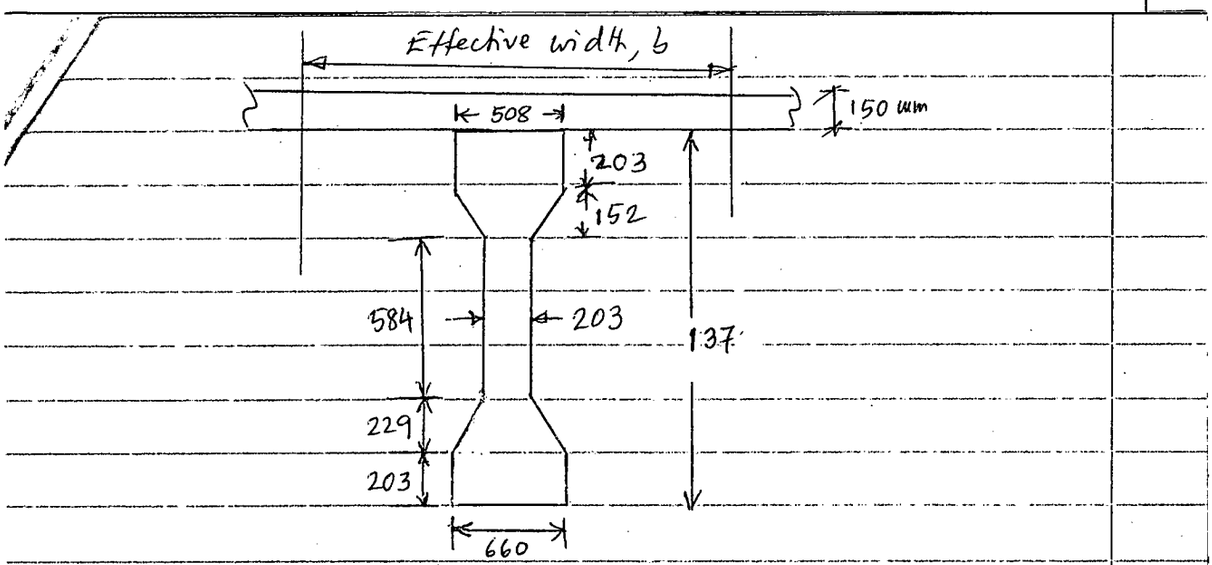


Fig. 2



TYPE IV

Fig. 3 (AASHTO – PCI SECTION)

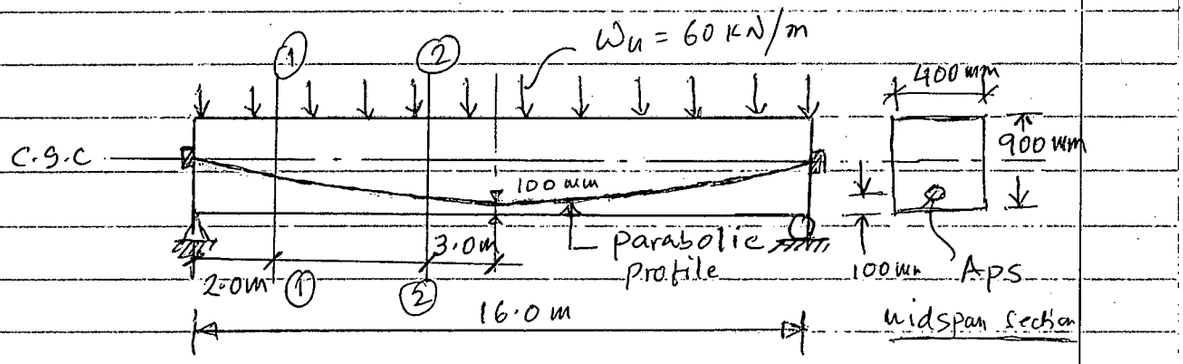


Fig. 4

Shear Stress Equations (following 1971 ACI Code)		Shear Force Equations (following 1977 ACI Code)	
$v_u = \frac{V_u}{\phi b_w d}$	(7-3)	V_u = Factored shear force at section •	
		$V_u \le \phi V_n$	(7-6)
where V_u in design is factored shear force at section. Use $\phi = 0.85$ for shear.		Design for V_u/ϕ as the nominal shear strength, V_n. Use $\phi = 0.85$ for shear.	
$v_{ci} = 0.05\sqrt{f'_c} + \frac{V_d + \left(\frac{V_i M_{cr}}{M_{max}}\right)}{b_w d} \ge 0.14\sqrt{f'_c}$	(7-4)	$V_{ci} = 0.05\sqrt{f'_c}\, b_w d + V_d + \frac{V_i M_{cr}}{M_{max}} \ge 0.14\sqrt{f'_c}\, b_w d$	(7-7)
where $M_{cr} = (I/y_t)(0.5\sqrt{f'_c} + f_{pe} - f_d)$	(7-9)	where $M_{cr} = (I/y_t)(0.5\sqrt{f'_c} + f_{pe} - f_d)$	(7-9)
$v_{cw} = 0.29\sqrt{f'_c} + 0.3 f_{pc} + \frac{V_p}{b_w d}$	(7-5)	$V_{cw} = (0.29\sqrt{f'_c} + 0.3 f_{pc}) b_w d + V_p$	(7-8)

For prob. 4(b)

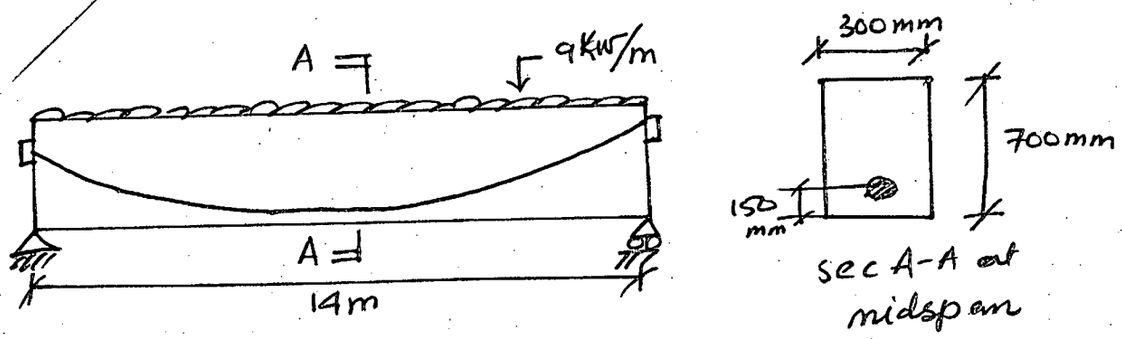


Fig. 5

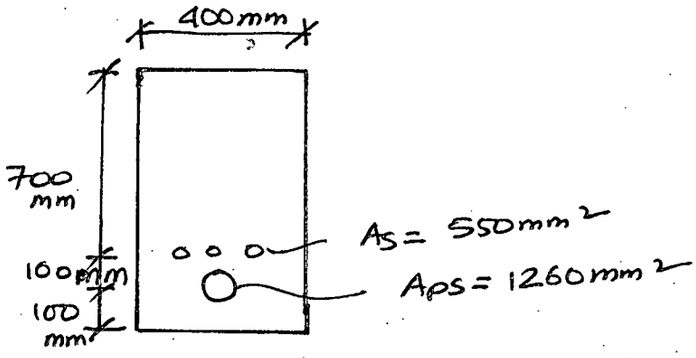
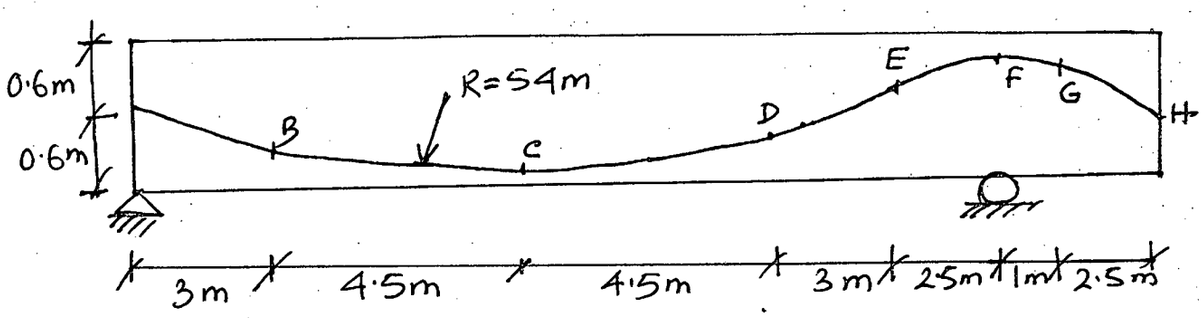


Fig. 6



Note: AB, DE, GH → straight line
BCD, EFG → curved line.

Fig. 7

L-4/T-2/CE **Date: 23/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2016-2017

Sub: **CE 413** (Introduction to Steel Concrete Composite Structures)

Full Marks: 140 Time: 3 Hours

The figures in the margin indicate full marks

Assume reasonable values for missing data, if any.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) What are the components of a steel concrete composite floor system? Show them in a net sketch? **(3½)**

   (b) Two bays of a composite floor system is illustrated in Fig. 1. **(14)**

   (i) Calculate the effective slab width for the secondary beam SB (W18×192). Draw the transverse (section A-A) and longitudinal section of the composite floor system across this beam and clearly show the deck orientation and effective slab width.

   (ii) Check whether the composite deck detailing along with the shear connectors and material properties for this floor system as shown in Fig. 2, satisfies the requirements of AISC specifications.

   Given: $f'_c = 4$ ksi and $E_c = 3600$ ksi; $F_y = 85$ ksi and $E_s = 29000$ ksi

2. (a) Calculate the service load flexural stresses in concrete and steel of the secondary beam SB (W18×192) for unshored construction. In addition to the self-weight of the slab and beam consider 80 psf of partition wall load, 30 psf for floor finish, 20 psf for construction live load and 60 psf for service live load. Assume, full interaction between steel and concrete. **(14)**

   Given: $f'_c = 4$ ksi and $E_c = 3600$ ksi; $F_y = 50$ ksi and $E_s = 29000$ ksi

   (b) Show the flexural stress distribution across the depth of the beam SB for pre-composite and composite stages of construction. **(3½)**

3. (a) Why shear connectors are required in composite floor system? Name different types of shear connectors with sketches. **(3½)**

   (b) (i) Evaluate the design ultimate moment capacity of the main beam MB (W21×93) as shown in Fig. 1 in positive bending for 65% composite action. **(14)**

   Given: $f'_c = 4$ ksi and $E_c = 3600$ ksi; $F_y = 50$ ksi and $E_s = 29000$ ksi

   (ii) Determine the number and placement of the 0.75 inch diameter stud type shear connectors for this beam to develop the design moment capacity under 65% composite action.

   Assume: $R_p = 0.75$, $R_g = 0.85$ and $F_u = 65$ ksi for shear connectors.

Contd P/2

CE 413

4. (a) Differentiate between pre-composite and composite stage in the design of composite beams. **(3½)**

(b) If the secondary beam SB (W18×192) provided in the floor system shown in Fig. 1 is designed with 0.75 inch stud type of shear connectors at a spacing of 12 inch c/c along the span of the beam, then **(14)**

(i) Determine the % of composite action in this partially composite beam.
Assume: $R_p = 0.75$, $R_g = 0.85$ and $F_u = 65$ ksi for shear connectors

(ii) Calculate the total vertical deflection at midspan of this beam for composite as well as for pre-composite stages and compare the values with the allowable limits for total deflection specified in AISC guide. The calculated uniformly distributed service loads on the beam is 0.5 k/ft for self weight of slab, deck and beam; 0.1 k/ft for construction live load; 0.2 k/ft for floor finish; 0.4 k/ft for partition walls and 1 k/ft for floor live load.
Given: For concrete $f'_c = 4$ ksi and $E_c = 3600$ ksi; for steel $F_y = 50$ ksi and $E_s = 29000$ ksi

5. (a) List the design considerations for serviceability limit states for composite beams. **(3½)**

(b) For the composite beam section shown in Fig. 3, **(14)**

(i) Calculate the section properties of the composite section. Transform the section into equivalent steel section.

For concrete $f'_c = 4$ ksi and $E_c = 3600$ ksi; for steel $F_y = 36$ ksi and $E_s = 29000$ ksi

(ii) Find the yield moment capacity of the composite beam in positive bending.

SECTION – B

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

6. (a) State the advantages and disadvantages of FEC column sections over CFT column sections. **(5)**

(b) A Fully Encased Composite (FEC) column section is shown in Figure 4. check whether the provided section satisfies the code specified limits for: **(2½)**

(i) Concrete strength
(ii) Specified minimum yield stress of structural and reinforcing steel
(iii) Structural steel ratio
(iv) Maximum and minimum longitudinal reinforcement ratio
(v) Transverse steel

Given: $F_y = F_{yr} = 60$ ksi; $f'_c = 4$ ksi; $E_s = 29000$ ksi and $E_c = 3600$ ksi.

(c) Check the adequacy of the section provided in Figure 4 to resist the given compressive load. Use the data provided in 6(b) as required. **(10)**

Contd P/3

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7. (a) Define Partially Encased Composite (PEC) column. Explain the failure behavior of PEC column with non-compact steel section. **(5)**

(b) A Partially Encased Composite (PEC) column is shown in Figure 5. **(12½)**

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

(ii) Determine the axial capacity of the column.

Given: f_y = 350 MPa; f'_c = 35 MPa; E_s = 200 GPa; E_c = 24 GPa and effective length of column = 14 ft.

8. (a) State the assumptions used in Plastic Stress Distribution method for developing P-M interaction diagram of composite columns. **(5)**

(b) For the FEC column section shown in Figure 6, calculate the nominal axial force and bending moment for balanced failure condition of P-M diagram for strong axis bending. Use plastic stress distribution method. The length of the column is 12 feet and the column is pin-pin connected in both axes. **(12½)**

Given: $F_y = F_{yr}$ = 60 ksi; f'_c = 3 ksi; E_s = 29000 ksi and E_c = 3600 ksi.

9. (a) Calculate the nominal axial load and bending moment for the four points in the P-M interaction diagram about strong axis bending of the CFT column shown in Figure 7, using plastic stress distribution method. Show the diagram in a neat sketch. **(12½)**

Given: f_y = 50 ksi; f'_c = 3.5 ksi; E_s = 29,000 ksi; E_c = 3600 ksi; wall thickness = 0.75 inch and effective length of column = 14 ft.

(b) Recalculate and redraw the P-M interaction diagram for the CFT column including the global slenderness effect. **(5)**

10 (a) Check the design adequacy of the CFT section shown in Figure 8 for a factored axial compressive load of 200 kips and a factored bending moment of 180 kip-ft about weak axis using interaction equation and simplified version of plastic stress distribution method. Use AISC-LRFD method. **(12½)**

Given: f_y = 50 ksi; f'_c = 4 ksi; E_s = 29,000 ksi; E_c = 4000 ksi and effective length of column = 15 ft.

(b) Provide your comments on the adequacy check using the two methods. Slenderness effects must be considered. **(5)**

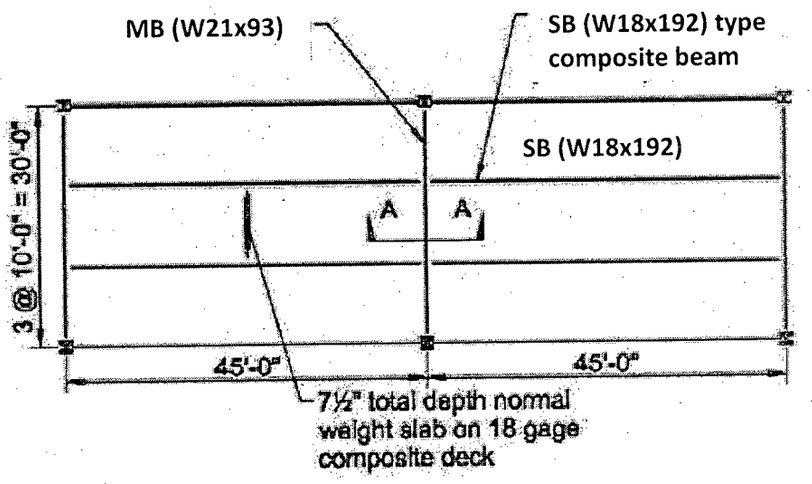


Fig. 1

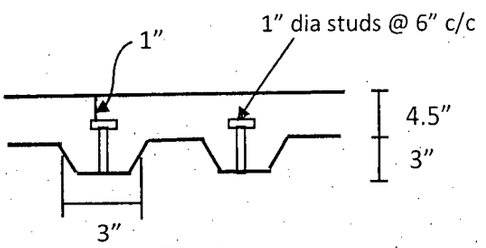


Fig. 2

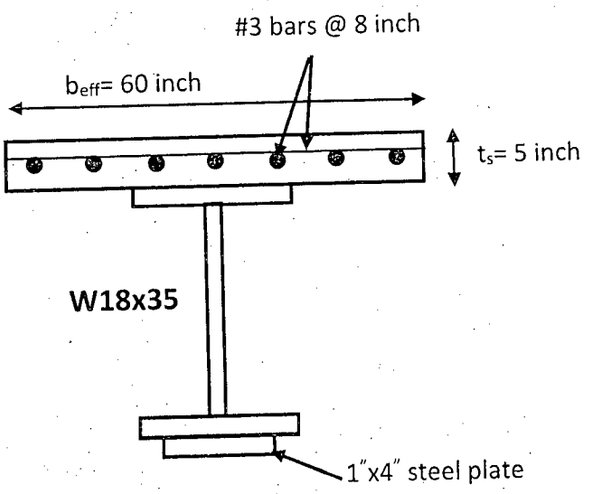


Fig. 3

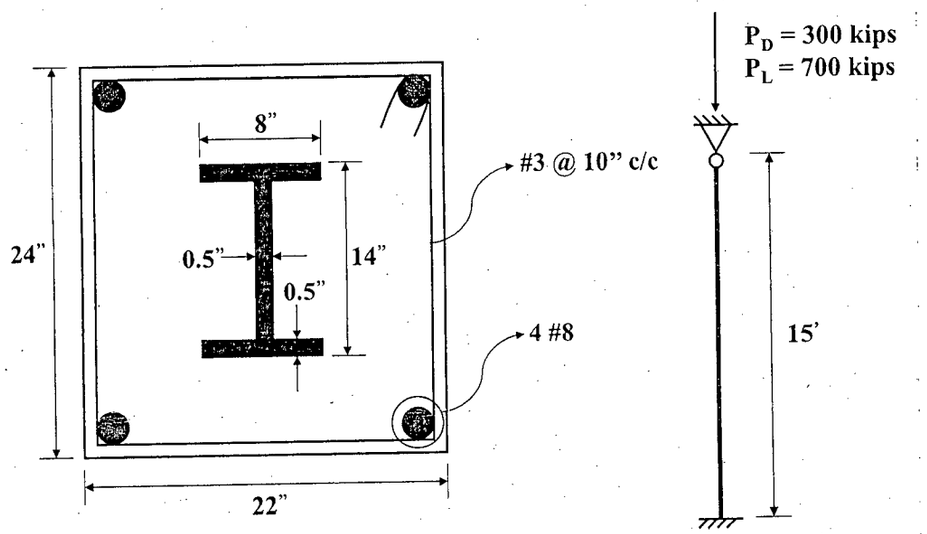


Figure # 4

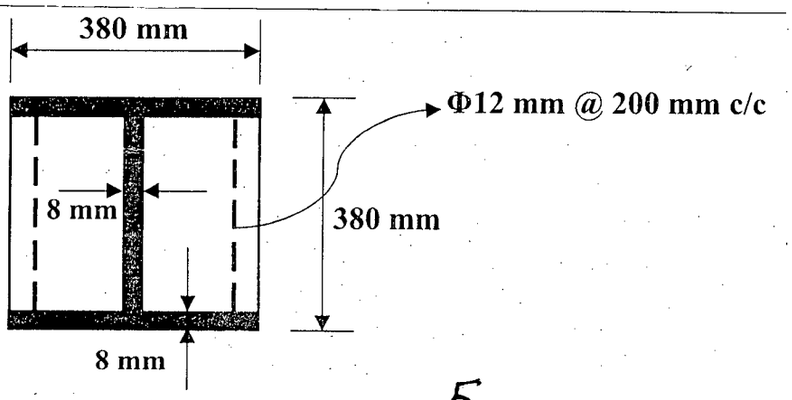


Figure # 5

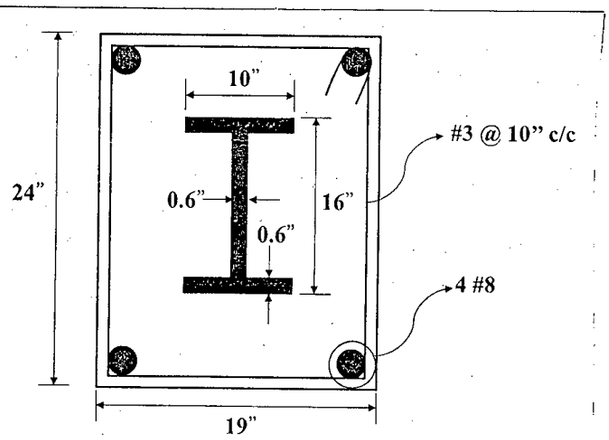


Figure # 6

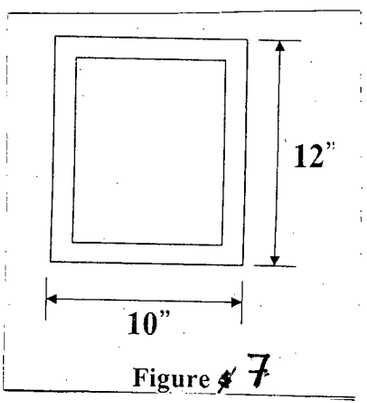


Figure # 7

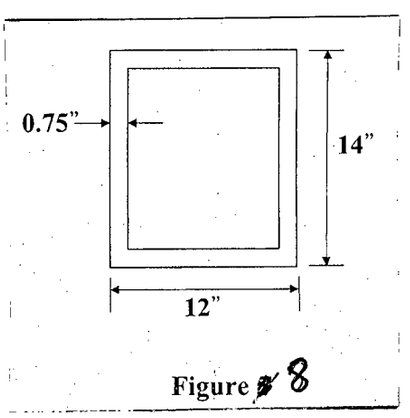


Figure # 8

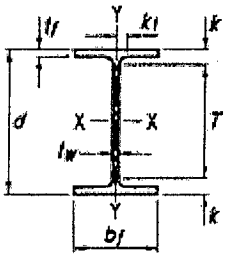


Table 1–1 (continued)
W Shapes
Dimensions

Shape	Area, A	Depth, d	Web			Flange				Distance					Work-able Gage
			Thickness, t_w		$\frac{t_w}{2}$	Width, b_f		Thickness, t_f		k		k_1	T		
										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	15/16	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 3/8	
×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 1/16		
×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 3/4	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 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.

Table 1–1 (continued)
W Shapes
Properties

W21 – W18

Nominal 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

ANNEXURE 1

Design Specifications 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

(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

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

ANNEXURE 2

(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

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

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

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

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

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

For FEC Columns:

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

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

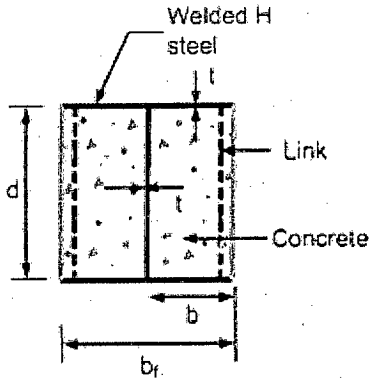
$$C_1 = 0.1 + 2\left(\frac{A_s}{A_c + A_s}\right) \leq 0.3$$

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

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

ANNEXURE 3

For PEC columns with Non-compact section:



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

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

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

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

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

AISC Interaction Equations:

(a) When $\dfrac{P_r}{P_c} \ge 0.2$

$$\frac{P_r}{P_c} + \frac{8}{9}\left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) \le 1.0$$

(b) When $\dfrac{P_r}{P_c} < 0.2$

$$\frac{P_r}{2P_c} + \left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) \le 1.0$$

L-4/T-2/CE **Date: 29/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2016-2017

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**.

1. (a) "Use of volatile solids content as a measure of the biodegradability of Municipal Solid Waste may not the most appropriate approach" — Justify this statement in light of modified approach in assessing the biodegradable fraction in MSW. Also, provide proof using the mathematical expression for biodegradability. **(6)**

   (b) List the two types of MRFs with their respective types of waste handling properties. **(6)**

   (c) 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. **(11⅓)**

   (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 8 hr workday on off-route activities.

2. (a) Excluding rubber, plastic and leather, list the biological properties of MSW for its organic components. **(6)**

Contd P/2

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Contd... Q. No. 2

(b) 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? **(6)**

(c) 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. **(11⅓)**

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

3. (a) List the guidelines for laying out the collection routes. **(6)**

(b) Draw the flow diagram for separation of the source-separated comingled plastics and glasses at an MRF. **(6)**

(c) Determine the break-even time for a hauled and stationary container system as compared to a system using transfer and transport operations for transporting wastes collected from a metropolitan area to a landfill disposal site. Assume the following cost data are applicable. [USE GRAPHICAL APPROACH TO SOLVE] **(11⅓)**

Transportation costs:

(i) HCS using a hoist truck with an 8-yd^3 container = Tk. 800/- per hr

(ii) SCS using 20-yd^3 compactor = Tk. 1200/- per hr

(iii) Tractor-trailer-trailer transport unit with a capacity of 120-yd^3 = Tk. 1600/- per hr

Other costs:

(i) Transfer station operating costs, including amortization = Tk. 30/- per m^3

(ii) Extra cost for unloading facilities for Tractor-trailer-trailer transport unit as compared to the cost of other vehicles = Tk. 5/- per yd^3

4. (a) Explain with diagrams the different types of transfer stations. **(6)**

(b) Draw and label the different types of shredding equipment employed for size reduction at MRFs. **(6)**

(c) The solid waste collection vehicle of Jessore Paurashava is abut to expire, and city officials are in need of advice on the size of the truck they should purchase. The compactor trucks available from the local supplier are rated to achieve a density of 400

Contd P/3

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Contd... Q. No. 4(c)

kg/m_3 and a dump time of 6.0 minutes. In order to ensure a once-a-week pick-up over the entire service area the truck must service 250 locations per day. The disposal site is 6.4 km away and the average Haul Speed is 27 km/hr. From previous experience, a delay time of 13 minutes each way per trip is expected. Data given in the following Table is representative of the Paurashava. Each collection stop has 3 containers (C*n*) containing 4 kg each. About 10% of the stops are backyard pick-up (PRH). Assume 2 trips per day will be made to disposal site. Also assume that the collection crew wize will be 2-ppersons and the empirical equation below is applicable for estimation of collection time (in minutes) at each stop, tp: **(13⅓)**

$$t_p \text{ (in min)} = 0.72 + 0.18\ C_n + 0.004*(PRH)$$

SECTION – B

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

5. (a) What are the ultimate disposal methods of solid wastes? Describe each method briefly. **(8⅓)**

(b) What is a sanitary landfill? List the merits and demerits of a sanitary landfill. **(7)**

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

Component	% by weight	Loose bulk density (lb/ft^3)
Garden waste	35	4.62
Glass	15	18.45
Paper	30	3.75
Food waste	20	8.55

The compacted waste density in the landfill is 44.3 lb/ft^3. Estimate the % volume reduction achieved during compaction of the waste. Also estimate the overall uncompacted bulk density if the food waste is removed for biogas production.

6. (a) Draw a layout plan of a sanitary landfill site and label it. **(7)**

(b) Sketch the typical concentration profile of leachate constituents and explain it. **(6⅓)**

(c) The following four layers are lying between the base of a landfill and the underlying aquifer. How long will it take for leachate to migrate to the aquifer? Also calculate the amount of leachate flowing down if the landfill area is 60 hectare. **(10)**

Soil layer	Depth (m)	Porosity (%)	Permeability (m/s)
A	1.75	41	3.1×10^{-9}
B	2.25	43	3.3×10^{-8}
C	2.0	42	3.0×10^{-8}
D	1.5	44	3.5×10^{-8}

Contd P/4

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7. (a) How leachate can be circulated to the landfill and what precautions are needed if the circulation is practiced? **(5 ⅓)**

   (b) List the typical composition of landfill gases. **(3)**

   (c) Discuss the different methods of estimation of landfill gas generation. **(8)**

   (d) List the objectives of landfill gas recovery. Draw a typical gas recovery system and label it. **(7)**

8. (a) What is a hazardous waste? Show the pathway of human exposure to hazardous wastes. **(5)**

   (b) Draw a flow sheet for hazardous waste treatment and disposal facilities. **(8)**

   (c) List the design considerations of a hazardous waste landfill. **(5)**

   (d) How will you treat and dispose the most common hazardous wastes of a hospital? **(5 ⅓)**

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

Component	Percent by weight (dry basis)					
	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[c]	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 2(a):

Component	Mass (kg)	Density (kg/m^3)	Volume (m^3)
Food wastes	4.3	288	0.0149
Paper	19.6	81.7	0.240
Cardboard[a]	2.95	99.3	0.0297
Plastics	0.82	64	0.013
Textiles	0.091	64	0.0014
Rubber	—	128	—
Leather	0.68	160	0.0043
Garden trimmings	6.5	104	0.063
Wood	1.59	240	0.00663
Glass	3.4	194	0.018
Tin cans	2.36	88.1	0.0268
Nonferrous metals	0.68	160	0.0043
Ferrous metals	1.95	320	0.00609
Dirt, ashes, brick	0.50	480	0.0010
Total	45.4		0.429

Table for Q 4 (a)

Table: Typical properties of uncompacted sold wastes as discarded in Jessore Paurashava