**L-4/T-2/CE** **Date : 21/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2015-2016

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

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

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## SECTION – A

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

1. (a) "Good highway planning should be long range, comprehensive and co-ordinated" – Explain the statement. **(7)**

   (b) What is system approach of Transportation planning? Explain with flow diagram. **(8 ⅓)**

   (c) State advantages and limitations of following road patterns: **(8)**

   (i) Rectangular and or Block pattern.

   (ii) Radial or Star and Grid patterns.

2. (a) Define Transportation demand. What are the nature of transportation demand? Explain relationship between land use and Transportation demand. **(11 ⅓)**

   (b) Following alternative plan proposals for different districts are given with different road length, population and productivity. **(12)**

| Proposal | Road length (km) | No's of towns and villages served with population range | | | | Productivity (1000 tones) |
|---|---|---|---|---|---|---|
| | | 2000-5000 | 5001-10000 | 10001-15000 | >15000 | |
| A | 320 | 150 | 100 | 40 | 10 | 250 |
| B | 380 | 200 | 75 | 48 | 12 | 300 |
| C | 420 | 220 | 120 | 55 | 17 | 400 |
| D | 350 | 180 | 110 | 50 | 13 | 375 |
| E | 440 | 245 | 125 | 45 | 20 | 420 |

Assume, utility units as given below:

| Population | Utility unit | |
|---|---|---|
| 2000-5000 | 0.25 | Productivity utility unit = 1 for per 1000 tones |
| 5001-10000 | 0.50 | |
| 10,001-15,000 | 1.10 | |
| > 15,000 | 2.25 | |

Workout the utility per unit length for each of the road systems and indicate which of the proposal yield the maximum utility based on saturation system.

Contd ..... P/2

## CE 457

3. (a) Explain assumptions of sequential decision of trip making process. **(4 1/3)**

(b) Write short note on (i) Cross classification method of trip generation (ii) Multiple linear Regression analysis of trip generation. **(8)**

(c) Trip productions and attractions, travel time between zones for a 3 zone study are given as follows: **(11)**

| Trip production - Attraction | | | | |
|---|---|---|---|---|
| Zone | 1 | 2 | 3 | Total |
| Trip production | 140 | 330 | 280 | 750 |
| Trip attraction | 300 | 270 | 180 | 750 |

| Travel time between zones (min) | | | |
|---|---|---|---|
| Zone | 1 | 2 | 3 |
| 1 | 5 | 2 | 3 |
| 2 | 2 | 6 | 6 |
| 3 | 3 | 6 | 5 |

| Travel time vs Friction factor | |
|---|---|
| Time (min) | F - value |
| 2 | 52 |
| 3 | 50 |
| 4 | 41 |
| 5 | 39 |
| 6 | 26 |

Determine the number of trips between each zone using Gravity model. Assume socio-economic factor 1.

4. (a) Explain "Logit model" of model choice process. What are the factors influences mode choice process. **(7 1/3)**

(b) What are the sequential steps for travel forecasting? Explain traffic assignment model. **(8)**

(c) Assign the vehicle trips shown in the following O-D trip table to the network, using the All-or-Nothing assignment technique. To summarize your results, list all the links in the network and their corresponding traffic volume often loading. **(8)**

Origin (O) - Destination (D) Trip Table

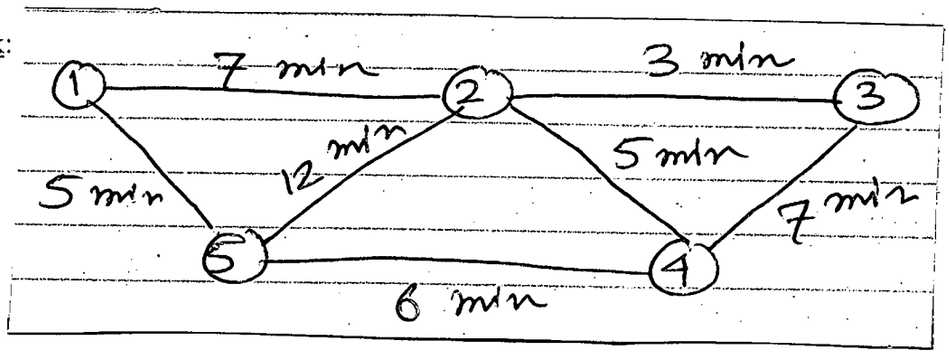
| From/To | Trip between zones | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 1 | -- | 100 | 100 | 200 | 150 |
| 2 | 400 | -- | 200 | 100 | 500 |
| 3 | 200 | 100 | -- | 100 | 150 |
| 4 | 250 | 150 | 300 | -- | 400 |
| 5 | 200 | 100 | 50 | 350 | -- |

Contd ..... P/3

## CE 457

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

Road Network:




**SECTION – B**

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

Assume reasonable values for missing data (if any).

5. (a) Identify some globally acknowledged urban transportation problems. Explain the statement – 'Congestion can be perceived as an unavoidable consequence of the usage of scarce transport resources, particularly if they are not priced.' Also list some measures that can help of alleviate such chronic congestion problem. **(7)**

(b) Carefully identify the stakeholders who got either positively or negatively affected by the Dhaka-Chittagong Highway four-lane project. Define the following types of costs generally associated with a transportation facility improvement project: (i) first cost (ii) continuing cost (iii) sunk cost and (iv) salvage value. **(8)**

(c) The authority concerned with the implementation of the Bus Rapid Transit (BRT) project in Dhaka, Bangladesh is examining six potential alignments throughout the city. The alignments differ in the amount of revenue collected, the number of passengers served, seating arrangement, length of the line, location, auto drivers diverted, accident reduction, air quality and noise level. Estimated values achieved by each criterion for each of the six alignments are shown in Table 1. The related transportation agency wants to evaluate each alignment using a ranking process. Determine which alignment(s) would be the most efficient for BRT operation and should be selected for further detailed investigation. **(8 1/3)**

Table 1: Measures of Effectiveness (MOE) for the six alignments

| MOE | Alignments | | | | | |
|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI |
| Annual return on investment (%) | 13.0 | 14.0 | 11.0 | 13.5 | 15.0 | 14.5 |
| Daily ridership (1000s) | 25 | 23 | 20 | 18 | 17 | 15 |
| Passengers seated in peak hour (%) | 25 | 35 | 40 | 50 | 50 | 35 |
| Length of line (mi) | 8 | 7 | 6 | 6 | 5 | 5 |
| No. of. existing junctions of the route | 4 | 5 | 16 | 15 | 2 | 6 |
| Auto drivers diverted (1000s) | 3.5 | 3.0 | 2.5 | 2.3 | 2.3 | 1.2 |
| Accident Reduction Factor | 1.2 | 1.5 | 1.4 | 1.5 | 1.4 | 1.6 |
| Air quality ($\mu g/m^3$ CO) | 825 | 536 | 450 | 409 | 386 | 395 |
| Noise (dBA) | 73 | 70 | 73 | 70 | 72 | 72 |

Contd ..... P/4

## CE 457

6. (a) Define 'Transportation System'. What are the primary variables considered for a systems perspective of transportation? **(5)**

(b) How could the system boundary be established for effective transportation planning? Explain with the help of relevant examples. Briefly describe the major components of a successful transportation system. **(3+4)**

(c) Three transportation projects have been proposed to increase the safety at a major intersection in an urban area. The annual maintenance cost of the intersection in the present condition is $15,000 and the annual user cost is $500,000. The following Table 2 shows the initial construction costs, annual maintenance and operating costs, useful life and the salvage values for each alternative. Assume a discount rate of 10% and determine the preferred alternative based on the economic criteria. **(11 ⅓)**

Table 2: Costs and Benefits of different alternatives

| Alternative | Capital Costs ($) | Annual Maintenance ($) | Annual User Cost ($) | Useful Life (Years) | Salvage Value ($) |
|---|---|---|---|---|---|
| I | 40,000 | 10,000 | 401,000 | 10 | 15,000 |
| II | 90,000 | 9,000 | 350,000 | 10 | 11,000 |
| III | 250,000 | 8,000 | 400,000 | 15 | 5,000 |

7. (a) What is Transportation System Management (TSM)? State the basic objective and goal of TSM. List some TSM strategic on the supply side that lead to (i) improved pedestrian and bicycle facilities and (ii) improved transit services. **(8)**

(b) State the specific objectives of Transportation Demand Management (TDM). Briefly describe some common TDM strategic for improving parking management. **(7)**

(c) Explain how alternate work schedule and ride sharing contribute in reducing peak period traffic congestion. **(8 ⅓)**

8. (a) What are the common elements of a standard BRT System? Explain the key features of a Metro Rail System. What are its advantages over a conventional BRT System? **(9)**

(b) Briefly describe the potential of Para-transit in establishing a multi modal transportation system for Dhaka city. **(5)**

(c) A bus route on a city street is scheduled for 5 minutes headways. On the average, 8 passengers per bus board at a particular stop and 12 passengers alight. All boarding passengers use the front door and all alighting use the back door. Assume clearance time is 15 s, and that maximum allowable probability of bus queuing is 2.5%. The stop is a near-side stop at an intersection with a g/C ratio of 0.50. How many berths are required? Co-efficient of Variation of dwell time can be taken as 0.6. Necessary charts are attached herewith. **(9 ⅓)**

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Typical Bus Passenger Boarding and Alighting Service Times for Selected Bus Types and Door Configurations (Seconds per Passenger)[R4]

| Bus Type | Available Doors or Channels | | Typical Boarding Service Times [a] (s) | | Typical Alighting Service Times (s) |
|---|---|---|---|---|---|
| | Number | Location | Prepayment [b] | Single Coin Fare | |
| Conventional (rigid body) | 1 | Front | 2.0 | 2.6 to 3.0 | 1.7 to 2.0 |
| | 1 | Rear | 2.0 | NA | 1.7 to 2.0 |
| | 2 | Front | 1.2 | 1.8 to 2.0 | 1.0 to 1.2 |
| | 2 | Rear | 1.2 | NA | 1.0 to 1.2 |
| | 2 | Front, Rear [d] | 1.2 | NA | 0.9 |
| | 4 | Front, Rear [f] | 0.7 | NA | 0.6 |
| Articulated | 3 | Front, Rear, Center | 0.9[f] | NA | 0.8 |
| | 2 | Rear | 1.2[g] | NA | — |
| | 2 | Front, Center [d] | — | — | 0.6 |
| | 6 | Front, Rear, Center [e] | 0.5 | NA | 0.4 |
| Special Single Unit | 6 | 3 Double Doors [h] | 0.5 | NA | 0.4 |

NA: data not available

[a] Typical interval in seconds between successive boarding and alighting passengers. Does not allow for clearance times between successive buses or dead time at stop.

[b] Also applies to pay-on-leave or free transfer situation.

[c] Not applicable with rear-door boarding. Higher end of range is for exact fare.

[d] One each.

[e] Two double doors each position.

[f] Less use of separated doors for simultaneous loading and unloading.

[g] Double door rear loading with single exits; typical European design. Provides one-way flow within vehicle, reducing internal congestion. Desirable for line-haul, especially if two-person operation is feasible. May not be best configuration for busway operation.

[h] Examples: Denver 16th Street Mall shuttle, airport buses used to shuttle passengers to planes. Typically low-floor buses with few seats serving short, high-volume passenger trips.

Values of Percent Failure Associated With $Z_a$[R2e]

| Failure Rate | $Z_a$ |
|---|---|
| 1.0% | 2.330 |
| 2.5% | 1.960 |
| 5.0% | 1.645 |
| 7.5% | 1.440 |
| 10.0% | 1.280 |
| 15.0% | 1.040 |
| 20.0% | 0.840 |
| 25.0% | 0.675 |
| 30.0% | 0.525 |
| 50.0% | 0.000 |

Charts for Question 8 (c)

**L-4/T-2/CE** **Date : 21/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2015-2016

Sub : **WRE 411** (Hydraulic Structures)

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

Assume reasonable value where necessary.

USE SEPARATE SCRIPTS FOR EACH SECTION

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## SECTION – A

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

1. (a) Write short notes on: **(2×4=8)**

   (i) critical exit gradient

   (ii) uplift on bottom floor of a syphon aqueduct

   (b) What are the corrections applied for determining the percentage of pressure at various key points of hydraulic structures? Explain, why it is necessary? **(6⅓)**

   (c) The concrete floor of a weir on permeable soil is 25 m long and has sheet piles at both ends. The upstream pile is 6 m deep and the downstream pile is 8 m deep. The weir creates a net head of 4 m. Neglecting the thickness of the floor, calculate the uplift pressures at the junctions of inner faces of the piles with the floor using Khosla's theory. **(9)**

2. (a) What do you mean by loose protections for weir and barrages? Show details of loose protection in neat sketch. **(7⅓)**

   (b) Give a comparison between a silt excluder and a silt ejector. **(5)**

   (c) Fig. 1 shows a hydraulic structure built on fine sand (C = 15). Determine whether the percolation gradient is safe. Also calculate the floor thickness at point 'A' and the exit gradient. Make use of Bligh's creep theory of seepage flow. **(11)**

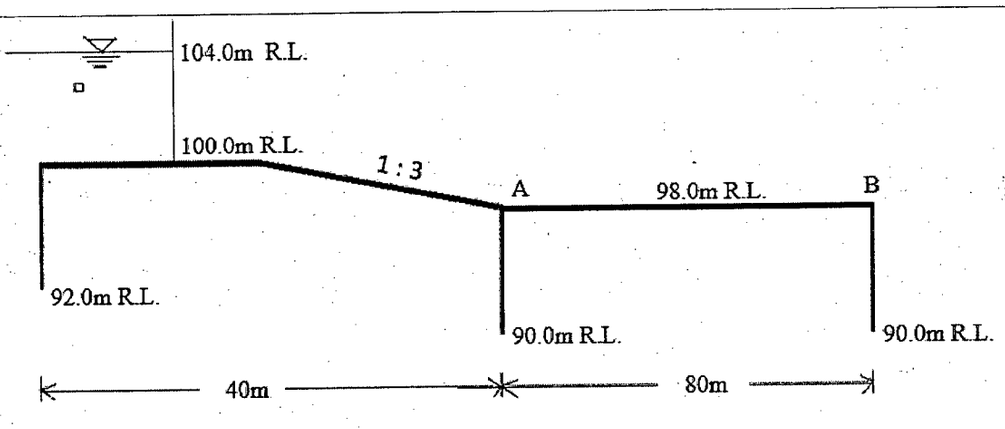



Fig. 1 for Question No. 2(c)

3. (a) Differentiate between a weir and a barrage. **(3⅓)**

   (b) What is meant by "piping" on foundation of a weir? How does it affect a weir constructed on permeable soil? **(5)**

Contd ..... P/2

## WRE 411(CE)

**Contd ... Q. No. 3**

(c) Given the following data for a barrage across a river, determine (i) Total discharge that can pass through the barrage during high flood assuming a velocity of approach of 2 m/s (ii) level of jump formation in the undersluice portion during high flood considering a discharge concentration of 20% and retrogression of 0.5 m. **(15)**

Undersluice: Crest level = 201.0 m, 5 bays of 15 m each

Barrage portion: Crest level = 202.5 m, 25 bays of 12 m each.

Crest width = 2 m, HFL (before construction of barrage) = 207.0 m, Afflux = 1.0 m

4. (a) In what condition of drainage and canal crossing, syphon is provided? Draw a typical plan and cross-section of a canal syphon. **(6⅓)**

(b) A syphon aqueduct is to be designed for the following situation: **(17)**

| | Canal | Drainage |
|---|---|---|
| Discharge, $m^3/s$ | 30.0 | 400.0 |
| Bed level, m | 100.0 | 98.0 |
| Canal FSL, m | 102.0 | ----- |
| Bed width, m | 20.0 | ----- |
| Side slope (H : V) | 1.5 : 1 | ----- |
| HFL, m | ---- | 100.5 |

Design (i) drainage waterway, (ii) canal waterway and (iii) transitions. Also calculate the head loss through the syphon barrels assuming $f_2 = 0.0033$ for the materials of the surface of barrel.

## SECTION – B

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

5. (a) Define Dam? Discuss the uses of dam. **(2+5)**

(b) Discuss different types of dams based on their uses. **(6⅓)**

(c) Discuss the following governing factors for the selection of particular types of dam: (i) Geology and foundation condition, (ii) Spillway size and location. **(10)**

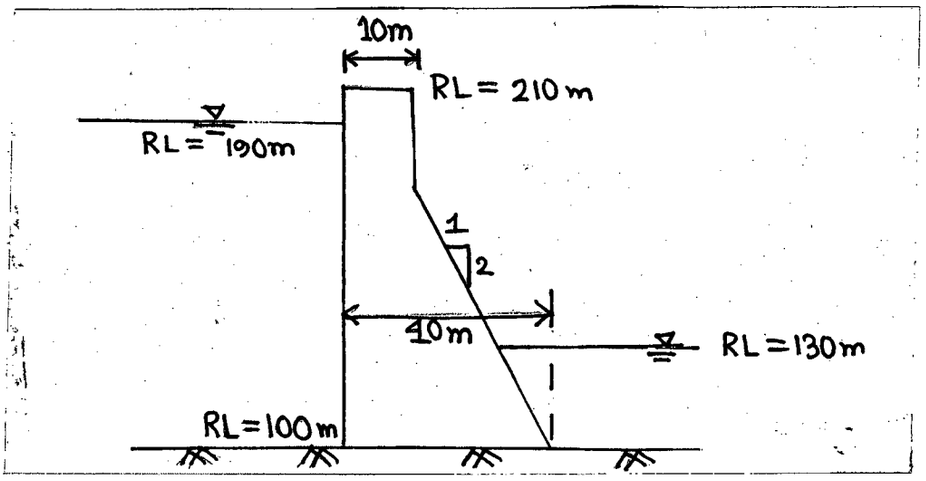
6. (a) Differentiate between straight drop type spillway and ogee types spillway. **(4)**

(b) Following figure shows the cross-section of a concrete gravity dam. Considering Earthquake forces, examine the stability of the section at the base for reservoir full condition. Assume any reasonable values if not given. Assume weight of concrete 24 kN/cubic m. Earthquake forces can be taken as 0.1 g for both horizontal and vertical direction. **(19⅓)**

Contd ..... P/3

## WRE 411(CE)

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




7. (a) Determine the required reservoir capacity from the following data. Prior water rights make it obligatory to release full natural water flow or 12 hectare meter, whichever is minimum. The net increased pool area is 400 hectares. Assume pan evaporation coefficient to be 0.8. **(18⅓)**

| Month | Inflow at Dam site (hectare Meter) | Pan evaporation (cm) | Precipitation (cm) | Demand (hec-m) |
|---|---|---|---|---|
| 1 | 1.3 | 1.8 | 1.3 | 15.8 |
| 2 | 0 | 1.8 | 1.7 | 14.3 |
| 3 | 0 | 2.6 | 0.6 | 9.6 |
| 4 | 0 | 10.2 | 0 | 4.8 |
| 5 | 0 | 15.4 | 0 | 3.5 |
| 6 | 0 | 1.6 | 1.1 | 3.4 |
| 7 | 240 | 10.8 | 16.1 | 5 |
| 8 | 430 | 11.7 | 16.4 | 5 |
| 9 | 1 | 10.8 | 2.2 | 10 |
| 10 | 0.6 | 9.6 | 0.8 | 15.6 |
| 11 | 0.5 | 7.8 | 0 | 16.8 |
| 12 | 0.2 | 2 | 0 | 16.8 |

(b) What is gravity dam? Write down different forces acting on a gravity dam. **(5)**

8. (a) Differentiate between storage basin and retarding basin. **(5)**

(b) Design the downstream portion of an Ogee spillway for a dam having following characteristics. The upstream portion is vertical and the downstream portion is having a slope of 0.7H: 1V. The design discharge is 8500 cumec. The height of spillway crest is kept at RL 310 m. And the bed elevation is 190 m. Spillway length consists of 6 spans having clear width of 10 m each. Pier thickness is 2.5 m. Assume Kp = 0.01, Ka = 0.1. **(18⅓)**

L-4/T-2/CE **Date : 19/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2015-2016

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

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

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## SECTION – A

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

1. (a) What are the main objectives of Bangladesh Environmental Policy 1992? What legal framework was proposed and institutional arrangements were considered to implement Bangladesh Environmental Policy? What were the policy statements in the following sectors: **(12)**

   (i) Forest, wildlife and biodiversity

   (ii) Housing and urbanization

   (iii) Transport and communication

   (b) What are the main features and limitations of Bangladesh Environmental Quality standards in ECR 1997? **(7 ⅓)**

   (c) Write down the names of 4 legal instruments in Bangladesh pertaining to workplace health and safety. What are the different safety provisions for the protection of public health in the Bangladesh National Building Code? **(4)**

2. (a) What are the powers and functions of the DG, DoE according to ECA 1995? **(10)**

   (b) Summarize the mitigation measures suggested for the following environmental issues for the implementation of the Bangabandhu Bridge Project: **(10)**

   (i) Deterioration of surface water quality

   (ii) Contamination of drinking water

   (iii) Dredged Spoils Disposal

   (iv) Transmission of disease among workers

   (v) Disruption of navigation

   (c) What is purpose of Environmental monitoring in EMP? **(3 ⅓)**

3. (a) What are the salient features of Bangladesh Environmental Court Act? **(7)**

   (b) What is an Environmental Management Plan (EMP)? How is it related to EIA? Who prepares the EMP? Discuss with diagrams how EMP can be incorporated into project design. **(9)**

   (c) Discuss the environmental impacts due to closure of northern intake of Dhaleshwari river in the Bangabandhu Bridge Project? **(7 ⅓)**

Contd ..... P/2

## CE 437

4. (a) Write short notes on: (i) Bangladesh Water Act 2013; (ii) Protection of Physical Cultural Resources; (iii) Equimarginal Principle. **(6)**

(b) Draw a schematic diagram showing the interaction of economic activities (production and consumption) with the natural environment. How can the residuals from production and consumption process be minimized? 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. **(10 ⅓)**

(c) From the data given below determine how much emission each plant has to reduce, if the total emission reduction of 7 tonnes/week is to be achieved at the minimum possible total cost. **(7)**

| Emission (tonnes/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 | 100 |
| 0 | 50 | 200 | 225 |

### SECTION – B

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

5. (a) What do you mean by 'Environmental Management'? Discuss. How can Environmental Management be applied to make projects sustainable? Discuss with examples. **(12 ⅓)**

(b) What are the differences between Human Carrying Capacity and Ecological Foot Print? Discuss. Why is Ecological Foot Print less of a developing country than that of a developed country? **(11)**

6. (a) What are the business tools commonly used for achieving sustainability in industrial sector? Describe two (2) such tools in brief. 'Increase GDP does not always mean increase of Sustainable Development' – Explain with examples. **(12)**

(b) What are the objectives of SDGs? Write a brief description on Goal 6. What are the differences between MDG and SDG? **(11 ⅓)**

Contd ..... P/3

## CE 437

7. (a) Describe the effects of global warming on agriculture. What measures and responses are undertaken in global and national level to mitigate climate change? Write a short note on 'BCCSAP, 2009'. **(15 1/3)**

   (b) State the effects of 'Acid Rain' on aquatic, terrestrial, materials and human health. How these effects can be mitigated? **(8)**

8. (a) Describe the environmental implications of Water Development and Flood Control Projects. How does development in tourism industry affect environment? Write short notes on (i) SMOG (ii) Human Development Index (HDI). **(13 1/3)**

   (b) A project is undertaken to export sand material to foreign countries by dredging a portion of Jamuna river near Sirajgong. The dredged material will be transported through waterways. Evaluate the potential impacts due to this project by checklist method. **(10)**

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L-4/T-2/CE **Date : 19/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2015-2016

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

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

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## SECTION – A

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

1. (a) What are the most important properties of solid waste to be known for it to be used as fuel? List the tests to determine these properties. **(10)**

(b) An enterprise gave you the responsibility to assess the feasibility of setting up a waste to energy facility. In this context you collected solid waste sample from a residential area and analyzed each component individually to determine the energy content (see table). If the community plans to recycle parts of its wastes by separating 60% of paper, 90% of cardboard and 40% of plastics, estimate the energy content in BTU/lb of the source separated waste. How is this source separation going to affect the feasibility of the waste to energy facility? **(13⅓)**

| Component | Solid Wastes, lb | Energy (BTU/lb) |
|---|---|---|
| Food wastes | 8 | 2000 |
| Paper | 35.8 | 7200 |
| Cardboard | 6.4 | 7000 |
| Plastics | 6.9 | 14000 |
| Textiles | 1.8 | 7500 |
| Rubber | 0.4 | 10000 |
| Leather | 0.4 | 7500 |
| Garden trimmings | 17.3 | 2800 |
| Wood | 1.8 | 8000 |
| Glass | 9.1 | 60 |
| Tin cans | 5.8 | 300 |
| Aluminum | 0.6 | --- |
| Other metals | 3 | 300 |
| Dirt, Ash, etc. | 2.7 | 3000 |

2. (a) "Use of volatile solids content as a measure of the biodegradability of Municipal Solid Waste may not be the most appropriate approach" – Justify this statement in light of modified approach in assessing the biodegradable fraction in MSW. Provide example, if necessary. **(10)**

(b) Consider a privately owned retail business that sells metal accessories. The business receives approximately 110kg of new merchandise every day. Since much of the merchandise is sold must matched to an old sample for verification, most customers bring their old merchandise into the store.

Contd ..... P/2

# CE 433

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

A number of customers leave their old parts behind to be disposed of by the business. It is estimated that about 20% of the total amount sold is brought in and left by customers. **(13⅓)**

Of the amount of total merchandise received, approximately 9% of the weight is in packing materials (paper and cardboard). Eighty-seven percent of the packaging materials is cardboard, of which 60% is recycled after the merchandise is unpacked. About 7% of the paper and 15% of the cardboard is sold with merchandise over the counter. The remaining paper is disposed of in dumpster.

The remaining weight of the merchandise is metal parts and chemicals. Chemicals make up 11% of the total and all but 10% are sold daily. The remaining 10% is used within the business for cleaning equipment and is disposed of as hazardous wastes. Seventy-eight percent of the metal parts are sold per day with the remainder stored internally. Perform a mass balance and draw a flow diagram for the problem.

3. (a) Draw the diagram to show the Solid Waste Management Hierarchy. Briefly explain the diagram. **(5)**

(b) A private solid waste collector wishes to locate a Municipal Recycling Facility (MRF) near a commercial area. The collector would like to use a HCS but fears that the haul cost might be prohibitive. What is the maximum distance from the commercial area that the MRF can be located so that the weekly costs of HCS do not exceed those of a SCS? Assume that one collector-driver will be used with each system and the following data applicable. For the purpose of this example assùme the travel times $t_1$ and $t_2$ are included in off-route factor. **(18⅓)**

Hauled Container System:

(i) Quantity of Solid Wastes = 300 $yd^3$/wk;
(ii) Container size = 8 $yd^3$/trip;
(iii) Container utilization factor = 0.67;
(iv) Container pick-up time = 0.033 hr/trip;
(v) Container unloading time = 0.033 hr/trip;
(vi) At site time = 0.053 hr/trip;
(vii) Haul time constants: a = 0.022 hr/trip and b = 0.022 hr/mile;
(viii) Overhead costs = $400/wk;
(ix) Operational costs = $15/hr of operation

Stationary Container System:

(i) Quantity of Solid Wastes = 300 $yd^3$/wk;
(ii) Container size = 8 $yd^3$/location;
(iii) Container utilization factor = 0.67;
(iv) Collection vehicle capacity = 30 $yd^3$/trip
(v) Collection vehicle compaction ratio = 2

Contd ..... P/3

# CE 433

**Contd... Q. No. 3 (b)**

(vi) Container unloading time = 0.05 hr/container;
(vii) Haul-time constants: a = 0.022 hr/trip and b = 0.022 hr/mile;
(viii) At-site time = 0.10 hr/trip;
(ix) Overhead costs = $750/wk;
(x) Operational costs = $20/hr of operation

4. (a) What is the relationship between intrinsic permeatibilty 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? **(5)**

(b) Determine the chemical composition of the organic fraction of the Municipal Solid Waste, with or without sulfur and with or without water, with the composition shown in the following Table. **(18⅓)**

| Component | Food Waste | Paper | Plastic | Yard Waste | Tin | Ash |
|---|---|---|---|---|---|---|
| Wt. in lb. | 45 | 26 | 9 | 16 | 1.5 | 2.5 |

## SECTION-B

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

5. (a) What is Solid Waste Management? Describe briefly the ultimate disposal methods of solid wastes. **(7)**

(b) Describe the depression method of land filling. List the items which should be included in the operational manual of a sanitary landfill. **(6⅓)**

(c) List the factors affecting the volume requirement of a landfill. **(4)**

(d) A refuse has the following components and bulk densities: **(6)**

| Component | Percent by weight | Uncompacted bulk density ($lb/ft^3$) |
|---|---|---|
| Food waste | 40 | 10.65 |
| Glass and cans | 10 | 19.35 |
| Garden waste | 20 | 4.50 |
| Miscellaneous paper | 30 | 3.85 |

Assume that the compaction in the landfill is 42.7 $lb/ft^3$. Estimate the % volume reduction achieved during compaction of the waste. Estimate the overall uncompacted bulk density if the food waste is removed for biogas generation.

Contd ..... P/4

## CE 433

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

(b) Describe the decomposition of solid wastes in landfills. **(7)**

(c) Name the two common methods of estimating the quantity of leachate generated in a landfill. Which method do you prefer and why? **(4⅓)**

(d) Estimate the percolation of leachate through a landfill 15 m deep, with 0.75 m cover of silty clay for the following data: **(6)**

Precipitation = 2250 mm/year
Run off coefficient = 0.38
Evapotranspiration = 820 mm/year
Silty clay field capacity = 390 mm/m
Solid waste field capacity = 295 mm/m

Assume further that the soil cover has moisture content of 330 mm/m when applied, and that the incoming waste has a moisture content of 165 mm/m.

7. (a) Discuss briefly how will you control leachate in a landfill. **(6)**

(b) Draw a neat sketch of idealistic development of landfill gases. **(6)**

(c) List the methods of estimating the quantity of methane gas generation from a landfill. Which method do you prefer and why? **(4⅓)**

(d) The following four soil 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 acres. **(7)**

| Soil layer | Depth (m) | Porosity (%) | Permeability (m/s) |
|---|---|---|---|
| Soil A | 2.5 | 43 | $2.2 \times 10^{-8}$ |
| Soil B | 2.0 | 42 | $2.8 \times 10^{-9}$ |
| Soil C | 3.0 | 44 | $2.0 \times 10^{-8}$ |
| Soil D | 2.8 | 41 | $3.1 \times 10^{-9}$ |

8. (a) List the problems of hazardous waste management in developing countries. **(4)**

(b) List the potential process and operation alternatives for hazardous waste minimization **(7⅓)**

(c) What are the advantages, disadvantages and limitations of biological treatment processes of hazardous waste? **(7)**

(d) Draw a general flow diagram of hospital waste management. **(5)**

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**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[b] | 4.5 | 0.6 | 4.3 | <0.1 | — | 90.5 |
| Dirt, ash, etc. | 26.3 | 3.0 | 2.0 | 0.5 | 0.2 | 68.0 |

**L-4/T-2/CE** **Date : 17/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2015-2016

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

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

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## SECTION – A

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

1. (a) Discuss, the affects of water on bearing capacity of foundations and stability of retaining structures. **(6)**

   (b) Explain the mechanism behind land slides and ground liquefaction problems. **(6)**

   (c) In designing granular filters, under what situation one or filter layers may be required. **(5⅓)**

   (d) Discuss various methods for improvement of hydraulic fills during placement. **(6)**

2. (a) Show, with sketches, how the design of dams and embankments can be made safer and economic in consideration to seepage forces. **(6)**

   (b) Discuss factors that affect the strength of geotextiles as determined in the laboratory. Mention specimen and grip sizes in various test standards. **(8⅓)**

   (c) Mention the use of hydraulic fills. Also discuss important factors for the design and performance of hydraulic fills. **(9)**

3. (a) Discuss the technical analyses that are necessary for the feasibility study of a hydraulic fill. **(8)**

   (b) A perforated pipe under-drain for a pavement is to be designed with geotextiles (Fig. 1). The pipe will be placed inside graded coarse aggregates which in turn will be surrounded by the geotextile.

   Flow will enter the under-drain at a head of 18″ which is the thickness of the stone base while infiltration will come from the surrounding native soil. It is estimated that maximum flow through the under-drain will be 450 $ft^3$/day per ft of drain. The surrounding soil is sandy silt (ML) with $d_{10}$ = 0.006 mm, $C_u$ = 5.5, k = $4.3 \times 10^{-5}$ ft/sec. The geotextile being considered is a needle punched non-woven with

   k = 0.15 in/sec, t = 0.045 inch.

   Calculate: **(10)**

   (i) required permittivity (ii) ultimate permittivity of the considered geotextile

   (iii) allowable permittivity using appropriate partial factor of safety (Table provided)

   (iv) Factor of safety for flow requirements

   (c) Discuss the effectiveness of granular filters for erosion control of soils with various ranges of particles and also for gap graded soils or soil-rock mixtures. **(5⅓)**

**CE 447**

4. (a) Define important hydraulic properties of geotextiles. **(7)**

(b) Draw neat sketches of the cross-section of a revetment structure on river bank, show its components and explain their functions. **(8⅓)**

(c) A revetment work is to be done on a river bank with rock rip-rap. A filter layer of intermediate sized material between the soil and the rock will also be placed. The gradation curve of the insitu soil, filter layer and the rock rip-rap layer are shown in Fig. 2. Will this filter layer work for erosion protection and drainage? Comment on the basis of appropriate analysis. **(8)**

## SECTION – B

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

Use attached chart where necessary

5. (a) With neat plots define permeability parameters (n and c) and permeability change index ($c_k$). **(5)**

(b) Derive equation of continuity and Laplace's equation in two dimensions. Also show that both potential function and stream function satisfy Laplaces equation while stream function satisfies equation of continuity. **(8⅓)**

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

(i) Cased hole with soil flush with the bottom of hole.

(ii) Cased hole with column of soil inside the casing to certain depth.

(iii) Cased hole with uncased or perforated extension to certain length.

6. (a) Derive Kozery-Carman equation for coefficient of permeability of soil. **(8⅓)**

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

(c) Draw neatly the entrance and exit requirements of the line of seepage (phreatic line) of an earth dam. **(5)**

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

## CE 447

7. (a) With neat sketches describe the procedure of determining coefficient of permeability in the laboratory by horizontal capillarity test. **(6 ⅓)**

   (b) A homogeneous earth embankment of height 10 m was constructed on an impervious foundation with side slopes 1.5 : 1 (horizontal : Vertical). The embankment retains water to a height of 9 m. The crest width of the embankment is 2.5 m. Plot the line of seepage using A. Casagrande's method (use plain graph paper for plotting). **(10)**

   (c) With neat sketches briefly describe any two methods of determining soil suction. **(7)**

8. (a) With neat figures describe the constant head borehole permeability test to estimate coefficient of permeability in the field. What are the possible sources of errors in this test? **(8)**

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

   (c) Saturated unit weight and effective angle of internal friction ($\phi'$) of a cohesonless soil are 18 kN/m$^3$ and 30°, respectively. A slope is to be made of this material. If the factor of safety is to be 1.5, determine the safe angle of the slope for the following cases: **(6)**

   (i) When the slope is dry.

   (ii) When seepage occurs at and parallel to the slope (i.e, water table is at the surface)

   (d) List the general criteria to be considered for the design of a revetment structure. **(4 ⅓)**

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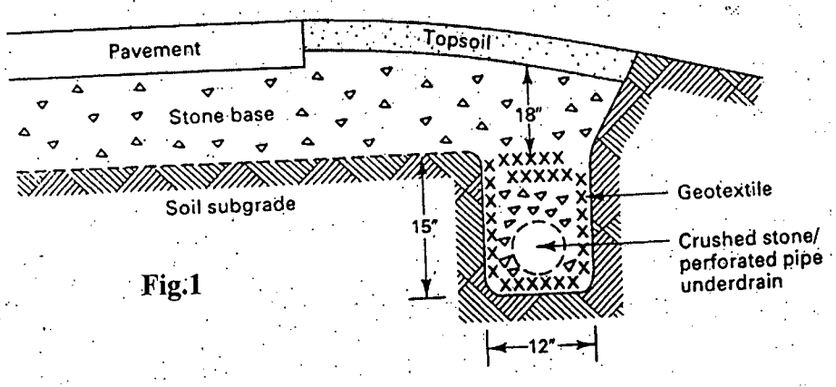


Fig.1

Table Recommended partial factors of safety values

| | Various Partial Factors of Safety | | | | |
|---|---|---|---|---|---|
| *Application* | *Soil Clogging and Blinding* | *Creep Reduction of Voids* | *Intrusion into Voids* | *Chemical Clogging* | *Biological Clogging* |
| Retaining wall filters | 2.0 to 4.0 | 1.5 to 2.0 | 1.0 to 1.2 | 1.0 to 1.2 | 1.0 to 1.3 |
| Underdrain filters | 5.0 to 10 | 1.0 to 1.5 | 1.0 to 1.2 | 1.2 to 1.5 | 2.0 to 4.0 |
| Erosion control filters | 2.0 to 10 | 1.0 to 1.5 | 1.0 to 1.2 | 1.0 to 1.2 | 2.0 to 4.0 |
| Landfill filters | 5.0 to 10 | 1.5 to 2.0 | 1.0 to 1.2 | 1.2 to 1.5 | 2.0 to 50 |
| Gravity drainage | 2.0 to 4.0 | 2.0 to 3.0 | 1.0 to 1.2 | 1.2 to 1.5 | 1.2 to 1.5 |
| Pressure drainage | 2.0 to 3.0 | 2.0 to 3.0 | 1.0 to 1.2 | 1.1 to 1.3 | 1.1 to 1.3 |

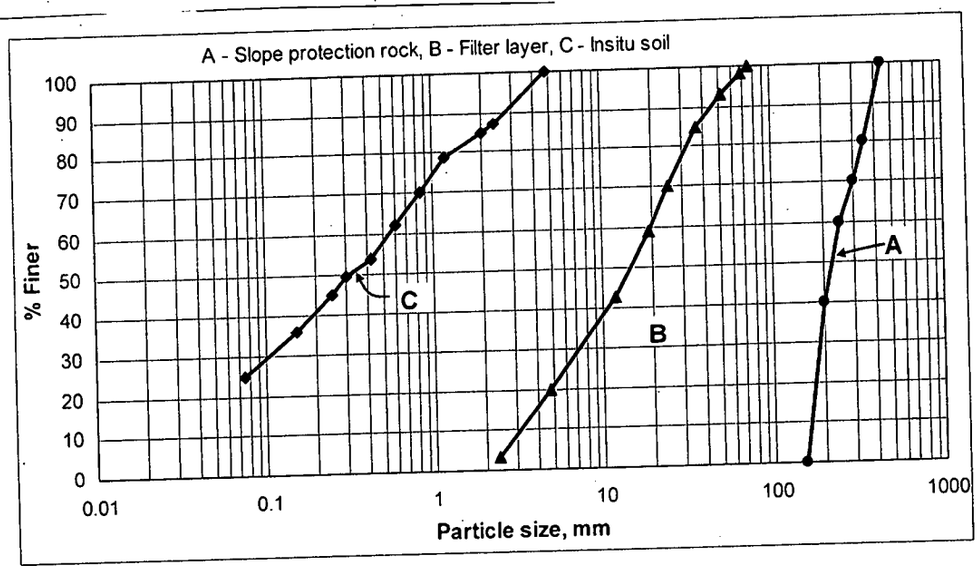


Fig.2

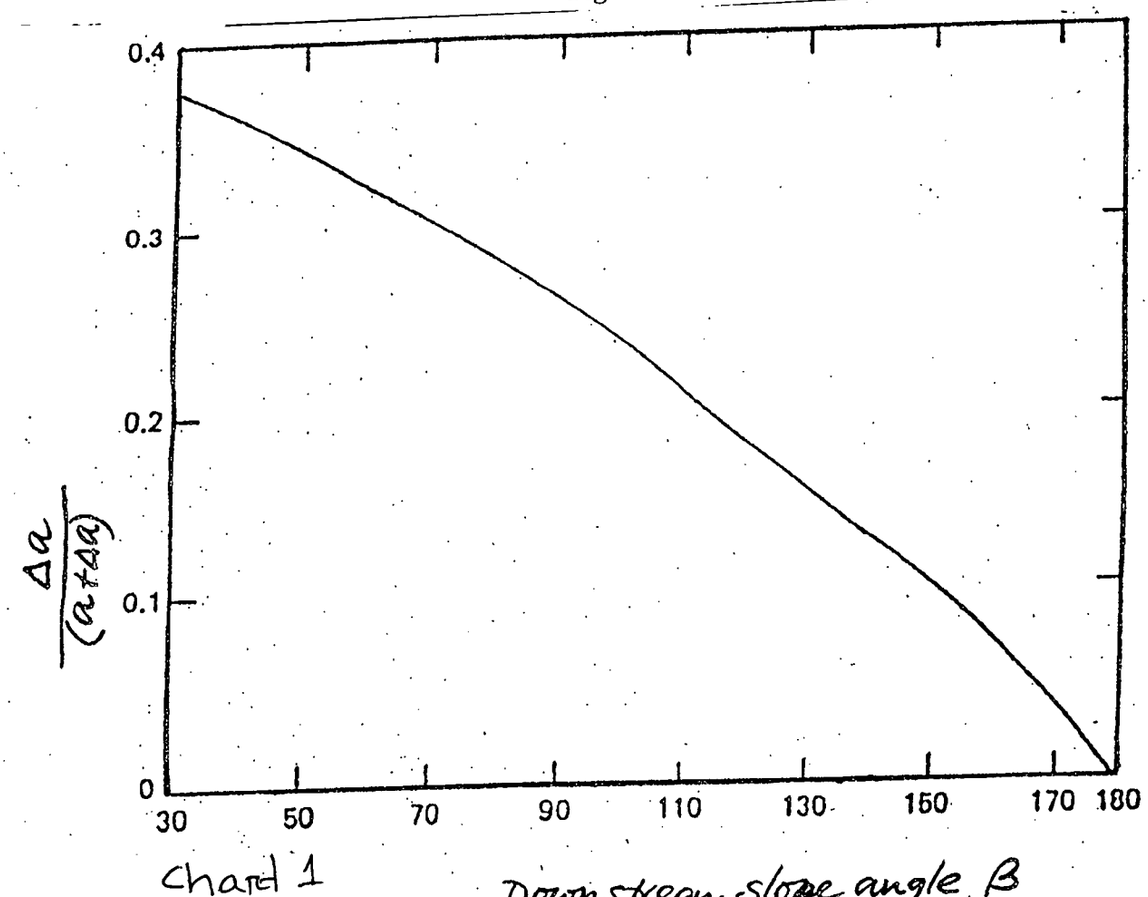


Chart 1

**L-4/T-2/CE** **Date : 17/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2015-2016

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

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

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## SECTION – A

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

1. (a) Discuss Dynamic Compaction method with neat sketches. **(10)**

   (b) Explain an application of the above method in Bangladesh with necessary diagrams. **(8)**

   (c) Name three instruments to measure different types of vibrations. **(5⅓)**

2. (a) Explain different types of faulting with neat sketches. **(13⅓)**

   (b) Estimate probability of earthquake hazard for nuclear power plant (NPP) for a return period of 200,950 and 2475 year. **(10)**

3. (a) Explain data completeness for seismic hazard analysis with necessary figures. **(13⅓)**

   (b) What are the countermeasures for building foundation against liquefaction? Explain with figures. **(10)**

4. (a) Explain the following: **(12)**

   (i) Liquefaction potential Index

   (ii) Blasting

   (iii) Magnitude and Intensity

   (vi) Risk Sensitive Land Use Planning

   (b) Write down the factors which influence site amplification. **(3)**

   (c) Explain extensive damage to highrise buildings during 1985 Mexico earthquake. **(8⅓)**

## SECTION – B

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

5. (a) List six sources of dynamic loading for soils and geotechnical structures. **(3)**

   (b) Draw typical loading diagram for the following cases: (i) operation of a rotary machine, (ii) impact of a hammer and (iii) earthquake. **(6)**

   (c) List the general problems related to the dynamic loading of soils and earth structures. **(6)**

   (d) 'Soil dynamics is an interdisciplinary area' – explain. **(8⅓)**

Contd ..... P/4

**CE 445**

6. (a) Define: (i) natural frequency, (ii) resonance and (iii) forced vibrations. **(3)**

   (b) Define degrees of freedom. Draw systems with the following degrees of freedom: (i) one degree of freedom, (ii) two degrees of freedom and (iii) three degrees of freedom. **(6)**

   (c) Draw typical relationship between static deflections and natural frequency. A mass 'm' supported by a spring has a static deflection of 1.0 mm. Determine its natural frequency of oscillation. **(6)**

   (d) In case of a free vibration of a spring-mass system, derive the following relationship. **(8⅓)**

$$\omega_n = \sqrt{\frac{k}{m}}$$

   Where, $\omega_n$ = circular natural frequency, k = spring constant, m = mass

7. (a) Briefly describe harmonic vibrations and transient forces. **(3)**

   (b) What is logarithmic decrement? Show that, $\delta = 2\pi\xi$ (where, the symbols have their usual meaning). **(6)**

   (c) Plot magnification ratio vs frequency ratio. Describe the effect of damping factor on this relationship. **(6)**

   (d) (i) Determine the equivalent spring constant for the systems at point C as shown in Fig. 1. If $x_1 = x_2$ and $K_1 = K_2 = K$, whet will be the equivalent spring constant. (ii) Also, determine the equivalent spring constant for the system shown in Fig. 2. If $K_1 = K_2 = K$, what will be the equivalent spring constant? **(8⅓)**

8. (a) List the usual dynamic properties of soils. **(3)**

   (b) Draw a typical stress-strain hysteresis loop and show $G_{max}$, $G_{sec}$, $\gamma_c$ and $\tau_c$ on the loop. Explain how you can determine the damping ratio (D) from such loop. Define 'complete stress reversal'. **(6)**

   (c) List the low-strain field and laboratory tests for determining the dynamic soil properties. Briefly describe the advantages of field tests in determining the dynamic soil properties. **(6)**

   (d) Prove that, critical damping ratio, $C_c = 2\ m\omega_n$ where, m = mass and $\omega_n$ = circular natural frequency. **(8⅓)**

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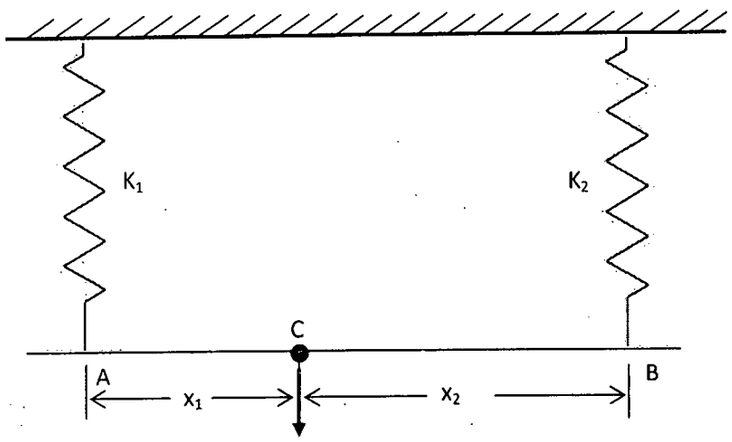


Fig. 1 for Q.7(d) (i)

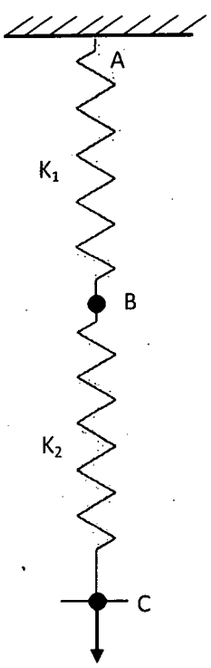


Fig. 2 for Q.7(d) (ii)

L-4/T-2/CE **Date : 15/07/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2015-2016

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

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

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## SECTION – A

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

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

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

2. (a) What are the major difficulties in conducting socio-economic assessments in developing countries? Explain with examples. **(15)**

   (b) Briefly discuss various methodologies in practice to ensure community participation. **(20)**

3. (a) Explain the following terms with explanations in the context of a WSS project in Bangladesh: **(5×4=20)**

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

   (b) What are the advantages and features of Social Impact Assessment (SIA) process? **(15)**

4. (a) Define "Participation". What is the significance of peoples' participation in WSS projects? **(20)**

   (b) List the Social Impact Assessment (SIA) variables to be addressed in impact study. **(8)**

   (c) What are the direct and indirect impacts associated with a wastewater treatment plant? Explain. **(7)**

## SECTION-B

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

5. (a) "Transforming our world: the 2030 Agenda for Sustainable Development" is a plan of action for people, planet and prosperity. What is sustainable development? How many goals and associated targets are there in this agenda? List the names (titles only) of all the goals in the agenda. **(25)**

   (b) Are the SDGs legally binding for nations? How will the SDGs be implemented and monitored at global and national levels? How many indicators are there in the "Official revised list of global SDG indicators"? **(10)**

Contd ..... P/2

**CE403**

6. (a) Distinguish between GNI, GDP and GNI per capita. Despite many weaknesses, why GNI/ GDP is the most widely used development indicator? Briefly discuss with examples, the weaknesses of GNI as a development indicator. **(17)**

(b) State SDG 6, targets 6.1, 6.2 and 6.3 and associated indicators for these targets. **(18)**

7. (a) What do you mean by development projects? What are some important characteristics of development projects? List names of 10 large infrastructure development projects in Bangladesh. **(10)**

(b) Make a list of major social and economic issues related to large development projects in Bangladesh. **(10)**

(c) Explain the differences between "economic growth", "economic development" and "human development". What are the four major elements in the concept of human development? Explain briefly, their importance in human development. **(15)**

8. (a) In a tabular form, compare the differences between the Bangladesh law (ARIPO, 1982) and the World Bank's OP 4.12 on land acquisition and resettlement with respect to coverage, compensation, impact minimization, consultation, relocation assistance and livelihood restoration. **(18)**

(b) How does climate change relate to sustainable development? State SDG 13, and associated targets 13.1, 13.2 and 13.3. **(17)**

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L-4/T-2/CE **Date : 15/07/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2015-2016

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

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

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## SECTION – A

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

1. (a) What is the role of a manager in the human resource frame? What are the best strategies to implement human resource management policy? **(17)**

   (b) Explain human needs based on Maslow's hierarchy of needs and Herzberg's motivation hygiene theory. **(18)**

2. (a) What are the five stages of a career? Describe them briefly. **(17)**

   (b) Describe the main points of the five steps for successful networking. **(18)**

3. (a) What is internship and why is it needed? Describe in brief the tips for success in internship. **(17)**

   (b) What is a resume and what is its purpose? Briefly describe the different resume formats. **(18)**

4. (a) Define career. What is career development and what is the value of career development? **(17)**

   (b) What is meant by internal and external dimensions of a career? Describe the problems of internal-external dichotomy. **(18)**

## SECTION-B

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

5. (a) What is the role of a manger according to the symbolic frame? What leadership challenges and dilemmas she faces? Give examples of the 'power of symbols'. **(25)**

   (b) What are the assumptions of political frame? **(10)**

6. (a) Explain ' the power of suppliers' and 'the power of buyers' within the context of the industry structure. **(25)**

   (b) What are the implications of understanding the forces that shape industry competition for strategy development? **(10)**

7. (a) How can be value created and appropriated? What are the routes for positive value addition? **(25)**

   (b) What is strategy? Explain customer centricity. **(10)**

8. (a) Explain 'Customer Job to be done' and 'Aligning business model' principles to organize for innovation. **(25)**

   (b) What is new market disruption? **(10)**

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L-4/T-2/CE **Date: 13/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2015-2016

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

Full Marks: 140 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

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## SECTION – A

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

Assume reasonable values for any missing data.

1. (a) A post tensioned simple beam on a span of 14 m is shown in Fig. 1. It carries a 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$^3$. **(8 ⅓)**

   (b) For the above problem [1(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)**

2. (a) Describe briefly the different stages of loading to which a prestressed concrete beam member is often subjected. **(7 ⅓)**

   (b) An I-shaped beam is prestressed with $A_{ps}$ = 2368 mm$^2$ as prestressing steel with an effective stress, $f_{se}$ of 1103 N/mm$^2$. The c.g.s of the strands which supply the prestress is 115 mm above the bottom of the beam as shown in Fig. 2 along with shape of the concrete section. Material properties are $f_{pu}$ = 1862 N/mm$^2$ and $f_c'$ = 48 N/mm$^2$. Find the ultimate resisting moment for the section for design following the ACI code. **(16)**

3. (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 $M_T$ 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. **(13 ⅓)**

4. Fig. 3 shows the midsection of a composite beam. The precast section is an inverted T-section 900 mm in depth and is post-tensioned with an initial force of 2800 kN which reduces to 2450 kN after losses. The beam is simply supported on 24 m span. The top slab 150×1000 mm is cast in place after erection of the precast element. After hardening of the floor slab, the composite section has to carry a maximum live load moment of 600 kN-m and superimposed DL moment of 150 kN-m at midspan. Compute the stresses at midspan section at various stages. Given: $f_c'$ = 49 MPa, $A_{ps}$ = 2580 mm$^2$, $\gamma_{con}$ = 25 kN/m$^3$. **(23 ⅓)**

Contd ..... P/2

**CE 415**

## SECTION-B

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

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

(b) A pretensioned concrete beam, 12 metre long is eccentrically prestressed with 1400 $mm^2$ of steel wires which are anchored to the bulk heads (Fig. 4). The stress at this situation is 1020 MPa. Compute the loss of prestress due to elastic shortening of concrete at the transfer of prestress. Use, $\gamma_{conc}$ = 25 $kN/m^3$ and n = 6. **(15)**

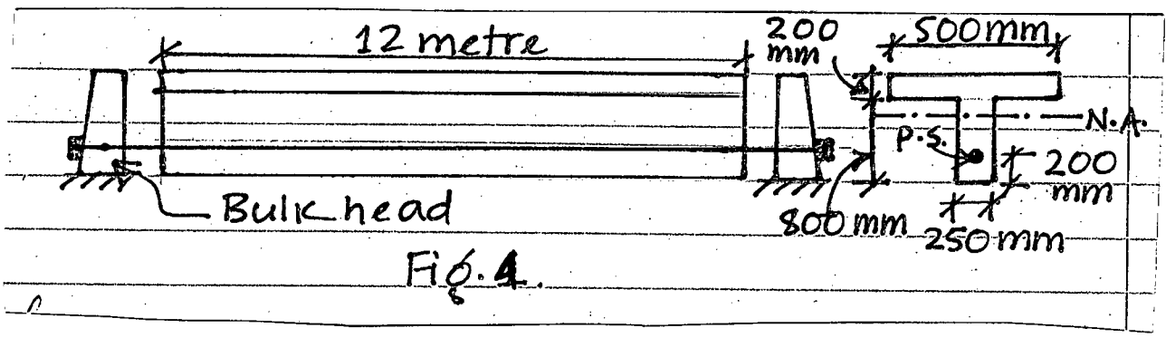

Fig. 4.

6. (a) What are the standard shapes of concrete sections that are generally used in prestressed concrete? Discuss factors that are needed to be considered in choosing a cross-sectional shape? **(8⅓)**

(b) A prestressed concrete beam shown in Fig. 5 is posttensioned with 800 $mm^2$ of high tensile steel to an initial prestress of 1100 MPa immediately after prestressing. Compute the initial deflection at midspan due to prestress and beam's own weight, assuming $E_c = 25\times10^3$ MPa. Estimate the deflection after two months, assuming a creep coefficient, $C_c$ = = 2.0 and effective prestress of 850 MPa at this time. Assume any data (if missing) appropriate for your calculation. **(15)**

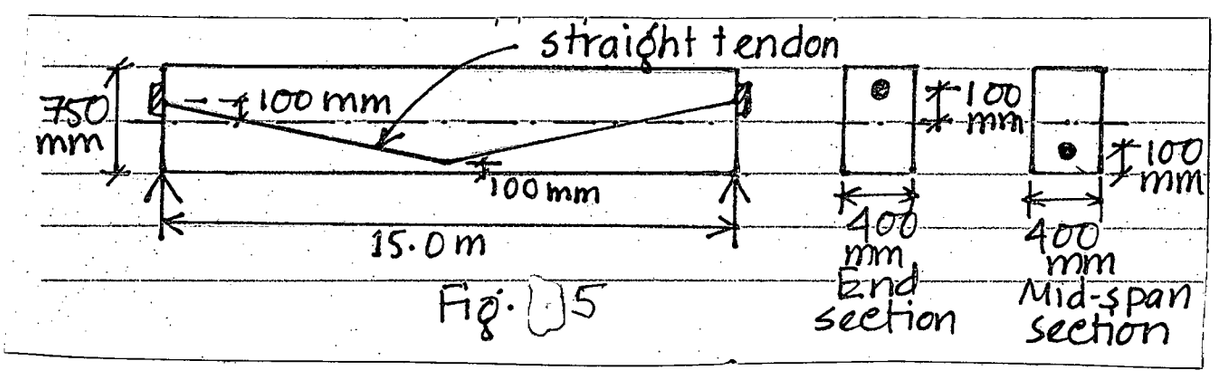

Fig. 5

**CE 415**

7. (a) Explain the importance of transfer bond in a pretensioned prestressed concrete member. Also, write down the factors which control such transfer bond and hence the transfer length. **(6)**

(b) Why the transverse tension in the anchorage zone is so important in the design of a posttensioned prestressed concrete beam? Explain briefly. **(6)**

(c) Determine the bearing plate area required for a tendon consisting of 14-12.7 mm dia 7-wire strands anchored at the end of a beam as shown in Fig. 6. The tendon forces for design are 2100 kN due to maximum Jacking force and 1500 kN at service load. Use $f'_{ci}$ = 35 MPa and $f'_c$ = 45 MPa. Follow the specification of Post-Tensioning Institute (PTI) for allowable bearing stresses on the concrete. **(11⅓)**

All service load: $f_{cp} = 0.6\, f'_c \sqrt{A'_b / A_b} \rangle f'_c$

All transfer load: $f_{cp} = 0.8\, f'_{ci} \sqrt{A'_b / A_b - 0.2} \rangle 1.25 f'_{ci}$

All symbols carry their usual meanings.

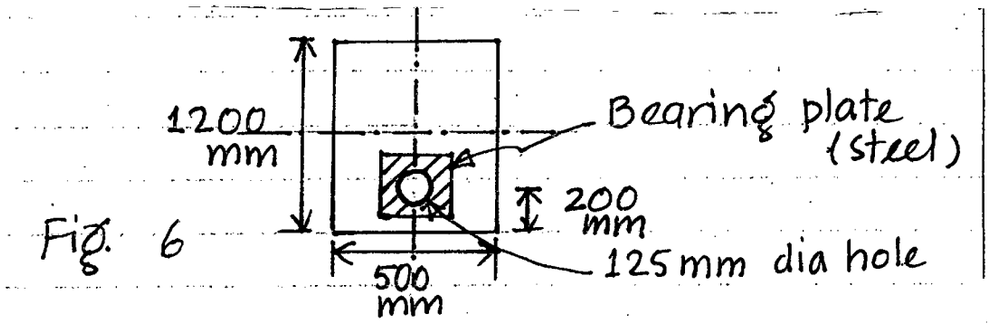


Fig. 6

8. (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). **(10)**

(b) Check shear strength for the beam shown in Fig. 7 at section 1-1 and 2-2 respectively. Given that the section is adequate for $W_u$ = 60 kN/m on the basis of its flexural strength. Given: Effective prestress = 1100 MPa, Initial prestress = 1400 MPa, $f'_c$ = 40 MPa. **(13⅓)**

Use ACI Equations provided in Annexure-I.

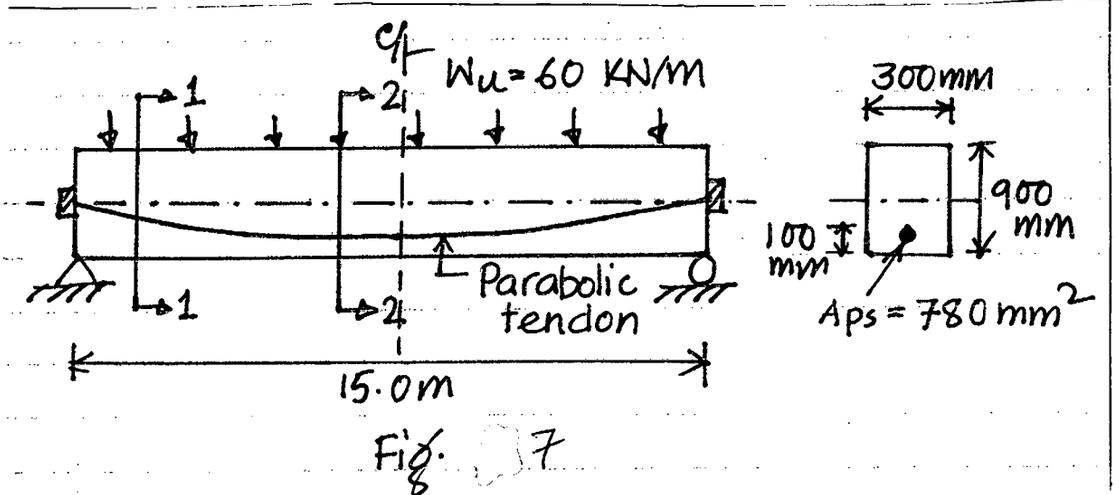


Fig. 7

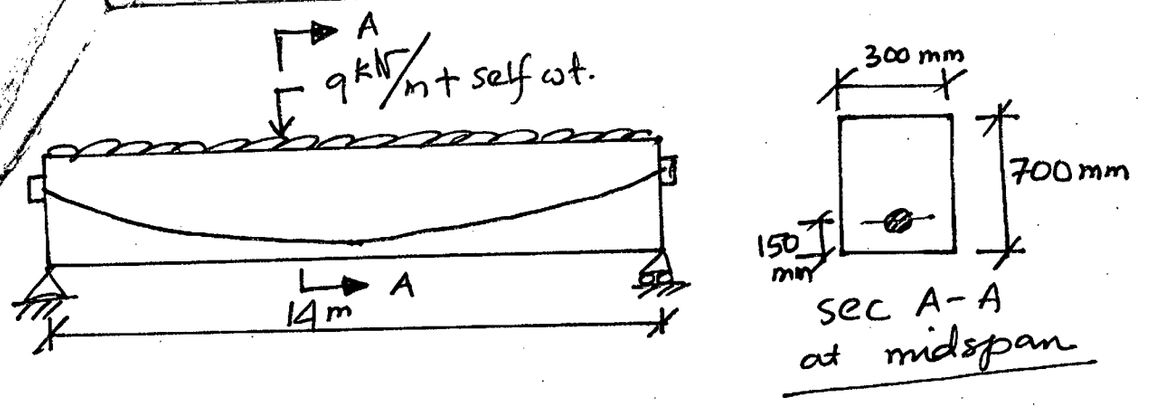


Fig. 1.

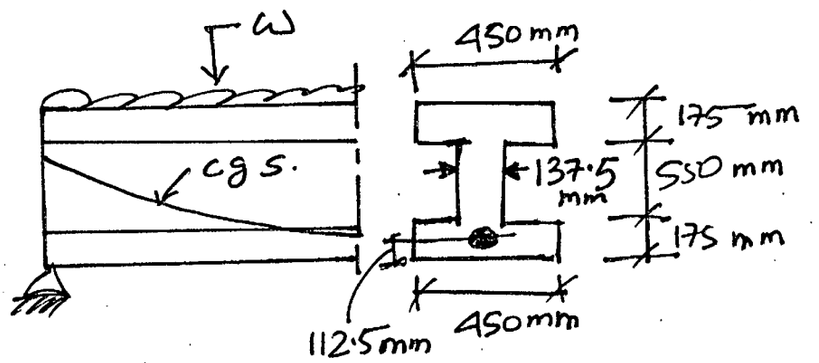


Fig. 2

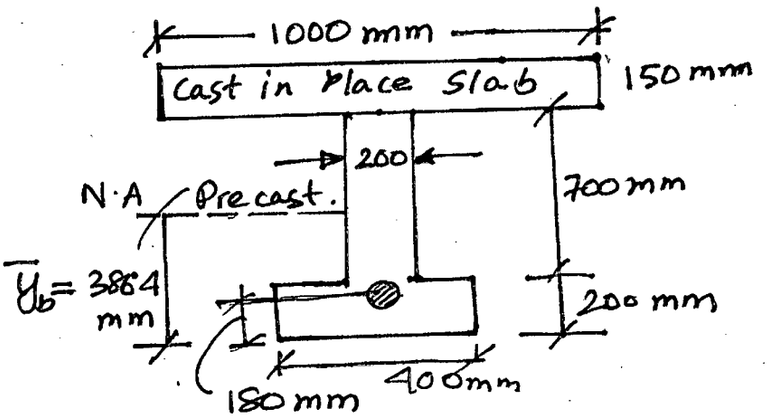


Fig. 3

# Annexure-I

**Table 7-1 ACI Equations for shear strength evaluation: Shear stress = $\frac{\text{shear force}}{b_w d}$**

| 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 $V_u/\phi$ 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) |

L-4/T-2/CE **Date : 13/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2015-2016

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

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

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## SECTION – A

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

1. (a) State five advantages of steel concrete composite floor system over reinforced concrete floor system. **(3.5)**

   (b) A typical bay of a composite floor system is illustrated in Fig. 1. **(14)**

   (i) Calculate the effective slab width for the secondary beam SB1 (W21 × 122). Draw the transverse section (section A-A) 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 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. $F_y = 50$ ksi and $E_s = 29000$ ksi

2. (a) Calculate the service load flexural stresses in concrete and steel of the secondary composite beam SB1 (W21 × 122) 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 SB1 for precomposite and composite stages of construction. **(3.5)**

3. (a) Why shear connectors are required in composite floor system? Name different types of shear connectors with sketches. **(3.5)**

   (b) (i) Evaluate the design ultimate moment capacity of the main beam MB1 (W24 × 146) as shown in Fig. 1 in positive bending for 80% composite action.

   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 80% composite action.

   Assume: $R_p = 0.75$, $R_g = 0.85$ and $F_u = 65$ ksi for shear connectors **(14)**

Contd ..... P/2

## CE 413

4. (a) Determine between shored and unshored construction method for composite floor system. **(3.5)**

(b) Determine the midspan deflection of the fully composite beam shown in Fig. 3, for unshored construction. The steel shape is W24 × 62. The floor has 5.5 inch normal weight concrete on metal deck with 2.5 inch ribs. This is an interior beam; spacing of the beam is 8 ft. Calculate the total vertical deflection for composite as well as for precomposite stage and compare the values with the allowable limits for total deflection (i.e., L/240) specified in AISC guide. The calculated uniformly distributed service loads on the beam is 0.5 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 floor life load. **(14)**

Given: $f'_c$ = 3 ksi; and $E_c$ = 3000 ksi. for steel $F_y$ = 50 ksi and $E_s$ = 29000 ksi

5. For the composite beam section shown in Fig. 4, **(7.5+10)**

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

For concrete: $f'_c$ = 3 ksi; and $E_c$ = 3000 ksi. For steel $F_y$ = 50 ksi and $E_s$ = 29000 ksi

(b) Find the yield moment capacity of the composite beam in positive as well as in negative bending.

## SECTION – B

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

6. (a) Briefly discuss the advantages and disadvantages of fully encased composite columns. **(4)**

(b) How much live load thrust can be supposed by an A36 steel tube if the effective length of the column is 12 ft and dead load thrust is 100 kip? The column has a cross section with a 0.50 inch wall thickness and 12 inch outside diameter. Moments are negligible. **(13½)**

Given: $f_y$ = = 36 ksi; and $f'_c$ = 4 ksi, $E_s$ = 29000 ksi and $E_c$ = 3600 ksi

7. (a) State the advantages and disadvantages of FEC sections over other composite column sections. **(4)**

(b) A fully encased composite (FEC) column section shown in Figure: 5. 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: $F_y$ = $F_{yr}$ = 50 ksi; and $f'_c$ = 3.5 ksi, $E_s$ = 29,000 ksi and $E_c$ = 4000 ksi

Contd ..... P/3

## CE 413

**Contd ... Q. No. 7**

(c) Check the adequacy of the section provided in Fig. 5 to resist the given compressive load. Use the data provided in 6(b) as required. **(11)**

8. (a) Name the methods specified in AISC guide to calculate the load-moment interaction diagram for composite column. **(4)**

(b) (i) Check the material and geometric properties of the given partially encased column (PEC column) in Figure 6 with the code specifed limits. **(13½)**

(ii) Determine the axial capacity of the column.

Given: $f_y$ = = 350 MPa; and $f'_c$ = 30 MPa, $E_s$ = 200 GPa and $E_c$ = 24 MPa

9. (a) Draw in a neat sketch the idealized P-M interaction diagram for strong axis bending for the CFT column using plastic stress distribution method. **(4)**

(b) For the CFT column section shown in Fig. 7, calculate the axial force and bending moment for balanced failure condition. Use, plastic stress distribution method. The length of the column is 12 feet and the column is pin-pin connected in both axes. **(13½)**

Given: $f_y$ = = 36 ksi; and $f'_c$ = 4 ksi, $E_s$ = 29000 ksi and $E_c$ = 3600 ksi and wall thickness = 0.5″

10. (a) Calculate the axial load and bending moment (M) for the four points in the P-M diagram about strong axis bending of the FEC column shown in Figure 8 using plastic stress.

Given: $F_y = F_{yr}$ = 50 ksi; and $f'_c$ = 3 ksi, $E_s$ = 29,000 ksi and $E_c$ = 3600 ksi

Effective length of the column = 10′ **(10½)**

(b) Redraw the P-M interaction diagram for the column including the global slenderness effect. **(7)**

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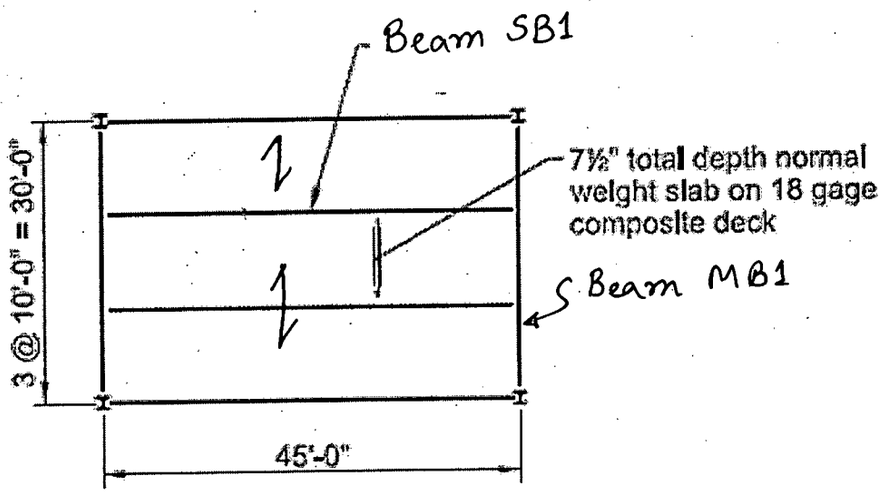



Fig. 1

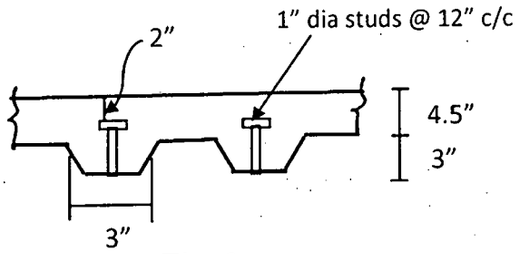



Fig. 2

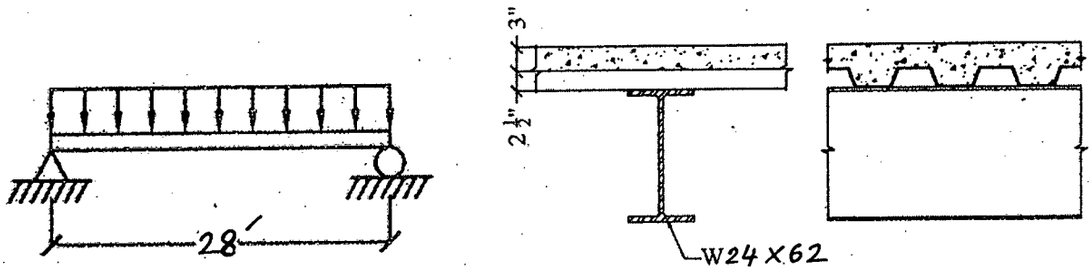



Fig. 3

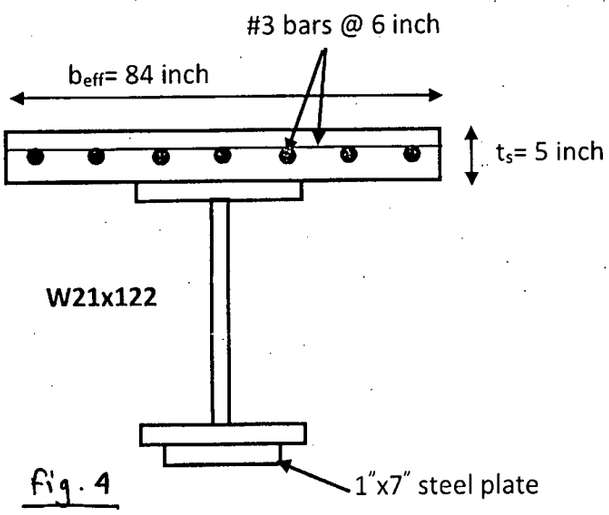
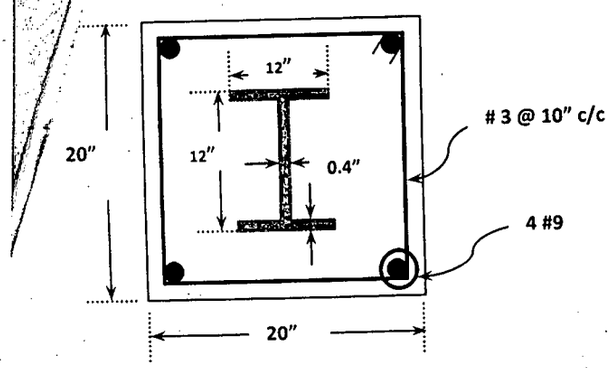



Fig. 4



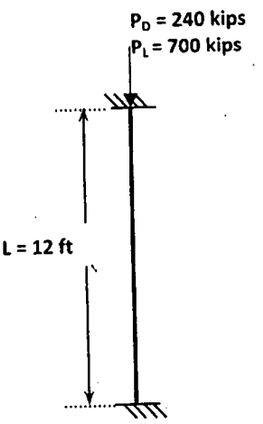




Figure 5 for Question 7(b) & 6(c)

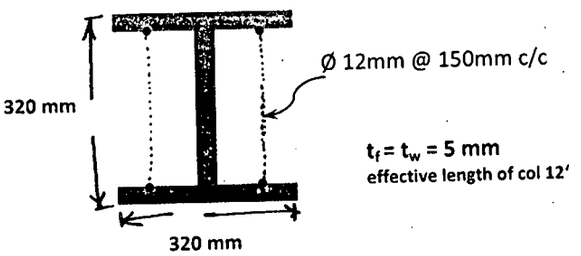



Figure 6 for Question 8(b)

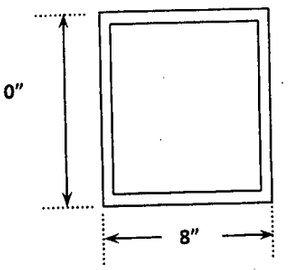



Figure 7 for Question 9(b)

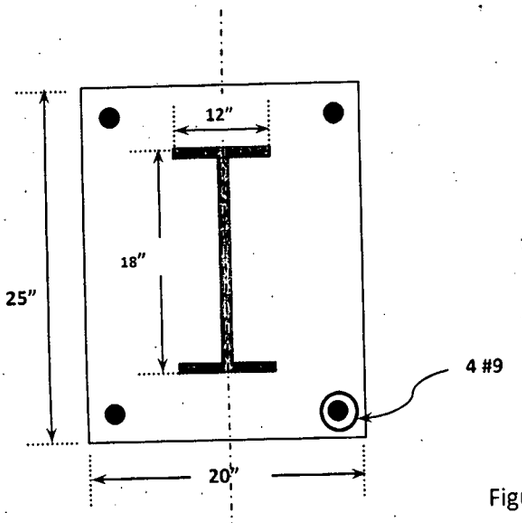
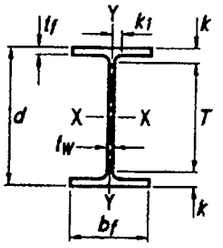



Figure 8 for Question 10




# Table 1–1 (continued)
# W Shapes
## Dimensions

| Shape | Area, A | Depth, d | | Web Thickness, $t_w$ | | $\frac{t_w}{2}$ | Flange Width, $b_f$ | | Flange Thickness, $t_f$ | | Distance k | | $k_1$ | T | Work-able Gage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | $k_{des}$ | $k_{det}$ | | | |
| | in.$^2$ | in. | | in. | | in. | in. | | in. | | in. | in. | in. | in. | in. |
| W24×370[h] | 109 | 28.0 | 28 | 1.52 | 1 1/2 | 3/4 | 13.7 | 13 5/8 | 2.72 | 2 3/4 | 3.22 | 3 5/8 | 1 9/16 | 20 3/4 | 5 1/2 |
| ×335[h] | 98.4 | 27.5 | 27 1/2 | 1.38 | 1 3/8 | 11/16 | 13.5 | 13 1/2 | 2.48 | 2 1/2 | 2.98 | 3 3/8 | 1 1/2 | | |
| ×306[h] | 89.8 | 27.1 | 27 1/8 | 1.26 | 1 1/4 | 5/8 | 13.4 | 13 3/8 | 2.28 | 2 1/4 | 2.78 | 3 3/16 | 1 7/16 | | |
| x279[h] | 82.0 | 26.7 | 26 3/4 | 1.16 | 1 3/16 | 5/8 | 13.3 | 13 1/4 | 2.09 | 2 1/16 | 2.59 | 3 | 1 7/16 | | |
| ×250 | 73.5 | 26.3 | 26 3/8 | 1.04 | 1 1/16 | 9/16 | 13.2 | 13 1/8 | 1.89 | 1 7/8 | 2.39 | 2 13/16 | 1 3/8 | | |
| ×229 | 67.2 | 26.0 | 26 | 0.960 | 15/16 | 1/2 | 13.1 | 13 1/8 | 1.73 | 1 3/4 | 2.23 | 2 5/8 | 1 5/16 | | |
| ×207 | 60.7 | 25.7 | 25 3/4 | 0.870 | 7/8 | 7/16 | 13.0 | 13 | 1.57 | 1 9/16 | 2.07 | 2 1/2 | 1 1/4 | | |
| ×192 | 56.3 | 25.5 | 25 1/2 | 0.810 | 13/16 | 7/16 | 13.0 | 13 | 1.46 | 1 7/16 | 1.96 | 2 3/8 | 1 1/4 | | |
| ×176 | 51.7 | 25.2 | 25 1/4 | 0.750 | 3/4 | 3/8 | 12.9 | 12 7/8 | 1.34 | 1 5/16 | 1.84 | 2 1/4 | 1 3/16 | | |
| ×162 | 47.7 | 25.0 | 25 | 0.705 | 11/16 | 3/8 | 13.0 | 13 | 1.22 | 1 1/4 | 1.72 | 2 1/8 | 1 3/16 | | |
| ×146 | 43.0 | 24.7 | 24 3/4 | 0.650 | 5/8 | 5/16 | 12.9 | 12 7/8 | 1.09 | 1 1/16 | 1.59 | 2 | 1 1/8 | | |
| ×131 | 38.5 | 24.5 | 24 1/2 | 0.605 | 5/8 | 5/16 | 12.9 | 12 7/8 | 0.960 | 15/16 | 1.46 | 1 7/8 | 1 1/8 | | |
| ×117[c] | 34.4 | 24.3 | 24 1/4 | 0.550 | 9/16 | 5/16 | 12.8 | 12 3/4 | 0.850 | 7/8 | 1.35 | 1 3/4 | 1 1/8 | | |
| ×104[c] | 30.6 | 24.1 | 24 | 0.500 | 1/2 | 1/4 | 12.8 | 12 3/4 | 0.750 | 3/4 | 1.25 | 1 5/8 | 1 1/16 | | |
| W24×103[c] | 30.3 | 24.5 | 24 1/2 | 0.550 | 9/16 | 5/16 | 9.00 | 9 | 0.980 | 1 | 1.48 | 1 7/8 | 1 1/8 | 20 3/4 | 5 1/2 |
| ×94[c] | 27.7 | 24.3 | 24 1/4 | 0.515 | 1/2 | 1/4 | 9.07 | 9 1/8 | 0.875 | 7/8 | 1.38 | 1 3/4 | 1 1/16 | | |
| ×84[c] | 24.7 | 24.1 | 24 1/8 | 0.470 | 1/2 | 1/4 | 9.02 | 9 | 0.770 | 3/4 | 1.27 | 1 11/16 | 1 1/16 | | |
| ×76[c] | 22.4 | 23.9 | 23 7/8 | 0.440 | 7/16 | 1/4 | 8.99 | 9 | 0.680 | 11/16 | 1.18 | 1 9/16 | 1 1/16 | | |
| ×68[c] | 20.1 | 23.7 | 23 3/4 | 0.415 | 7/16 | 1/4 | 8.97 | 9 | 0.585 | 9/16 | 1.09 | 1 1/2 | 1 1/16 | | |
| W24×62[c] | 18.2 | 23.7 | 23 3/4 | 0.430 | 7/16 | 1/4 | 7.04 | 7 | 0.590 | 9/16 | 1.09 | 1 1/2 | 1 1/16 | 20 3/4 | 3 1/2[g] |
| ×55[c,v] | 16.2 | 23.6 | 23 5/8 | 0.395 | 3/8 | 3/16 | 7.01 | 7 | 0.505 | 1/2 | 1.01 | 1 7/16 | 1 | 20 3/4 | 3 1/2[g] |
| W21×201 | 59.2 | 23.0 | 23 | 0.910 | 15/16 | 1/2 | 12.6 | 12 5/8 | 1.63 | 1 5/8 | 2.13 | 2 1/2 | 1 5/16 | 18 | 5 1/2 |
| ×182 | 53.6 | 22.7 | 22 3/4 | 0.830 | 13/16 | 7/16 | 12.5 | 12 1/2 | 1.48 | 1 1/2 | 1.98 | 2 3/8 | 1 1/4 | | |
| ×166 | 48.8 | 22.5 | 22 1/2 | 0.750 | 3/4 | 3/8 | 12.4 | 12 3/8 | 1.36 | 1 3/8 | 1.86 | 2 1/4 | 1 3/16 | | |
| ×147 | 43.2 | 22.1 | 22 | 0.720 | 3/4 | 3/8 | 12.5 | 12 1/2 | 1.15 | 1 1/8 | 1.65 | 2 | 1 3/16 | | |
| ×132 | 38.8 | 21.8 | 21 7/8 | 0.650 | 5/8 | 5/16 | 12.4 | 12 1/2 | 1.04 | 1 1/16 | 1.54 | 1 15/16 | 1 1/8 | | |
| ×122 | 35.9 | 21.7 | 21 5/8 | 0.600 | 5/8 | 5/16 | 12.4 | 12 3/8 | 0.960 | 15/16 | 1.46 | 1 13/16 | 1 1/8 | | |
| ×111 | 32.7 | 21.5 | 21 1/2 | 0.550 | 9/16 | 5/16 | 12.3 | 12 3/8 | 0.875 | 7/8 | 1.38 | 1 3/4 | 1 1/8 | | |
| ×101[c] | 29.8 | 21.4 | 21 3/8 | 0.500 | 1/2 | 1/4 | 12.3 | 12 1/4 | 0.800 | 13/16 | 1.30 | 1 11/16 | 1 1/16 | | |

[c] Shape is slender for compression 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.
[v] Shape does not meet the $h/t_w$ limit for shear in Specification Section G2.1a with $F_y$ = 50 ksi.

# Table 1–1 (continued)
# W Shapes
## Properties

W24 – W21

| 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.$^6$ |
| 370 | 2.51 | 14.2 | 13400 | 957 | 11.1 | 1130 | 1160 | 170 | 3.27 | 267 | 3.92 | 25.3 | 201 | 186000 |
| 335 | 2.73 | 15.6 | 11900 | 864 | 11.0 | 1020 | 1030 | 152 | 3.23 | 238 | 3.86 | 25.0 | 152 | 161000 |
| 306 | 2.94 | 17.1 | 10700 | 789 | 10.9 | 922 | 919 | 137 | 3.20 | 214 | 3.81 | 24.9 | 117 | 142000 |
| 279 | 3.18 | 18.6 | 9600 | 718 | 10.8 | 835 | 823 | 124 | 3.17 | 193 | 3.76 | 24.6 | 90.5 | 125000 |
| 250 | 3.49 | 20.7 | 8490 | 644 | 10.7 | 744 | 724 | 110 | 3.14 | 171 | 3.71 | 24.5 | 66.6 | 108000 |
| 229 | 3.79 | 22.5 | 7650 | 588 | 10.7 | 675 | 651 | 99.4 | 3.11 | 154 | 3.67 | 24.3 | 51.3 | 96100 |
| 207 | 4.14 | 24.8 | 6820 | 531 | 10.6 | 606 | 578 | 88.8 | 3.08 | 137 | 3.62 | 24.1 | 38.3 | 84100 |
| 192 | 4.43 | 26.6 | 6260 | 491 | 10.5 | 559 | 530 | 81.8 | 3.07 | 126 | 3.60 | 24.0 | 30.8 | 76300 |
| 176 | 4.81 | 28.7 | 5680 | 450 | 10.5 | 511 | 479 | 74.3 | 3.04 | 115 | 3.57 | 23.9 | 23.9 | 68400 |
| 162 | 5.31 | 30.6 | 5170 | 414 | 10.4 | 468 | 443 | 68.4 | 3.05 | 105 | 3.57 | 23.8 | 18.5 | 62600 |
| 146 | 5.92 | 33.2 | 4580 | 371 | 10.3 | 418 | 391 | 60.5 | 3.01 | 93.2 | 3.53 | 23.7 | 13.4 | 54600 |
| 131 | 6.70 | 35.6 | 4020 | 329 | 10.2 | 370 | 340 | 53.0 | 2.97 | 81.5 | 3.49 | 23.5 | 9.50 | 47100 |
| 117 | 7.53 | 39.2 | 3540 | 291 | 10.1 | 327 | 297 | 46.5 | 2.94 | 71.4 | 3.46 | 23.4 | 6.72 | 40800 |
| 104 | 8.50 | 43.1 | 3100 | 258 | 10.1 | 289 | 259 | 40.7 | 2.91 | 62.4 | 3.42 | 23.3 | 4.72 | 35200 |
| 103 | 4.59 | 39.2 | 3000 | 245 | 10.0 | 280 | 119 | 26.5 | 1.99 | 41.5 | 2.40 | 23.6 | 7.07 | 16600 |
| 94 | 5.18 | 41.9 | 2700 | 222 | 9.87 | 254 | 109 | 24.0 | 1.98 | 37.5 | 2.40 | 23.4 | 5.26 | 15000 |
| 84 | 5.86 | 45.9 | 2370 | 196 | 9.79 | 224 | 94.4 | 20.9 | 1.95 | 32.6 | 2.37 | 23.3 | 3.70 | 12800 |
| 76 | 6.61 | 49.0 | 2100 | 176 | 9.69 | 200 | 82.5 | 18.4 | 1.92 | 28.6 | 2.34 | 23.2 | 2.68 | 11100 |
| 68 | 7.66 | 52.0 | 1830 | 154 | 9.55 | 177 | 70.4 | 15.7 | 1.87 | 24.5 | 2.30 | 23.1 | 1.87 | 9430 |
| 62 | 5.97 | 50.1 | 1550 | 131 | 9.23 | 153 | 34.5 | 9.80 | 1.38 | 15.7 | 1.75 | 23.2 | 1.71 | 4620 |
| 55 | 6.94 | 54.6 | 1350 | 114 | 9.11 | 134 | 29.1 | 8.30 | 1.34 | 13.3 | 1.71 | 23.1 | 1.18 | 3870 |
| 201 | 3.86 | 20.6 | 5310 | 461 | 9.47 | 530 | 542 | 86.1 | 3.02 | 133 | 3.55 | 21.4 | 40.9 | 62000 |
| 182 | 4.22 | 22.6 | 4730 | 417 | 9.40 | 476 | 483 | 77.2 | 3.00 | 119 | 3.51 | 21.2 | 30.7 | 54400 |
| 166 | 4.57 | 25.0 | 4280 | 380 | 9.36 | 432 | 435 | 70.0 | 2.99 | 108 | 3.48 | 21.1 | 23.6 | 48500 |
| 147 | 5.44 | 26.1 | 3630 | 329 | 9.17 | 373 | 376 | 60.1 | 2.95 | 92.6 | 3.45 | 20.9 | 15.4 | 41100 |
| 132 | 6.01 | 28.9 | 3220 | 295 | 9.12 | 333 | 333 | 53.5 | 2.93 | 82.3 | 3.42 | 20.8 | 11.3 | 36000 |
| 122 | 6.45 | 31.3 | 2960 | 273 | 9.09 | 307 | 305 | 49.2 | 2.92 | 75.6 | 3.40 | 20.7 | 8.98 | 32700 |
| 111 | 7.05 | 34.1 | 2670 | 249 | 9.05 | 279 | 274 | 44.5 | 2.90 | 68.2 | 3.37 | 20.6 | 6.83 | 29200 |
| 101 | 7.68 | 37.5 | 2420 | 227 | 9.02 | 253 | 248 | 40.3 | 2.89 | 61.7 | 3.35 | 20.6 | 5.21 | 26200 |

ANNEXURE 1

**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 | $\lambda_p$ Compact/ Noncompact | $\lambda_r$ 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 | $D/t$ | $\frac{0.15E}{F_y}$ | $\frac{0.19E}{F_y}$ | $\frac{0.31E}{F_y}$ |

(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

$\lambda$, $\lambda_p$ and $\lambda_r$ are slenderness ratios determined from Table I1.1a

$P_p$ is determined from Equation I2-9b

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

(c) For slender sections

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

ANNEXURE 2

where

(i) For rectangular filled sections

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

(ii) For round filled sections

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

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

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

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

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

**For FEC Columns:**

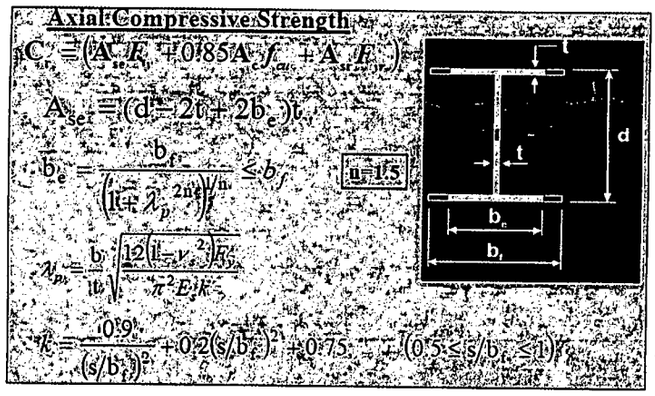
Nominal compressive strength: $P_o = A_s F_y + A_{sr} F_{yr} + 0.85 A_c f'_c$

$EI_{eff} = E_s I_{sy} + 0.5 E_s I_{sry} + C_1 E_c I_{cy}$

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

Nominal Tensile Strength: $P_o = A_s F_y + A_{sr} F_{yr}$

**For PEC Column with non-compact section :**



**L-4/T-2/CE** **Date : 12/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2015-2016

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

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

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## SECTION – A

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

1. (a) Why is phosphorus typically the limiting nutrient in lakes? What are the different strategies for managing water quality in lakes? **(6)**

   (b) What are the merits and demerits of chemical and biological monitoring of water quality is rivers? **(4)**

   (c) A city of 200,000 people discharges 37 $ft^3$/sec of sewage having a BOD of 28 mg/L and 1.8 mg/L of DO into a river that has a flowrate of 250 $ft^3$/sec and flow speed of 1.2 ft/sec. Just upstream of the release point, the river has a BOD of 3.6 mg/L and a DO of 7.6 mg/L. The saturation value of DO is 8.5 mg/L. Deoxygenation coefficient, $k_d$ is 0.61/day and the reaeration coefficient $k_r$ is 0.76/day. Assuming complete and instantaneous mixing of the sewage and river, find **(13 ⅓)**

   (i) the initial oxygen deficit and ultimate BOD just downstream of the outfall.

   (ii) the time and distance to reach the minimum DO.

   (iii) the minimum DO.

   (iv) the DO that could be expected 10 miles downstream.

2. (a) Explain with diagrams the effect of NBOD on the DO sag curve and its implications. What are the important sources and sinks of DO in rivers? **(5)**

   (b) What is NAPL? Why is DNAPL extremely difficult to remove? What are the factors affecting residual saturation of NAPL plumes? **(6)**

   (c) A lake with a surface area of $8.5 \times 10^7$ $m^2$ is fed by a stream having an average flow rate of 6.5 $m^3$/s and average total phosphorus concentration of 0.05 mg/l. The Lake also receives phosphorus from two other sources: a wastewater treatment plant with a flow rate of 0.25 $m^3$/s and a phosphorus concentration of 6.0 mg/l; and a domestic sewage outfall with a flow rate of 0.15 $m^3$/s and phosphorus concentration of 3.5 mg/l. The phosphorus settling rate in the Lake is 11 m per year. **(12 ⅓)**

   (i) Estimate average phosphorus concentration in the Lake.

   (ii) How much Phosphorus removal efficiency is required for the wastewater treatment plant so that the average phosphorus concentration in the Lake can be maintained at 0.03 mg/ L?

Contd ..... P/2

## CE 435

**Contd ... Q. No. 2(c)**

(iv) What is the minimum possible ambient phosphorus concentration in the lake that could be achieved by completely removing phosphorus from effluent at the wastewater treatment plant?

3. (a) What do you mean by thermal stratification in lakes? How does thermal stratification and seasonal overturns affect the water quality in lakes both in summer and winter? Explain with diagrams. **(12)**

(b) How does density stratification in estuaries affect water quality in such environments? **(5)**

(c) The ultimate CBOD (i.e., Lo) and $BOD_5$, (at standard condition) of a wastewater sample are 290 mg/l and 175 mg/l, respectively. It also has a TKN of 30 mg/L. **(6⅓)**

(i) Estimate 4-day CBOD (i.e., $BOD_4$) of the wastewater at 26°C.

(ii) Estimate the ultimate NBOD.

4. (a) Write short notes on (i) Cultural Eutrophication, (ii) Bio-accumulation and Bio-magnification, (iii) Hydrodynamic control of groundwater plume, (iv) "Silent Spring". **(12)**

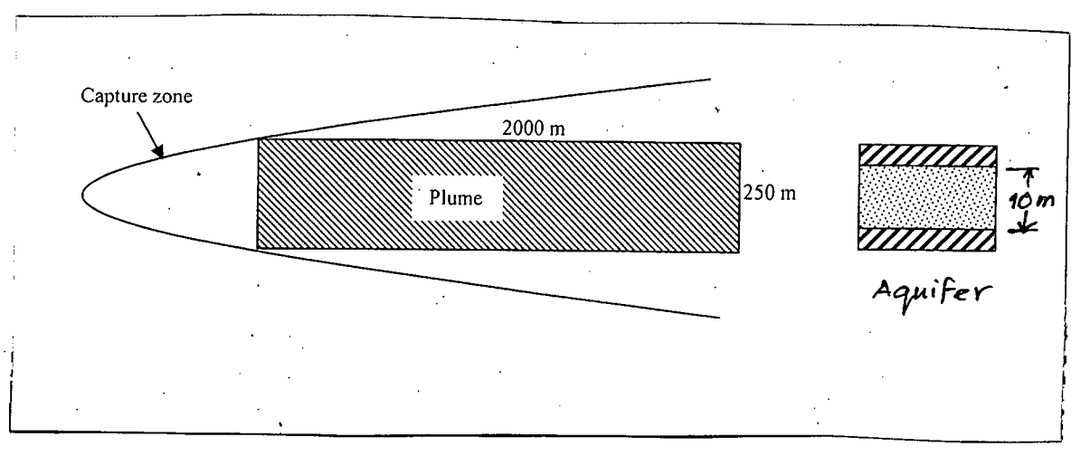
(b) Suppose a spill of 0.10 $m^3$ of TCE (density 1.46 gm/cc) distributes itself evenly throughout an aquifer 10 m thick, forming a rectangular plume 2000 m long and 250 m wide. The aquifer has porosity 0.40, hydraulic gradient 0.001 and hydraulic conductivity 0.001 m/s. **(11⅓)**

(i) What would be concentration of TCE in this idealized groundwater plume?

(ii) An extraction field is to be designed to pump out the plume under the assumption that the wells are lined up along the leading edge of the plume (see figure), with each well to be pumped at the same rate, not to exceed 0.003 $m^3/s$ per well. What is the smallest number of wells that could be used to capture the whole plume?

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

(iv) What would be the optimum spacing be between the wells (at minimum pumping rate)?




Contd ..... P/3

**CE 435**

## SECTION – B

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

5. (a) On a particular day, air quality data recorded at the CAMS in Gazipur are as follows: **(7)**

$PM_{2.5}$ (24-hr) = 175 $\mu g/m^3$

$PM_{10}$(24-hr) = 330 $\mu g/m^3$

CO (8-hr) = 9.75 $mg/m^3$

$SO_2$ (24-hr) = 445 $\mu g/m^3$

Determine AQI for each parameter and report AQI for that particular day.

[Given T = 25°C; P = 1 atm; Table for calculating AQI provided]

(b) Describe the $NO\text{-}NO_2\text{-}O_3$ photochemical reaction sequence. Explain how hydrocarbons affect this reaction sequence and help produce ozone and aldehyde. Can $SO_2$ promote formation of photochemical smog? Explain. **(9 ⅓)**

(c) What do you understand by stoichiometric ratio, lean mixture, and rich mixture? Calculate stoichiometric ratio for the fuel $C_6H_{10}$. **(7)**

6. (a) A coal-fired power plant emits $SO_2$ at the rate of 60 g/sec through a stack that has an effective height of 50 m. Estimate $SO_2$ concentration on the top of a 20-storey building with a height of 65 m. The building is located 1.5 km down-wind along the centerline of the plume. Consider wind speed at instrument height (10 m) to be 3.1 m/sec. First, consider the atmosphere to be "neutral". Then repeat the calculation considering the atmosphere to be "very unstable". Compare the results and comment on the effect of atmospheric stability on air quality. **(12)**

[Given: p = 0.15 for "very unstable" atmosphere; p = 0.25 for neutral atmosphere; Table for calculation of dispersion coefficient provided]

(b) What do you understand by "stable", "unstable" and "neutral" atmosphere? Draw idealized shapes of the following types of plumes (along with corresponding temperature profile) emitted from a smoke stack: (i) Fumigating; (ii) Lofting. **(3)**

(c) What are the common "post-engine" devices available for control of vehicular emission? How do catalytic converters reduce vehicular emission? How does air-fuel ratio affect the performance of a catalytic converter? Explain. **(8 ⅓)**

7. (a) On a particular day, cars are traveling on a elevated expressway such that 8 cars are passing a given spot per second. The height of the expressway is 6.0 m from the ground surface. Each car, on an average, emits carbon monoxide (CO) at a rate of 4.4 g/km. If wind speed is 2.5 m/sec perpendicular to the expressway, estimate ground level concentration of CO at a point 300 m down-wind. Consider the atmosphere to be "slightly stable". [Note Table for calculation of dispersion coefficient provided] **(9)**

Contd ..... P/4

## CE 435

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

(b) Explain the effects of atmospheric aerosols/particulates on global warming, distinguishing between positive and negative, and direct and indirect forcing. **(8⅓)**

(c) Derive an expression for determining the diameter of particle (dp) that would be removed with 100% theoretical efficiency in a gravitational settling chamber of length L and height H. **(6)**

8. (a) On a particular day, ambient atmospheric temperature profile is given by the following equations: **(9)**

$$\Lambda = 30 + 0.05\,z \quad ; \; z \leq 170 \text{ m}$$

$$38.5 - 0.001(z - 170) \quad ; \; z > 170 \text{ m; where, } z = \text{altitude in m.}$$

Plumes are being emitted at 40°C from the top of two smoke stacks, one with a height of 10 m and the other with a height of 100 m. Estimate how high the plumes would rise in each case. Also calculate the ventilation coefficient in each case, assuming an average wind speed of 3.0 m/sec.

(b) What ate the major processes leading to the emission of pollutants to the atmosphere? What do you understand by primary and secondary pollutants? Explain with examples. **(4)**

(c) Starting from combustion of S-containing fuel, explain the process of formation of sulfate particles in the atmosphere. Why $SO_X$ is particularly harmful in dusty atmosphere? Explain. **(6)**

(d) What are halocarbons? Explain the direct and indirect radiative forcing of the individual halocarbons. **(4⅓)**

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## 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)]

| | | $x \leq 1$ km | | | $x \geq 1$ 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 $\sigma$ will be in meters when $x$ is given in kilometers.

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

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

L-4/T-2/CE **Date : 12/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2015-2016

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

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

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## SECTION – A

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

1. (a) Explain the causes of braiding of a river. **(6⅓)**

   (b) What is the regime channel concept? Based on the regimes concept, explain how a river will response if discharge and sediment load are decreased at a location. **(7)**

   (c) What are the general considerations of designing an earthen dam/levee? Describe the main causes of failure of an earthen dam/levee with neat sketches. **(10)**

2. (a) Describe different types of temporary measures to control river bed for navigation purposes with neat sketches. **(8⅓)**

   (b) Design and sketch different components of a Guide bank using the following given data. Maximum discharge of the river is 100,000 cumec. Highest Flood level is 9.2 mPWD, River bed level is – 10.00 mPWD and mean diameter of sediment particle is 0.15 mm. Assume any other data if needed. **(15)**

3. (a) Describe different types of groynes with neat sketches. **(7⅓)**

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

   (c) Describe the following terms in brief with neat sketches, if necessary. **(3×3=9)**

   (i) Grouted Stone

   (ii) Mattresses

   (iii) Gabbions

4. (a) Classify different types of bed forms according to their flow regime and describe them with neat sketches. **(8⅓)**

   (b) Describe how flow diversion and dredging help to improve flood situation. **(7)**

   (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 $7.0 \times 10^{-4}$. Mean diameter of sediment particle is 0.15 mm. Assume any other data if needed. **(8)**

Contd ..... P/2

**WRE 409(CE)**

## SECTION – B

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

5. (a) Define (i) Meander width (ii) Cross-over (iii) Sinuosity and (iv) Tertuosity. **(4)**

   (b) Classify Meanders. Summarize the general features of Meandering. **(10⅓)**

   (c) Describe the classification of rivers based on *location of reach* and based on plan-form. **(9)**

6. (a) Define Bankful Discharge. Draw qualitative hydrographs of different rivers based on variation of discharge. **(5⅓)**

   (b) Explain how secondary motion is related to meander development. **(7)**

   (c) What is domiant discharge? Show with clear sketches, how to estimate it for any river section. **(11)**

7. (a) What is aggradation? Briefly describe the =occurrence of aggradation. **(6⅓)**

   (b) Write down the causes and impacts of degradation. How it can be controlled? **(8)**

   (c) Sketch the plan view and typical cross section showing estimated dimensions for a river that carries a discharge of 3500 cumec. **(5)**

   (d) Define rating curve and discuss its use. **(4)**

8. (a) Derive the relationship between Shield's Entrainment Function and Particle Reynolds Number. **(9⅓)**

   (b) A bridge is going to be built over the *Mohananda* Rive. Where the section is 300 m wide. Here the maximum discharge is 6800 $m^2/s$ and corresponding upstream water depth is 5 m. There will be 10 circular cylindrical piers of 12 m diameter each, and the abutments will protrude 20 m into the river. **(14)**

   (i) Calculate abutment scour.

   (ii) Select design scour depth for bridge pier using at least four different formula, and

   (iii) Show the variation of pier scour for increasing angle of attack for this given data.

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**L-4/T-2/CE** **Date: 08/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2015-2016

Sub: **CE 453** (Transportation Engineering III: Traffic Engineering Design and Management)

Full Marks: 140 Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

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## SECTION – A

There are **NINE** questions in this section. Answer any **SEVEN**.

1. Discuss "Avoid-Shift-Improve approach" as future transport policy for urban transport. Why 'Mobility of the Urban Poor' is a crucial issue for urban transport? Classify Urban Transportation Problems into seven major categories. **(3+3+4)**

2. With the help of a schematic diagram illustrate congestion phenomena as a result of urban transport supply and demand disparities. Classify congestion based on the location it occurs. In light of understanding 'Urban Transport Problems' in order to mitigate them, discuss alarming growths and constraints in urban/suburban areas. **(3+3+4)**

3. What is meant by a "Problem"? Name the five contrasting transport planning approaches in the context of various demand and supply side measures to mitigate urban transport problems. In light of the statement- "It is increasingly important that cities in developing countries rely heavily on traffic management than capital intensive measures.", mention the key elements that are requiring urgent attention towards achieving an increased level of roadway capacity and improving roadway safety. **(3+3+4)**

4. Mention the elementary requirements that should be met by traffic control devices. Discuss various kinds of uniformity in traffic control devices. Briefly discuss various types of longitudinal lines as pavement markings. **(3+3+4)**

5. What do you understand by the statement- "Road traffic injury is a significant disease."? In terms of road accidents, write down the Haddon countermeasure matrix. Mention the principles of 'Safe System Approach'. **(3+3+4)**

6. Define- (i) Intersection Accident, (ii) Road Traffic Death, and (iii) PDO accident. Make a list of the minimum data considered necessary to examine accidents at any one location. Briefly discuss the Traffic engineering uses of Accident Records. **(3+3+4)**

Contd ..... P/2

**CE 453**

7. What do you mean by road safety audit? Define- Hazardous Road Location (HRL) Programs and mention the objectives of HRL programs. Mentioning the objectives in each case, briefly discuss the four investigatory techniques of HRL programs. **(3+3+4)**

8. 'According to TRRL Guide 1991, opportunities for road safety engineering in general apply at four levels'- name them. Write short notes on different types of roadside safety barriers. State the main design principles at intersections according to Ogden (1996) and Corben and Cunningham (1989). **(3+3+4)**

9. Write short notes on semi control (partial control) at intersection. State the drawbacks of at grade intersections and two major functions of an interchange. Write short notes on Diamond interchange. **(3+3+4)**

## SECTION-B

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

10. (a) Define Traffic Management. List its principles and objectives and hence state its differences from basic Traffic Engineering. **(8)**

(b) Group the standard short-term traffic management schemes from functional point of view. Thereby identify three measures in each group commonly applied for tackling urban traffic problems. **(6)**

(c) Suppose, a highway has 4 lanes in each direction. The average headway in the northbound direction when the highway operates at capacity is found to be 0.5 sec/veh and the free-flow speed is 60 mph. What is the maximum flow rate, the corresponding density and the jam density? If a one-hour vehicle count in the northbound direction for the outside lane gives 6020 vehicles in a non-congested condition, what is the estimated space mean speed of these 6020 vehicles? Assume that the traffic stream follows linear speed-density relationship. **(9 ⅓)**

11. (a) Write down the mathematical expressions for three single regime speed-density models and hence state each of their limitations. Explain Eddie's model as a representative multi regime macroscopic traffic model. **(8)**

(b) Describe the 'Cell Transmission Model' with its underlying assumptions and boundary conditions. **(5)**

Contd ..... P/3

**CE 453**

**Contd... Q. No. 11**

(c) Figure 1 shows the time-space diagram of a road segment for a certain time interval. Determine the following traffic flow parameters from the diagram: **(10⅓)**

(i) Headway between vehicles 2 and 3 at 80 m distance

(ii) Spacing between vehicles 3 and 4 at the $9^{th}$ second

(iii) Flow as measured at 50 m distance of the road segment

(iv) Density of the road segment at the $7^{th}$ second

(v) Time-mean speed of the traffic stream at the $9^{th}$ second.

12. (a) Schematically explain the 'Ramp Metering' technique for urban freeway traffic management. Mention its associated benefits/costs and implemental issues. **(7)**

(b) What is the basic difference between the safe distance and psycho-spacing approaches of modeling car-following phenomenon? Describe the four driving states identified by Widemann for psycho-physical modeling. **(6)**

(c) State Raff's definition of critical gap. Table 1 shows the data of gap acceptance on an expressway at the vicinity of the merging area of an on ramp. Using the graphical method, determine the length of the critical gap (as per Raff's definition) from the provided data. The peak hour volume at this location was determined to be 2700 veh/h. If it is assumed that the arrival of expressway vehicles can be described by a Poisson distribution, calculate the expected number of acceptable gaps for ramp vehicles that will occur on the expressway during the peak hour. **(1+9⅓)**

13. (a) Discuss mandatory and discretionary lane changing. What are the variables that affect these lane changing decisions? **(6)**

(b) Describe with the help of neat diagrams the different High Occupancy Vehicles facilities available for managing urban traffic. Explain the design concept of 'Super Street Arterials' typically used for improving urban arterial mobility. What are the principles that should be followed in designing and improving at-grade arterial intersections? **(4+4+4)**

(c)Describe how the operation of 'One-way-streets' helps to increase capacity and facilitate multimodal improvements of urban local streets. **(5⅓)**

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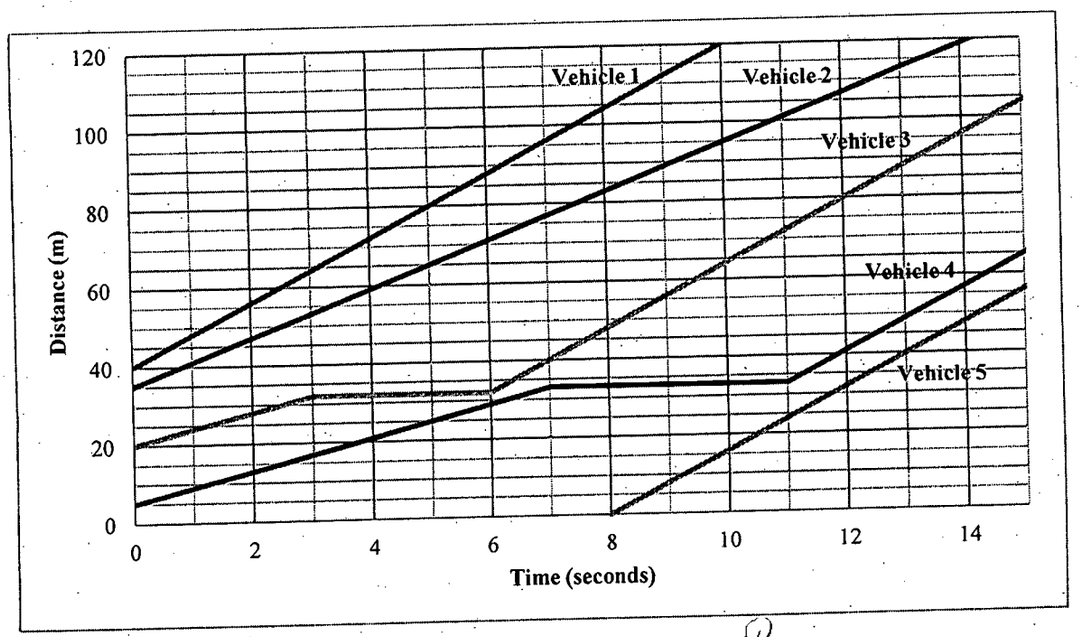


**Figure 1:** Time-space diagram for Question 11(c)

**Table 1:** Gaps Accepted and Rejected on an expressway at the vicinity of the merging area of an on ramp (for Question 12(c))

| Length of Gap (t sec) | Number of Accepted Gaps (less than t sec) | Number of Rejected Gaps (greater than t sec) |
|---|---|---|
| 0 | 0 | 115 |
| 1 | 3 | 102 |
| 2 | 13 | 65 |
| 3 | 34 | 38 |
| 4 | 58 | 19 |
| 5 | 85 | 6 |
| 6 | 115 | 0 |

**L-4/T-2/CE** **Date : 06/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2015-2016

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

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

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## SECTION – A

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

1. (a) List the causes that may induce lateral load to foundations. How does lateral load affect the bearing capacity of foundation? **(5)**

   (b) Referring to the excavation shown in Fig. 1, show that failure by bottom heaving will not occur if $(\gamma h + q)B_1 - q_u\left(H - \frac{q_u}{\gamma}\right) - \frac{\pi}{2}B_1 q_u \le q_u B_1$ **(8)**

   (c) Check the stability against sliding for the square footing (2.0 m × 2.0 m ) shown in the Fig. 2. What should be the minimum factor of safety against sliding? If the factor of safety against sliding is not sufficient what can be done? **(10 ⅓)**

2. (a) Compare between cantilever retaining wall and counterfort retaining wall. **(4)**

   (b) Show with neat sketches the ultimate limit states of external instability for gravity retaining walls. **(6)**

   (c) Determine the factor of safety against overturning and sliding failure for the retaining wall shown in Fig. 3. Ignore 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 ⅓)**

3. (a) List the principal components of a braced cofferdam. Write the main functions of each principal component. **(4)**

   (b) Discuss briefly the phenomenon of 'earth pressure on braced cofferdams in sand'. Why does the lateral earth pressure on braced cofferdam in stiff clay change over time? **(6)**

   (c) A bracing system for an open cut is shown in Fig. 4. Determine the force in the struts A, B and C. The struts are spaced 3 m center to centre horizontally. **(13 ⅓)**

4. (a) What is meant by caissons? Draw schematic diagrams of open caisson and box caisson. Compare the advantages of open caissons and box caissons. **(6)**

   (b) Describe briefly the design loads for designing caissons. **(6)**

   (c) Will the caisson shown in the Fig. 5 be self sinking? If not determine (a) the required amount of ballast and (b) the thickness for self sinking. **(11 ⅓)**

Contd ..... P/2

**CE 443**

## SECTION – B

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

Assume reasonable value of missing data, only if necessary.

5. (a) Discuss importance of construction dewatering. Describe the methods of dewatering using well points and deep wells. Comment on pumps available for these methods. **(12 ⅓)**

   (b) What do you mean be slurry trench wall construction? List advantages and disadvantages of this method. **(11)**

6. (a) Write short notes on the following (answer any three): **(4×3=12)**

   (i) Effect of wall movement on lateral earth pressure

   (ii) Raker bracing

   (iii) Design against clay bursting in excavation pit.

   (iv) p-y curve for analysis of laterally loaded piles.

   (b) With neat sketch describe construction sequences of a braced excavation. Also comment on the preloading of struts and why it is recommended. **(5 ⅓)**

   (c) Discuss advantages and disadvantages of using steel sheet piles. **(6)**

7. (a) A cantilever sheet pile needs to retain 3.5 m of sandy backfill material. It is embedded in sandy soil as shown in Fig. 6. Determine the required depth of penetration of the sheet pile, assuming a surcharge load of 10 $kN/m^2$ on backfill. **(15)**

   (b) With neat sketches show different types of anchorage systems for anchored sheet piles. **(5 ⅓)**

   (c) How do you account for unbalanced water pressure in sheet pile design? **(3)**

8. (a) Determine the required length of anchored sheet pile shown in Fig. 7 retaining sandy soil but embedded in cohesive soil. Also determine the size and spacing of mild steel tie rod. **(19)**

   (b) Why do you need to consider moment reduction in anchored sheet pile design? How do you account for it in design? **(4 ⅓)**

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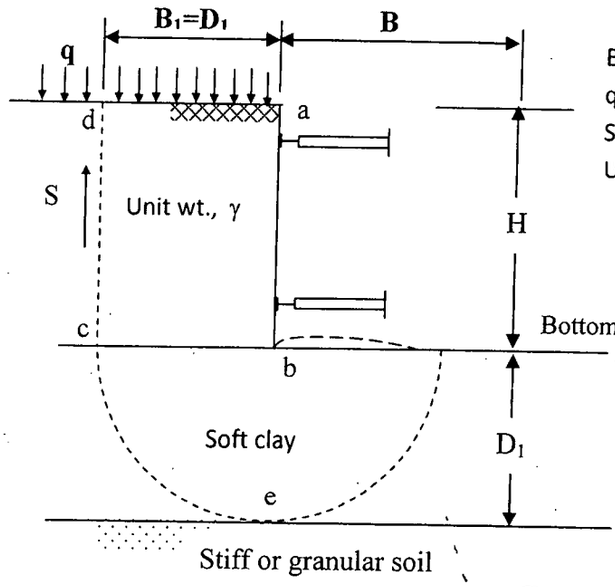
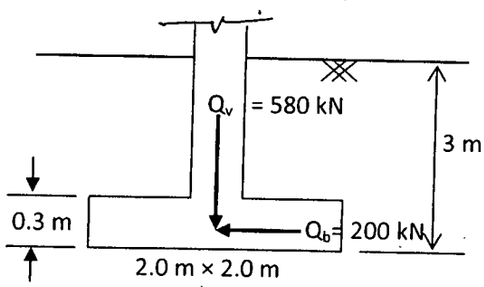



B= width of excavation
q= surcharge per unit length
S= shear resistance along the surface 'cd'
Unconfined compressive strength of soft clay= $q_u$

Fig 1. for Q. 1(b)




Uniform soil layer
γ=17.0 kN/m³
ϕ=27°
c=30 kPa

**Fig. 2. for Q. 1(c)**

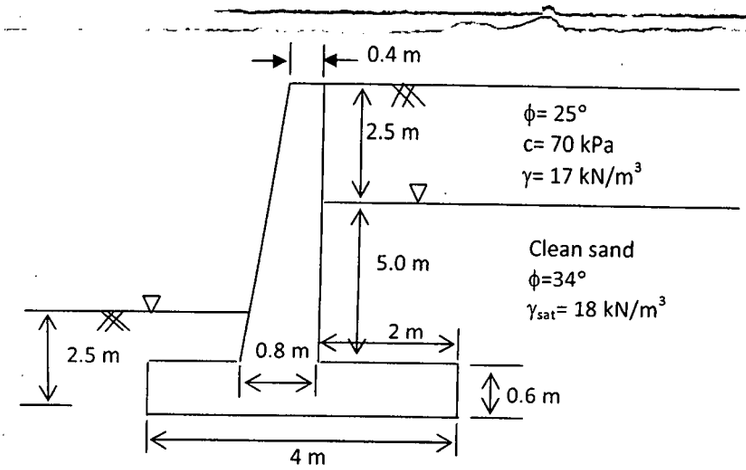



**Fig. 3. for Q. 2(c)**

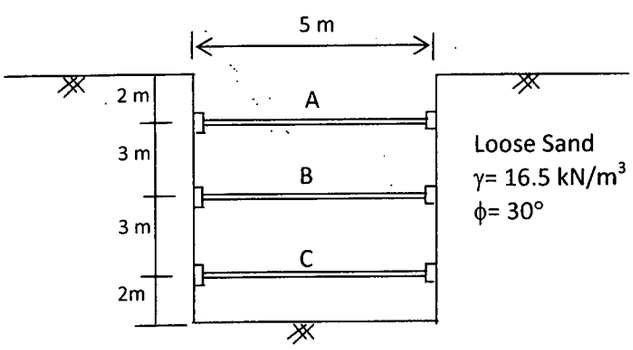



**Fig. 4. for Q. 3(c)**

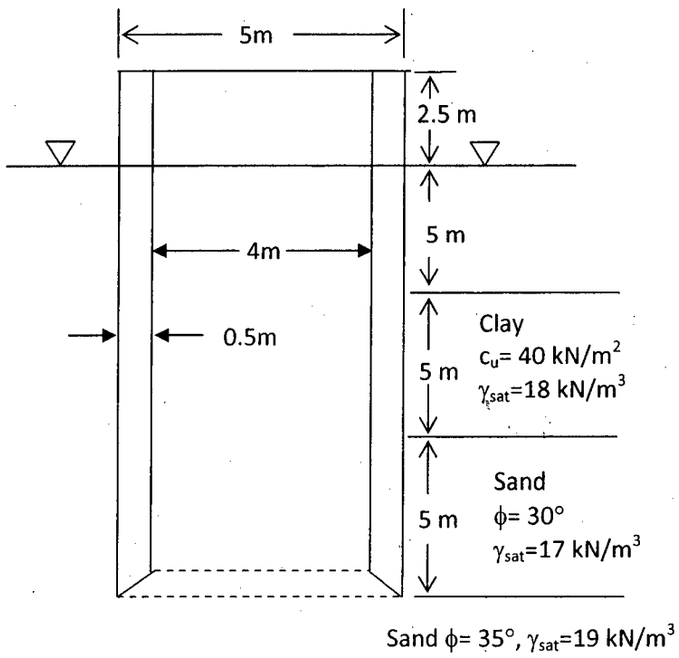



**Fig. 5. for Q. 4(c)**

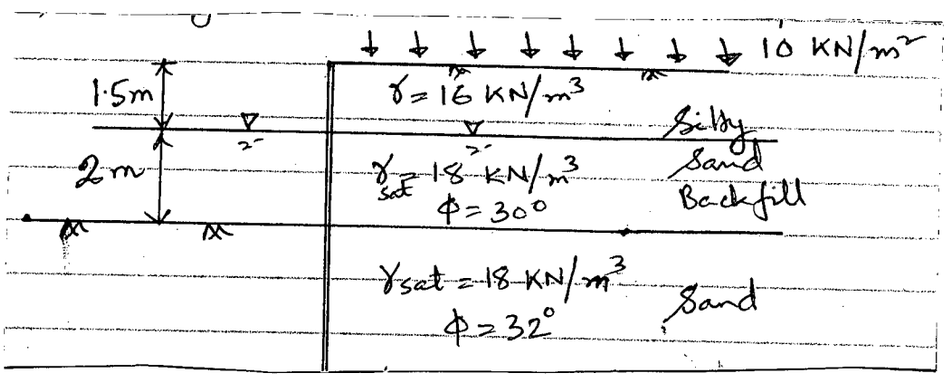



fig : 6

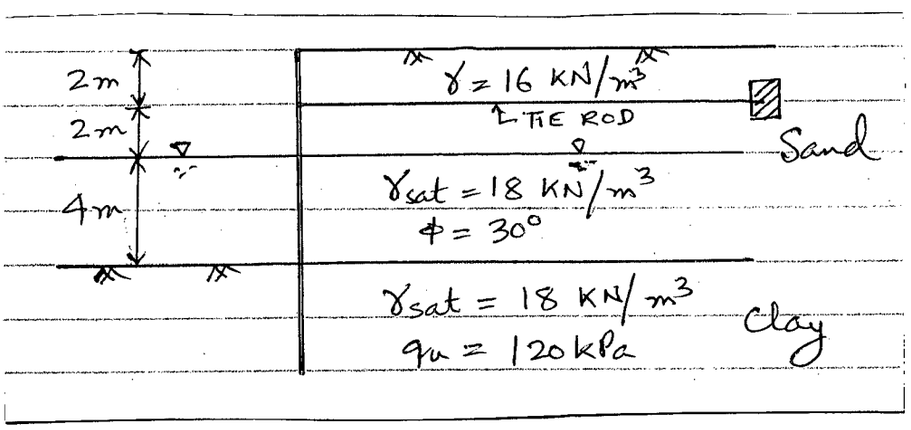



fig : 7

**L-4/T-2/CE** **Date : 02/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2015-2016

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

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## SECTION – A

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

Symbols have their usual meanings. Assume reasonable values for any missing data.

1. (a) What are the basic assumptions in analyzing a structure based on linear static analysis? **(5)**

   (b) Write three statements to describe the advantage of FEM over other methods in solving an engineering problem. **(6)**

   (c) For the spring system with arbitrarily defined nodes and elements as shown in Figure 1, find the global stiffness matrix, Comment on the problem and your derived result. **(12 1/3)**

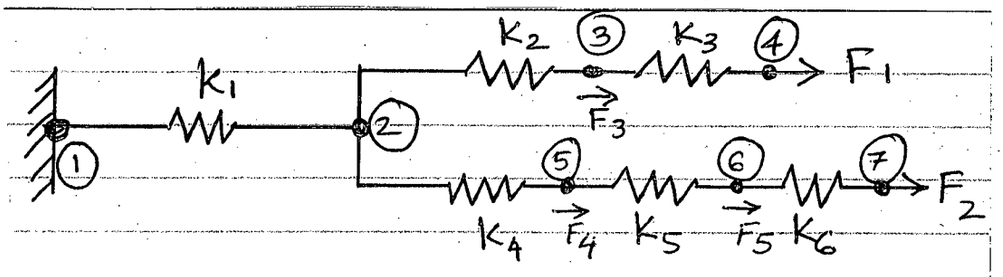


Figure 1

2. (a) Introduce reasonable shape functions for a two nodded beam element (Figure 2) and derive the element stiffness matrix (K),. In this process also consider axial stiffness of a bar element and formulate the stiffness matrix of a 2D general beam element. **(15)**

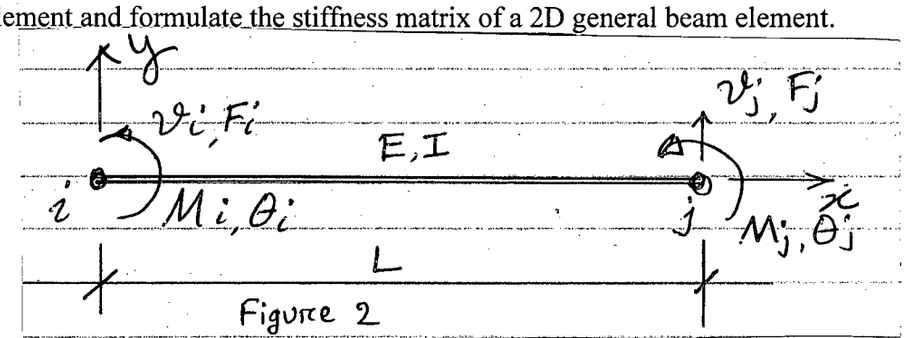


Figure 2

   (b) A cantilever beam shown in Figure 3 is subjected to distributed load. Write down the global FE equation for the beam and find out (i) deflection and rotation at right end (ii) reaction force and moment at the left end. **(8 1/3)**

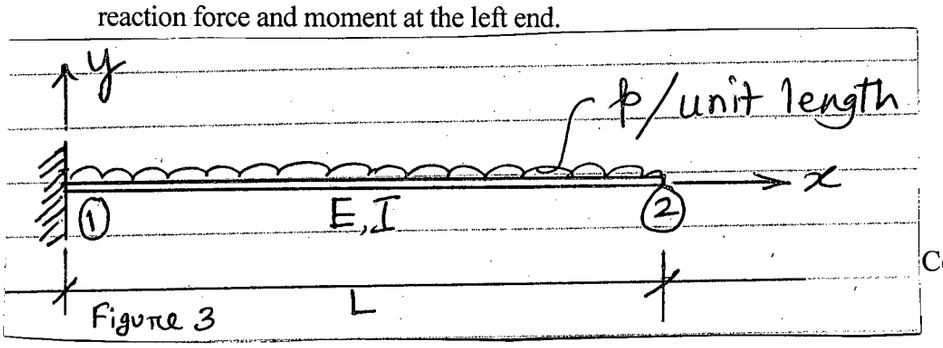


Figure 3

Contd ..... P/2

## CE 419

3. (a) Introduce and explain isoparametric concept in finite element analysis. **(5)**

   (b) State the three basic theorems on which he isoparametric concept is developed. **(6)**

   (c) Discuss the convergence criteria for isoparametric elements. **(6 1/3)**

   (d) Explain he following terms: **(6)**

   (i) Sub parametric element

   (ii) Super parametric element.

4. (a) Explain the term, 'Shape Functions'. Why polynomials are preferred for shape functions? **(11 1/3)**

   (b) List four major discontinuities that may exist in a real structure and the necessity of considering those in discretizing a structure. Draw necessary sketches. **(12)**

### SECTION – B

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

5. (a) What are the basic components of a general purpose finite element software? **(5 1/3)**

   (b) Approximate the area of a circle by dividing it into a number of triangles. In this process show that $S_N = \pi R^2$ when $n \rightarrow \infty$.

   where R = radius of the circle, N = number of triangles, $S_N$ = area of the circle. **(12)**

   (c) Summarize the basic procedural steps that are followed in FEM for analyzing a structure. **(6)**

6. (a) Define plane stress and plane strain as applied to 2D element. **(8)**

   (b) In civil engineering problems, the derived global stiffness matrix is usually 'symmetric" and "banded". Explain the implications of these characteristic features in solving global FE equation by employing band solution technique. **(7 1/3)**

   (c) Give an illustrative example to compare frontal solution technique with band solution technique. Explain the aspects where frontal solution technique can offer economic solution. **(8)**

7. (a) Distinguish between Gauss elimation and iterative methods in solving global finite element equations. **(6)**

   (b) A displacement based FEM formulation provides lower bound of the exact solution – Explain. **(9 1/3)**

   (c) What is the necessity of refining an FEM mesh? Discuss different mesh refining methods. **(8)**

8. (a) What is constitutive relation? What is the purpose of an FEM program? **(5)**

   (b) Introduce natural coordinate systems and derive the Jacobian matrix $\underline{\underline{J}}$ for any element. In this process also derive the strain displacement matrix $\underline{\underline{B}}$. **(15)**

   (c) What is a numerical error? **(3 1/3)**

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L-4/T-2/CE **Date : 02/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2015-2016

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

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## SECTION – A

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

Symbols carry their usual meaning. Assume missing data, if any.

1. (a) If maximum deflection occurs at a frequency ratio of 0.86, what would be maximum dynamic magnification factor. **(10)**

   (b) A structure weighing 50 kips have a lateral stiffness of 100 kip/in. The structure is laterally shaken by a portable harmonic loading machine with a frequency of 4.4 Hz. It was found that the deflection increased with time and became constant after several cycles. The maximum deflection is found to be 0.015 in for a force amplitude of 500 lb. What is the damping of the structure? **(13 1/3)**

2. (a) Design an accelerometer and a displacement meter to measure vibration of frequencies between 0.5 Hz. to 5.0 Hz. **(12)**

   (b) A vibrating machine with natural frequency of 5 Hz is operated at a frequency of 20 Hz. The machine foundation has a damping of 25%. The force produced by the machine is 100 kips. How much force is transferred to the supporting structure? **(11 1/3)**

3. (a) A vehicle weighs 4,000 lb. Its spring stiffness is 1250 lb/in. and damping is 40%. The vehicle travels at a speed of 45 mph on a bride with a profile of wavelength of 40 ft and amplitude 1.2 in. Predict the steady state vertical motion in the car. **(13 1/3)**

   (b) A reciprocating machine weighing 20,000 lb. develops a vertical harmonic force of amplitude 500 lb . at its operating speed of 40 Hz. Determine the support stiffness required to limit the total transmitted force to 80lb. Given,

   Input frequency, $\bar{f} = \frac{1}{2\pi}\sqrt{\frac{g}{\Delta_{st}}\left(\frac{2-IE}{1-IE}\right)}$

   where symbols carry their usual meaning. **(10)**

Contd ..... P/2

## CE 421

4. (a) What are the main characteristics of impulse load? **(2)**

   (b) What are the two phases of a impulse loading? How do we determine the response of Phase II? **(4)**

   (c) For shorter duration impulse loading, which loading pattern produces smaller response? What is the maximum response ratio for rectangular impulse for $t_1/T = 1.0$ or greater? **(4)**

   (d) A single story building, as shown in Fig. 1, is subjected to a triangular blast load, as shown in Fig. 2. For the given weight and column stiffness what would be maximum displacement of the structure? What would be the total elastic resistance force in the columns? **(13 1/3)**

### SECTION – B

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

5. (a) Derive the equation of motion of the basic dynamic system. **(11 1/3)**

   (b) Write the equation of motion of the one-story, one-bay frame shown in Figure 3. The flexural rigidity of the beam and column is as noted. The mass lumped at the beam is m, otherwise, assume the frame to be massless and neglect damping. **(12)**

6. (a) Derive the equation of Undamped free vibrations. **(11 1/3)**

   (b) A one story building is idealized as a rigid girder supported by weightless columns, as shown in Figure 4. In order to evaluate the dynamic properties of this structure, a free vibration test is made, in which the roof system (rigid girder) is displaced laterally by a hydraulic jack and then suddenly released. During the jacking operation, it is observed that a force of 20 kips [9.072 kg] is required to displace the girder 0.20 in [0.508 cm]. After the instantaneous release of this initial displacement, the maximum displacement on the first return swing is only 0.16 in [0.406 cm] and the period of this displacement cycle is T = 1.40 see. From these data, find out a) Effective weight of the girder b) Undamped frequency of vibration c) Logarithmic decrement d) Damping ratio e) Damping coefficient f) Damped frequency g) Amplitude after six cycles. **(12)**

7. (a) Determine the natural vibration period and damping ratio of the plexiglass frame model from the acceleration record of its free vibration shown in Figure 5. **(8 1/3)**

   (b) Derive the equation of motion of the weight w suspended from a spring at the free end of a cantilever steel beam shown in Figure 6. For steel, E = 29,000 ksi. Neglect the mass of the beam and spring. **(10)**

   (c) What do you mean by critically damped system and undercritically damped system? **(5)**

Contd ..... P/3

## CE 421

8. (a) Discuss on the Undamped system subjected to harmonic loading. **(11 1/3)**

(b) A portable harmonic loading machine provides an effective means for evaluating the dynamic properties of structures in the field. By operating the machine at two different frequencies and measuring the resulting structural response amplitude and phase relationship in each case, it is possible to determine the mass, damping and stiffness of a SDOF structure. In a test of this type on a single story building, the shaking machine was operated at frequencies of $\omega 1 = 16$ rad/sec and $\omega 2 = 25$ rad/sec, with a force amplitude of 500 lb [226.8 kg] in each case. The response amplitudes and phase relationships measured in the two cases were: **(12)**

| | |
|---|---|
| $\rho 1 = 7.2 \times 10^{-3}$ in $[18.3 \times 10^{-3}$ cm | $\cos \theta 1 = 0.966$ |
| $\theta 1 = 15°$ | $\sin \theta 1 = 0.259$ |
| $\rho 2 = 14.5 \times 10^{-3}$ in $[36.8 \times 10^{-3}$ cm] | $\cos \theta 2 = 0.574$ |
| $\theta 2 = 55°$ | $\sin \theta 2 = 0.819$ |

What is the damping ratio?

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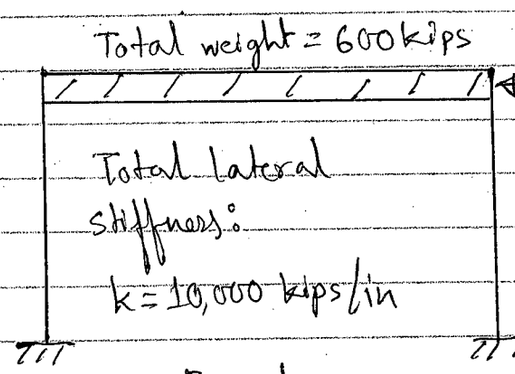


Fig. 1

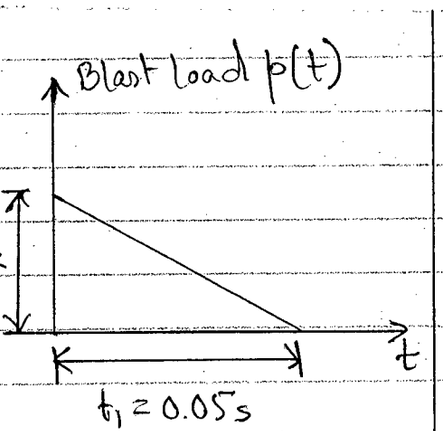


Fig. 2

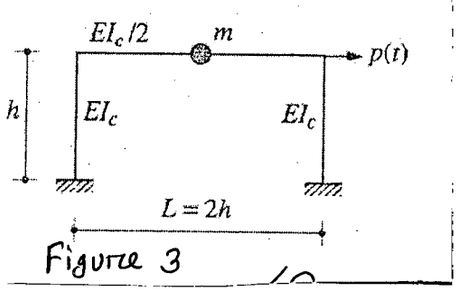


Figure 3

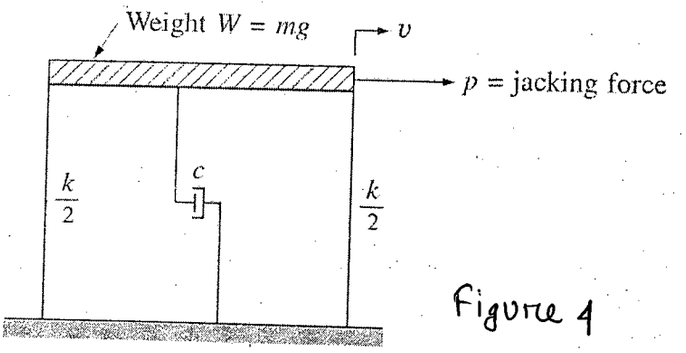


Figure 4

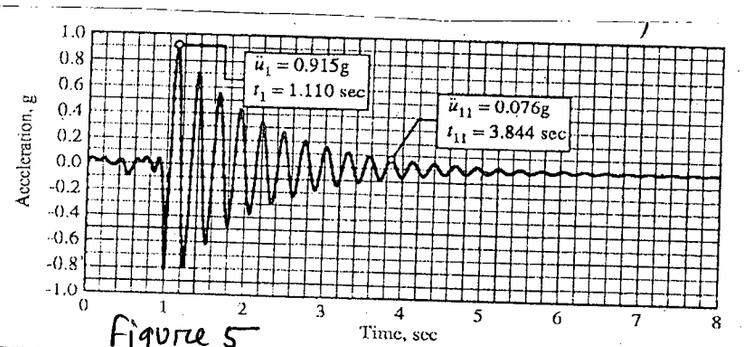


Figure 5

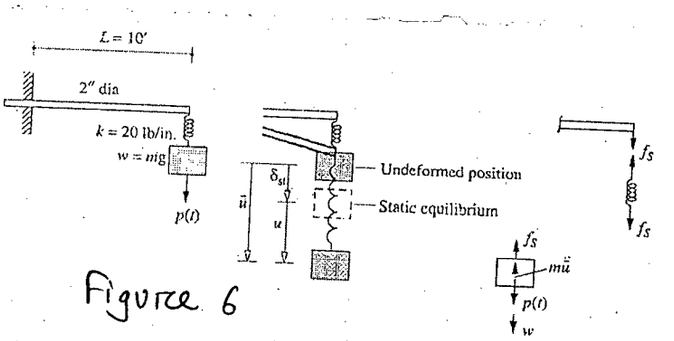


Figure 6