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L-3/T-2/CE **Date : 08/12/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2012-2013

Sub : **CE 333** (Environmental Engineering II)

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Compare between the following two wastewater treatment methods: (i) Activated Sludge Method, (ii) Trickling Filter Method. **(12⅔)**

(b) In a series of three Maturation ponds the hydraulic retention time of wastewater in the first, second, and third ponds are 5 days, 6 days, and 6 days, respectively. Influent faecal coliform count in the wastewater is 4×10^5 FC/100 ml. Calculate the faecal coliform count in the effluent water from the series of ponds. Let, value of first order rate constant for faecal coliform removal (k_b) is $2.7d^{-1}$. **(12)**

(c) Define "Recirculation Ratio" in the context of Trickling Filter. Why recirculation of treated municipal wastewater is done in Trickling Filters? Calculate the effluent BOD from a trickling filter having a depth of 1.8 m and a recirculated rate of 200 percent of the flow. The influent BOD is 180 mg/L following primary treatment. Use the following formula, where the symbols have their usual meaning: **(12)**

$$C_e = \left(\frac{C_i + rC_e}{1+r}\right)e^{-kD}$$

(d) Draw a schematic layout of waste stabilization ponds system showing different types of pond. State and derive Marai's Theorem regarding maximum efficiency in a series of ponds. **(10)**

2. (a) Describe different phase in a typical bacterial growth pattern. Explain the relationship between F/M ratio and biomass settling characteristics. **(8+4)**

(b) Briefly describe the two main processes involved in biological treatment of wastewater. Why aeration is done in an activated sludge treatment process? **(4+4)**

(c) What are the purposes of primary treatment of municipal wastewater? **(6⅔)**

(d) For a BOD test (at 25°C) initial DO = 7.5 mg/L. After 5 days, DO = 2.8 mg/L. Given, dilution factor = 50, BOD rate constant, k = 0.20/day at 20°C, and Θ = 1.047. **(6)**

(i) Calculate BOD5 at 20°C.

(ii) Calculate BOD remaining after 5 days at 20°C.

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Contd ... Q. No. 2

(e) Name the different units of Primary Treatment used in domestic wastewater treatment facilities. What is the function of a communitor and how it functions within a wastewater treatment facility? **(12)**

3. (a) What are the features of an appropriate technology? How engineering should be applied to solve novel problems? **(6+4)**

(b) Why is conventional water borne sanitation system inappropriate for developing countries? Why centralized systems are inappropriate for water supply and sanitation sector? **(4+4)**

(c) Differentiate between "natural needs" and "acquired needs" of humans. What are the basic principles of waste treatment? **(6+6)**

(d) Name the principal plumbing system of drainage. Which system do you prefer and why? Explain. **($1\frac{2}{3}$+6)**

(e) Define "fixture trap". How will you determine the size of pipe for sanitary drainage? **(3+6)**

4. (a) What are the objectives of the water supply and drainage systems of a building? **(4+4)**

(b) How will you avoid the contamination of the water supply in buildings? **(6)**

(c) List the underlying principles of design of water supply piping of a building? **(11)**

(d) Write a short note on use of valves in the water supply system of a building. **($6\frac{2}{3}$)**

(e) Calculate the permissible pressure loss in the riser pipe to supply water in the top-most floor of a 6-storied building from the following data: **(15)**

Floor to floor height = 11 ft.
Minimum fixture operating pressure = 4 psi.
Maximum fixture operating pressure = 8 psi.

The water supply is intermittent. Assume reasonable value for any missing data, if required.

SECTION – B

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

5. (a) A 525 mm diameter concrete pipe is to be placed on a 150 mm sand bed in an ordinary trench with clearance of 100 mm from each side of the trench walls. The trench with trapezoidal cross-section has a side slope of 1:2 (V:H). The trench cut is to be filled with damp clay. What is the maximum depth of clear cover that can be provided over the said pipe satisfying the overburden loading restrictions of 20 tons/m. [Use the specific value of $k\mu'$ for Clay. Assume appropriate values for missing data, if required]. **(20)**

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(b) What do you understand by a Small Bore Sewerage (SBS) system? How does the design of sewer network in SBS system differ from that in a "conventional system"? Briefly discuss the applicability of SBS system in the context of Bangladesh. **(9)**

(c) What do you understand by a "hygienic latrine"? What types of "seals" are commonly used in direct and off-set pit pour flush latrines in Bangladesh? Draw neat sketches of these "seals" and show "seal depth" for water seals. **(9)**

(d) What is a composite sample? Why is it necessary to collect composite sample? **(8⅔)**

6. (a) (i) Design a suitable latrine for a family of 7 members in a village where water supply is "limited". The groundwater table is 3.7 m below ground surface. The pit is to be constructed with concrete rings 1.1 m in diameter and 0.3 m in depth. Design the latrine (pit and vent pipe), estimate its design life and draw a neat sketch of the designed latrine. After one year of use, the family wants to convert the latrine (designed by you) into a pour-flush latrine due to installation of a tubewell at the household. Check adequacy of the pit you designed for use as leach pit of a pour-flush latrine. Consider water use for the latrine to be 10 lpcd and long-term infiltration capacity of soil to be 20 L/m^2. day. Also estimate the remaining design life of the latrine (if used as a pour-flush latrine). **(26⅔)**

   (ii) What do you understand by "fecal sludge" and "septage"? Explain.

   [Assume reasonable values for parameters not given]

   (b) List the items to be shown on the vertical profile for a sewer conveyance network. **(10)**

   (c) Draw and identify the schematic diagram of an ETP employing Physico-chemical and Activated Sludge units. **(10)**

7. (a) The following data on characteristics of sewage are collected from the Tejgaon Industrial Area: **(20)**

   (i) BOD_3 at 20°C = 300 mg/L

   (ii) BOD_7 at 20°C = 443 mg/L

   (iii) Flow, Q = 1 m^3/sec

   (iv) Temperature of the sewage = 26°C

   A circular concrete sewer of diameter 600 mm is to be installed in Tejgaon Industrial Area at a slope of 0.0009. It is essential that the Sulfide Generation Potential (Z) be determined under half full condition prior to construction of the sewer conveyance system. Based on your result, comment what precautionary measures to be taken, if any.

   (b) What are the main advantages of a VIP latrine over a "simple pit latrine"? Explain how the use of a vent pipe help control insect/fly nuisance in a VIP latrine. **(9)**

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Contd ... Q. No. 7

(c) With neat sketches show the latrine designs commonly used in high water table areas of Bangladesh. List the common reasons for fecal contamination of tubewell water in Bangladesh. Also explain the measures commonly taken to prevent such contamination from pit latrines. **(9)**

(d) What is Sustained Loading? Describe the usefulness of Peak and Low Sustained Mass Loading curves in the operation of a Secondary Treatment Plant with Activated Sludge unit. **(8⅔)**

8. (a) (i) Design a septic tank for a family of 12 members. The estimated wastewater flow rate is 95 lpcd and the tank is to be desludged every 2.5 years. The hydraulic detention time of the tank should be at least 1 day in order to maintain acceptable effluent quality. Also draw: **(26⅔)**

   A. A plan view of the designed septic tank (consider a single chamber)

   B. A section showing depths of different zones of the septic tank, and

   C. A section showing the positions and dimensions of inlet and outlet devices.

   (ii) Discuss the limitations of "on-site sanitation systems" for densely populated urban areas in Bangladesh.

   [Consider a design temperature of 23°C; assume reasonable values for parameters not given]

   (b) Draw schematic diagram showing the different pathways for inflow and infiltration into a sanitary sewer.

   What do you understand by Hard to Reach (HtR) areas? Identify the hard to reach areas in Bangladesh. **(11)**

   (c) List the rules for placement of manholes in a sewer network. **(9)**

15.12.2014

L-3/T-2/CE **Date : 15/12/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2012-2013

Sub : **CE 317** (Design of Concrete Structures-II)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

Use USD Method of Design.

1. (a) A circular column carries a working unfactored DL = 650 kip and LL = 400 kip. Design the spirally reinforced column using about 2 percent main reinforcement. Also design the ACI spiral. Given : f'_c = 4.0 ksi and f_y = 60 ksi. **(12)**

(b) A 16 × 30 inch column is reinforced with Ten No. 9 bars as shown in Fig. 1. Construct the nominal strength interaction diagram for the column with five points corresponding to pure axial load, pure bending, balance condition, ε_s = 0.001 (tensile) and ε_s = 0.004 (tensile). Also find corresponding ϕ for the above points. Assume bending about Y-Y axis. Given : f'_c = 5 ksi and f_y = 60 ksi. **(23)**

2. (a) A ground floor column of a multistoried building is to designed for the following load combinations (axial force and uniaxial bending)- **(16)**

Gravity load condition P_u = 700 kip, M_u = 80 kip-ft

Lateral load combination P_u = 600 kip, M_u = 500 kip-ft

Architectural considerations require that a rectangular column with b = 16 in. and h = 25 in. is to be used. Material strengths are f'_c = 4 ksi and f_y = 60 ksi. Find the required column reinforcement and show in a sketch. Use supplied design chart and assume that the reinforcements are distributed along the perimeter.

(b) Design tie for the above column considering seismic provisions of an IMRF system. Clear height of the column is 10 ft. Show arrangements in cross and long-sections. **(9)**

(c) Explain seismic detailing provisions for flat plate as part of an intermediate moment resisting frame as per ACI/BNBC code. **(10)**

3. (a) A 25 × 25 inch column is reinforced with sixteen No. 8 bars arranged around the column perimeter. Material strengths are f'_c = 4.0 ksi and f_y = 60 ksi. Check adequacy of the short column using Reciprocal Load method for: **(13)**

$$P_u = 400 \text{ kip}, M_{ux} = 300 \text{ kip-ft}, M_{uy} = 300 \text{ kip-ft}$$

Use supplied design chart.

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(b) A shear wall of a 15-storey building is subjected to following factored loads: **(16)**

$P_u = 400$ kip

$V_u = 600$ kip

$M_u = 5000$ kip-ft

The wall is 18 ft long, 150 ft high and 14 inch thick. Design the shear wall with $f'_c = 3$ ksi and $f_y = 60$ ksi. Ignore axial force as it is less than balanced load of the section.

(c) Discuss different modes of failure of a high-rise shear wall. **(6)**

4. (a) Describe briefly the loss of prestress in pretensioned member from each individual source. **(12)**

(b) A pretensioned concrete member shown in Fig. 2 is prestressed with 780 mm^2 of steel wires which are anchored at both ends with a stress of 1100 MPa. Compute the loss of prestress at section 1-1 due to elastic shortening of concrete. Use n = 7 and solve the problem using both gross and transformed area of concrete sections. Also, compare the results. **(17)**

(c) As per ACI/BNBC code, slenderness effects can be neglected if slenderness ratio of a column is below certain limits, write these limits for columns of sway and non-sway frames. **(6)**

SECTION – B

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

5. (a) Compare prestressed concrete with reinforced concrete with respect to interaction between concrete and steel at different stages of loading. **(13)**

(b) Compute the value of live load that the beam of Fig. 3 can carry with producing tension of 2.0 MPa at section 1-1 of the beam (5.0 m from the left support). Use any method for the analysis. Given: Effective prestress in Tendon = 900 kN; parabolic tendon and n = 6. **(22)**

6. (a) A residential building is to be designed using a flat plate floor system. The interior columns are 24" × 24" and they are spaced 22 ft c/c in one direction and 24 ft c/c in other direction. Design the interior panel (22' × 24') and show the reinforcements in long direction only with neat sketch. Assume slab thickness 8". Specified live load = 40 psf; Floor finish and partition wall load = 60 psf in addition to the self weight of floor slab. $f'_c = 35{,}00$ psi and $f_y = 60{,}000$ psi. **(25)**

(b) What are the limitations of Direct Design method for the analysis of two way slab? **(10)**

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7. (a) The plan of a pile cap with 12 nos. 20" dia coast-in-situ piles is shown in Fig. 4. The piles are provided for a RC column 30" × 30" in section carrying DL = 950 kip and LL = 550 kip (working). Individual pile capacity is adequate. Design the pile cap showing all the reinforcements with necessary details. Given: f'_c = 4,000 psi and f_y = 60,000 psi. **(17)**

   (b) Two interior columns of a high rise building are spaced 15 ft apart and each carries DL = 400 kip and LL = 300 kip. The columns are 21" × 21" in cross-section. The columns will be supported on a rectangular combined footing with a long-side dimension twice that of the short side. The allowable soil bearing pressure is 5000 psf. The bottom of the footing will be 6 ft below grade. Design the footing and show the reinforcement with neat sketches. f'_c = 3 ksi and f_y = 60 ksi. **(18)**

8. (a) A flat plate floor has thickness h = 8" and is supported by 18" × 18" columns spaced 20 ft on centres each way. The floor will carry a DL = 180 psf including its self weight and a live load of 100 psf. Check the adequacy of the slab in resisting punching shear and provide shear reinforcement, if needed. Consider d = 6.5" ; f'_c = 3500 psi and f_y = 60,000 psi. **(17)**

   (b) Design a square footing for an interior column that carries total working DL = 600 kip and LL = 400 kip. The column is 25" × 25" in cross-section. Allowable bearing capacity of soil is 4200 psf. The bottom of the footing is 6 ft below grade. Show the reinforcements in plan and sections with neat sketches **(18)**

   Given: f'_c = 3000 psi and f_y = 60,000 psi.

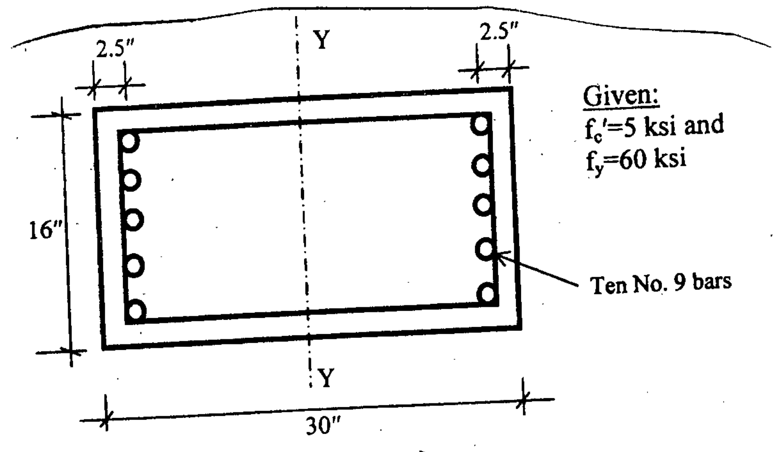


Fig. 1

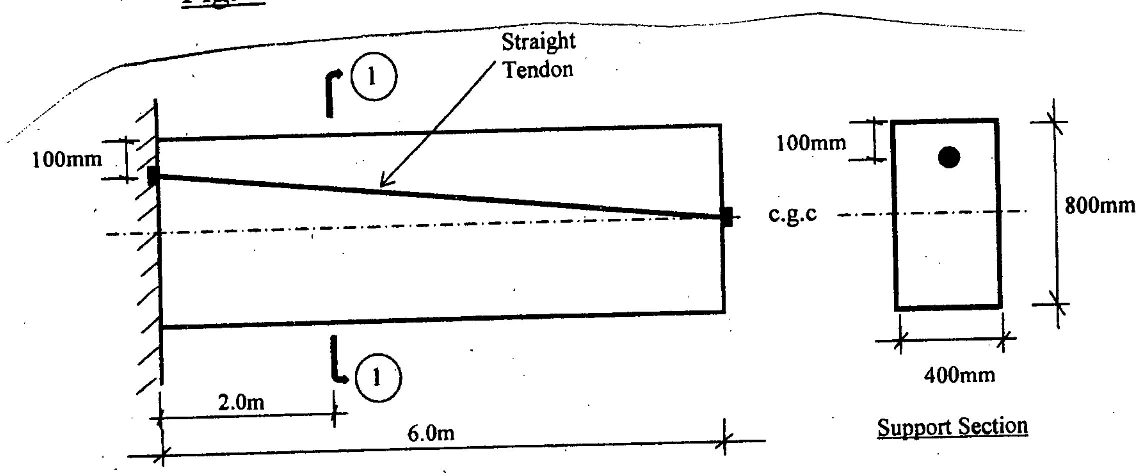


Fig. 2

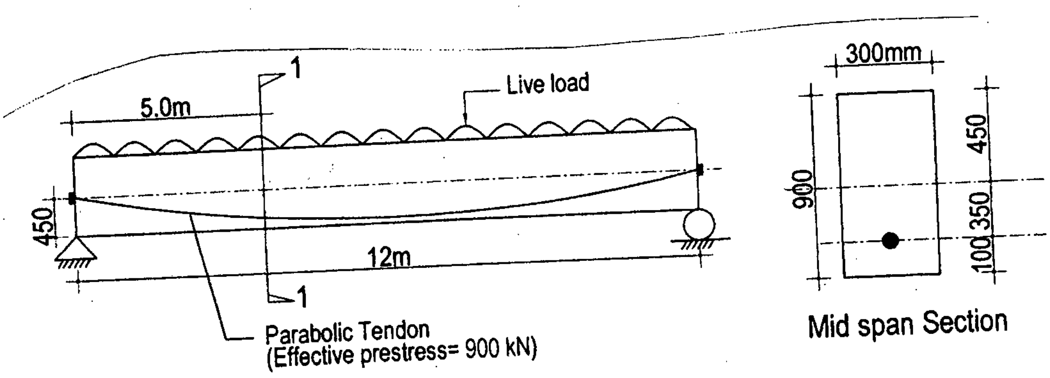


Fig- ~~1~~ 3

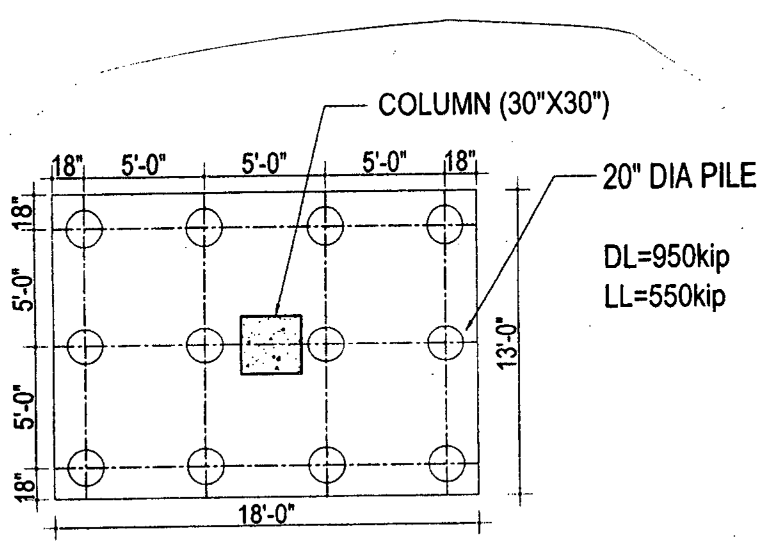
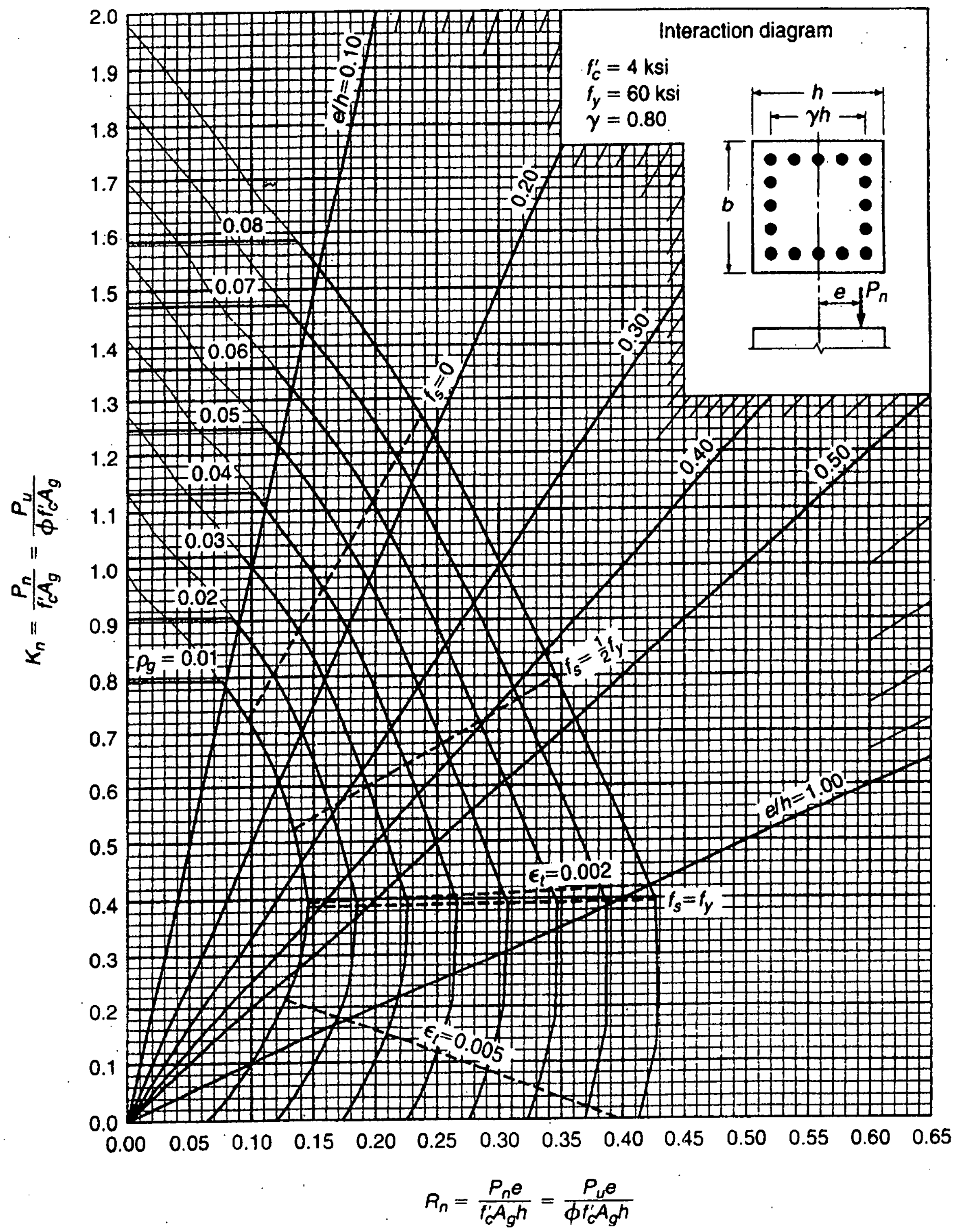


Fig- ~~2~~ 4



GRAPH A.7
Column strength interaction diagram for rectangular section with bars on four faces and $\gamma = 0.80$.

Design of Concrete structures, 14th Ed.
by Nilson, Darwin, Dolan

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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B.Sc. Engineering Examinations 2012-2013

Sub : **CE 319** (Design of Steel Structures)

Full Marks : 210　　　　　　　　　　Time : 3 Hours

The figures in the margin indicate full marks.

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

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

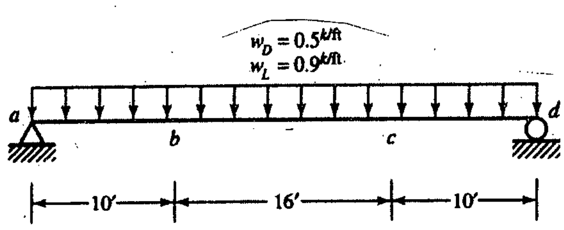
There are **FOUR** questions in this Section. Answer any **THREE**.

Use Annexure-I for section properties and beam LTB formulas if necessary.

1. (a) Briefly discuss the importance of connection design in the overall structural design process of steel structures. **(8)**

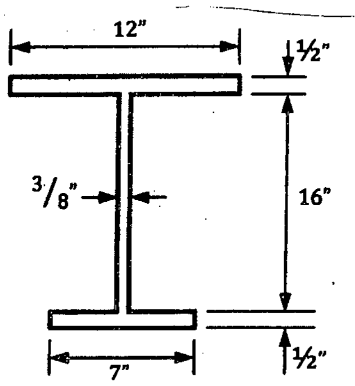
(b) The beam shown in Fig. 1 has lateral support at locations *a*, *b*, *c*, and *d*. Compute C_b for segment $b - c$. Use the unfactored service loads as shown. **(12)**

Fig.1



(c) Compute the shape factor of the beam section shown in Fig. 2. **(15)**

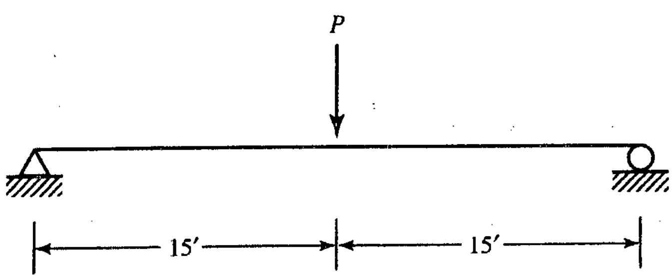
Fig.2



2. (a) Briefly discuss, with neat sketches, how the structural properties of steel are affected by temperature. **(8)**

(b) The beam shown in Fig. 3 is a W10 × 77 and is laterally unsupported except at ends. If F_y = 50 ksi, what is the maximum permissible value of *P*? Neglect self-weight of the beam and follow ASD principle. For this beam C_b = 1.32 **(12)**

Fig.3



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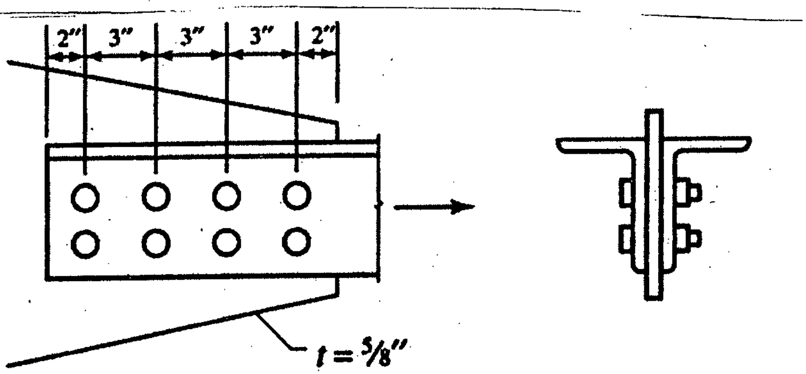
(c) A double-angle shape, 2L6 × 6 × $\frac{5}{8}$ is connected to a $\frac{5}{8}$-inch thick gusset plate as shown in Fig. 4. Determine the maximum total service tension load (ASD) that can be applied on the angles based on bolt limit states. The bolts are $\frac{7}{8}$-inch-diameter, A325 bearing type bolts (F_{by} = 90 ksi, F_{bu} = 120 ksi). A572 Grade 50 steel (F_y = 50 ksi, F_u = 70 ksi) is used for the angle, and A36 steel (F_y = 36 ksi, F_u = 58 ksi) is used for the gusset plate. **(15)**

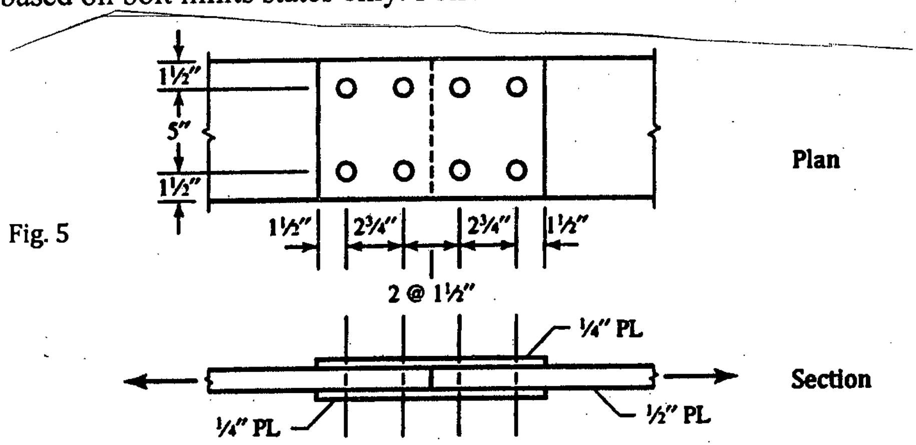
Fig.4



3. (a) State some typical differences between steel and concrete structures. **(8)**

(b) A $\frac{1}{2}$-inch-thick tension member is spliced with two $\frac{1}{4}$-inch-thick splice plates as shown in Fig. 5. The bolts are $\frac{7}{8}$-inch-diameter, A325 (F_{by} = 90 ksi, F_{bu} = 120 ksi) and all steel is A36 (F_y = 36 ksi and F_u = 58 ksi). Compute the design tension capacity of the splice based on bolt limits states only. Follow LRFD method. **(12)**

Fig. 5



(c) Determine the required size and thickness of a base plate for a W12 × 50 column to carry a factored axial load P_u of 370 kips. The base plate is supported on a 5-ft square concrete footing having f'_c = 3500 psi. Use A36 material (F_y = 36 ksi, F_u = 58 ksi) for base plate. Follow LRFD principle. **(15)**

4. (a) Name the different types of welded joints and draw neat sketches for each of them. **(8)**

(b) A plate is used as a bracket and is attached to a column flange as shown in Fig. 6. Use an elastic analysis and compute the maximum bolt shear force. **(12)**

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Contd ... Q. No. 4(b)

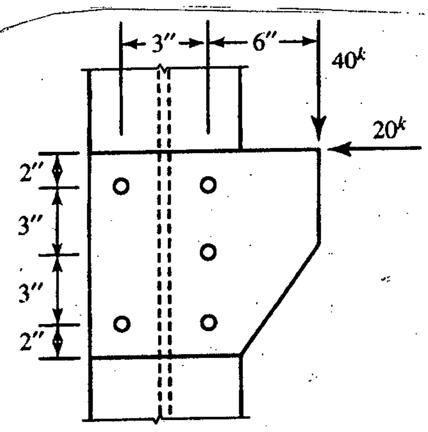

Fig.6

(c) Select the lightest W section to carry a uniformly distributed dead load (including self-weight) of 0.5 kip/ft and line load of 1.0 kip/ft on a simply supported span of 30.0 ft. Adequate lateral support is provided along the span. The live load deflection is limited to $\frac{1}{360}$th of the span. Use A572 Grade 50 steel (F_y = 50 ksi, F_u = 70 ksi). Follow ASD principle and shear design is not required.. **(15)**

SECTION – B

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

Annexures are provided to facilitate design.

5. (a) With neat sketches explain shear lag and its implications in design. **(9)**

(b) The residual stress for a 18 × 2-in. plate to be used as a tension member is shown in Fig. 7. Derive the equation for the stress-strain behaviour in tension of the plate applicable at an imposed tensile strain of 0.0014. What is the tangent modulus in the section at this strain? Given: F_y = 36 ksi; E = 30000 ksi. **(26)**

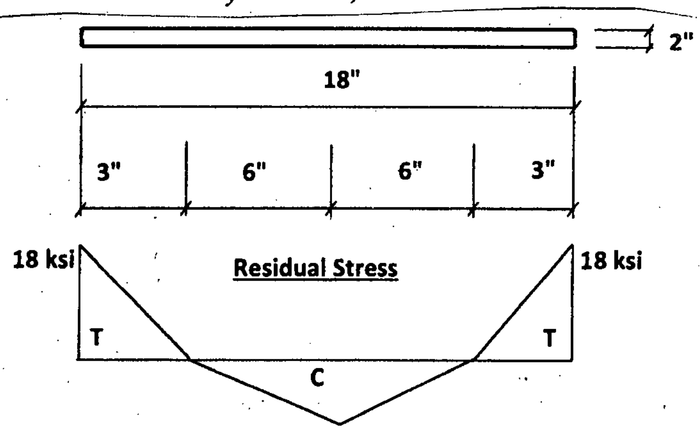

Fig. 7

6. (a) With neat sketches explain the phenomenon of strain aging. **(9)**

(b) Calculate the probable net areas for the tension splice shown in Fig. 8 and hence find the net area that governs the splice design. All material is A36 steel (F_y = 36 ksi, F_u = 58 ksi). Bolts are $\frac{5}{8}$-in. diameter A325 in standard holes. Also determine the design strength (in LRFD) of the splice based on capacity of the plates only. For plates all bolted, U = 1. Block shear or capacities based on bolt shear or bearing are not required. **(26)**

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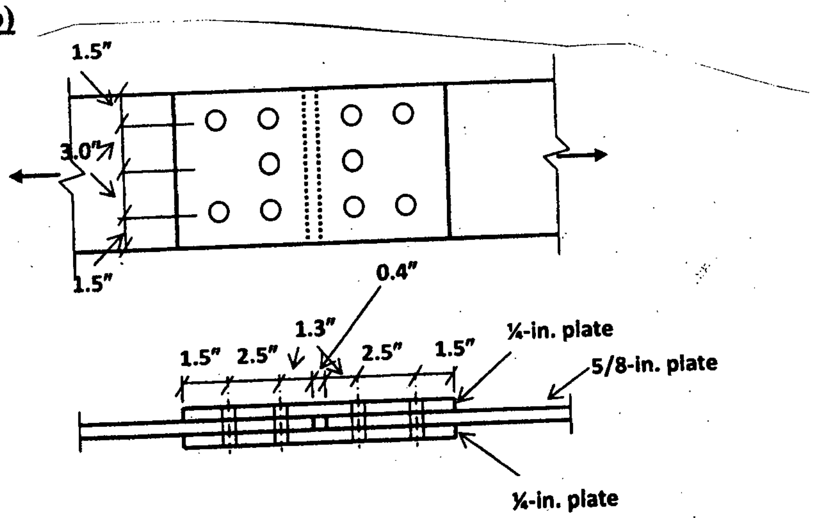

Fig. 8

7. (a) Calculate the allowable strength (in ASD) of a W14 × 90 column section with a strong axis unbraced length of 30 ft and weak axis unbraced length of 15 ft. Assume ends of unbraced lengths as pinned. The material is ASTM A992 (F_y = 50 ksi, F_u = 65 ksi); E = 29000 ksi. Assnexure-2 is provided to facilitate design. **(17)**

(b) Calculate the allowable strength (in ASD) in block shear for the connection developed by the L4 × 4 × $\frac{3}{4}$ angle attached with three $\frac{7}{8}$-in. diameter bolts to a $\frac{3}{8}$-in. gusset plate, as shown in Fig. 9. The material is A36 steel (F_y = 36 ksi, F_u = 58 ksi) for both angle and gusset plate. Other limit states need not be checked. Annexure-3 is provided to facilitate the design. Assume uniform tensile stress. **(18)**

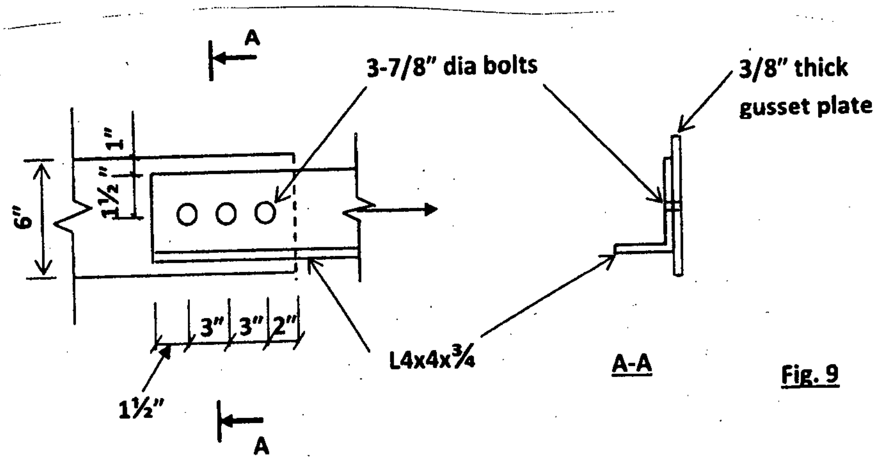

Fig. 9

8. (a) Two plates each $\frac{5}{8}$-in. thick are lap welded as shown in Fig. 10. The transverse weld size is 5/16" and the longitudinal weld size is 1/4". Welds are deposited using E70XX electrodes. Plates are ASTM A992 (F_y = 50 ksi, F_u = 65 ksi). If the service dead load tension is 50 kips, what live load tension may be transmitted through the welded connection? Use AISC/LRFD method. **(17)**

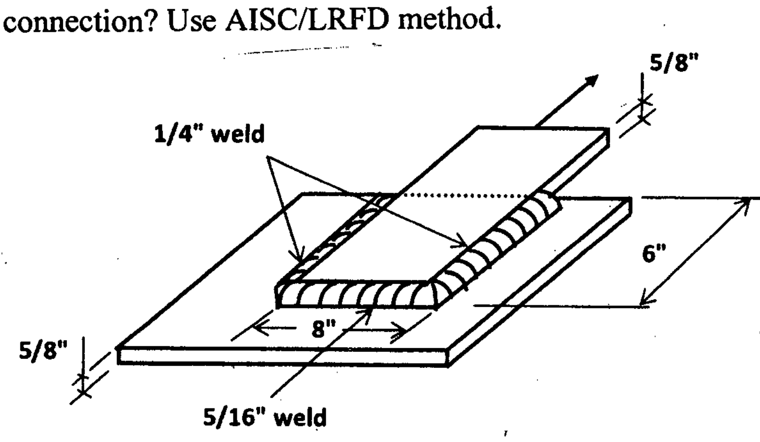

Fig. 10

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(b) Determine the effective length coefficients for the columns BC, EF, CD and FG of the frame shown in Fig. 11. The moments of inertia for members in $inch^4$ are shown alongside the members. The multiplication factors for stiffnesses for a beam with far end fixed are 2/3 (with sidesway) and 2 (without sidesway). Annexure-4 is provided to facilitate the design. **(18)**

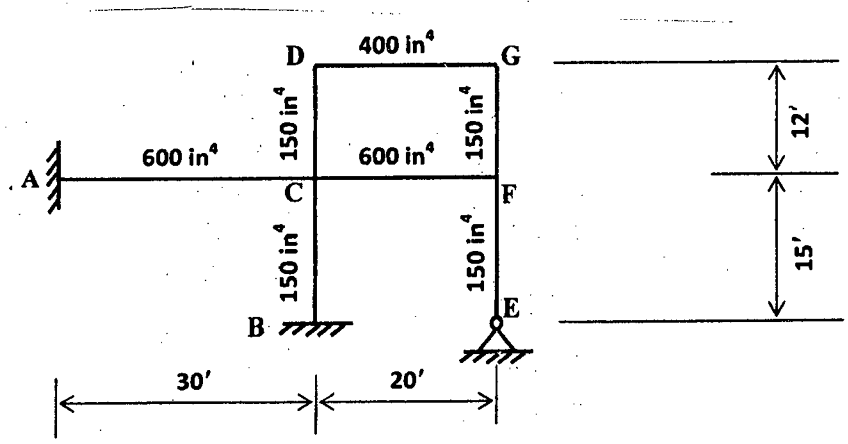


Fig. 11

=6=

ANNEXURE-I

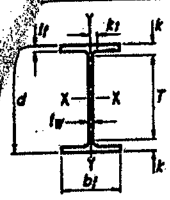


Table 1-1 (continued) W Shapes Dimensions

Shape	Area, A	Depth, d		Web Thickness, t_w		$\frac{t_w}{2}$	Flange Width, b_f		Flange Thickness, t_f		Distance k: k_{des}	k_{det}	k_1	T	Workable Gage
	in.²	in.		in.		in.	in.		in.		in.	in.	in.	in.	in.
W14×132	38.8	14.7	14 5/8	0.645	5/8	5/16	14.7	14 3/4	1.03	1	1.63	2 5/16	1 9/16	10	5 1/2
×120	35.3	14.5	14 1/2	0.590	9/16	5/16	14.7	14 5/8	0.940	15/16	1.54	2 1/4	1 1/2	↓	↓
×109	32.0	14.3	14 3/8	0.525	1/2	1/4	14.6	14 5/8	0.860	7/8	1.46	2 3/16	1 1/2		
×99[f]	29.1	14.2	14 1/8	0.485	1/2	1/4	14.6	14 5/8	0.780	3/4	1.38	2 1/16	1 7/16		
×90[f]	26.5	14.0	14	0.440	7/16	1/4	14.5	14 1/2	0.710	11/16	1.31	2	1 7/16		
W14×82	24.0	14.3	14 1/4	0.510	1/2	1/4	10.1	10 1/8	0.855	7/8	1.45	1 11/16	1 1/16	10 7/8	5 1/2
×74	21.8	14.2	14 1/8	0.450	7/16	1/4	10.1	10 1/8	0.785	13/16	1.38	1 5/8	1 1/16	↓	↓
×68	20.0	14.0	14	0.415	7/16	1/4	10.0	10	0.720	3/4	1.31	1 9/16	1 1/16		
×61	17.9	13.9	13 7/8	0.375	3/8	3/16	10.0	10	0.645	5/8	1.24	1 1/2	1		
W14×53	15.6	13.9	13 7/8	0.370	3/8	3/16	8.06	8	0.660	11/16	1.25	1 1/2	1	10 7/8	5 1/2
×48	14.1	13.8	13 3/4	0.340	5/16	3/16	8.03	8	0.595	5/8	1.19	1 7/16	1	↓	↓
×43[c]	12.6	13.7	13 5/8	0.305	5/16	3/16	8.00	8	0.530	1/2	1.12	1 3/8	1		
W12×58	17.0	12.2	12 1/4	0.360	3/8	3/16	10.0	10	0.640	5/8	1.24	1 1/2	15/16	9 1/4	5 1/2
×53	15.6	12.1	12	0.345	3/8	3/16	10.0	10	0.575	9/16	1.18	1 3/8	15/16	9 1/4	5 1/2
W12×50	14.6	12.2	12 1/4	0.370	3/8	3/16	8.08	8 1/8	0.640	5/8	1.14	1 1/2	15/16	9 1/4	5 1/2
×45	13.1	12.1	12	0.335	5/16	3/16	8.05	8	0.575	9/16	1.08	1 3/8	15/16	↓	↓
×40	11.7	11.9	12	0.295	5/16	3/16	8.01	8	0.515	1/2	1.02	1 3/8	7/8		
W10×112	32.9	11.4	11 3/8	0.755	3/4	3/8	10.4	10 3/8	1.25	1 1/4	1.75	1 15/16	1	7 1/2	5 1/2
×100	29.4	11.1	11 1/8	0.680	11/16	3/8	10.3	10 3/8	1.12	1 1/8	1.62	1 13/16	1	↓	↓
×88	25.9	10.8	10 7/8	0.605	5/8	5/16	10.3	10 1/4	0.990	1	1.49	1 11/16	15/16		
×77	22.6	10.6	10 5/8	0.530	1/2	1/4	10.2	10 1/4	0.870	7/8	1.37	1 9/16	7/8		
×68	20.0	10.4	10 3/8	0.470	1/2	1/4	10.1	10 1/8	0.770	3/4	1.27	1 7/16	7/8		
×60	17.6	10.2	10 1/4	0.420	7/16	1/4	10.1	10 1/8	0.680	11/16	1.18	1 3/8	13/16		
×54	15.8	10.1	10 1/8	0.370	3/8	3/16	10.0	10	0.615	5/8	1.12	1 5/16	13/16		
×49	14.4	10.0	10	0.340	5/16	3/16	10.0	10	0.560	9/16	1.06	1 1/4	13/16		

Table 1-1 (continued) W Shapes Properties

W14 – W12

Shape	Compact Section Criteria $\frac{b_f}{2t_f}$	$\frac{h}{t_w}$	Axis X-X I	S	r	Z	Axis Y-Y I	S	r	Z	r_{ts}	h_o	Torsional Properties J	C_w
			in.⁴	in.³	in.	in.³	in.⁴	in.³	in.	in.³	in.	in.	in.⁴	in.⁶
W14×132	7.15	17.7	1530	209	6.28	234	548	74.5	3.76	113	4.23	13.6	12.3	25500
×120	7.80	19.3	1380	190	6.24	212	495	67.5	3.74	102	4.20	13.5	9.37	22700
×109	8.49	21.7	1240	173	6.22	192	447	61.2	3.73	92.7	4.17	13.5	7.12	20200
×99[f]	9.34	23.5	1110	157	6.17	173	402	55.2	3.71	83.6	4.14	13.4	5.37	18000
×90[f]	10.2	25.9	999	143	6.14	157	362	49.9	3.70	75.6	4.11	13.3	4.06	16000
W14×82	5.92	22.4	881	123	6.05	139	148	29.3	2.48	44.8	2.85	13.5	5.07	6710
×74	6.41	25.4	795	112	6.04	126	134	26.6	2.48	40.5	2.82	13.4	3.87	5990
×68	6.97	27.5	722	103	6.01	115	121	24.2	2.46	36.9	2.80	13.3	3.01	5380
×61	7.75	30.4	640	92.1	5.98	102	107	21.5	2.45	32.8	2.78	13.2	2.19	4710
W14×53	6.11	30.9	541	77.8	5.89	87.1	57.7	14.3	1.92	22.0	2.22	13.3	1.94	2540
×48	6.75	33.6	484	70.2	5.85	78.4	51.4	12.8	1.91	19.6	2.20	13.2	1.45	2240
×43[c]	7.54	37.4	428	62.6	5.82	69.6	45.2	11.3	1.89	17.3	2.18	13.1	1.05	1950
W12×58	7.82	27.0	475	78.0	5.28	86.4	107	21.4	2.51	32.5	2.82	11.6	2.10	3570
×53	8.69	28.1	425	70.6	5.23	77.9	95.8	19.2	2.48	29.1	2.79	11.5	1.58	3160
W12×50	6.31	26.8	391	64.2	5.18	71.9	56.3	13.9	1.96	21.3	2.25	11.8	1.71	1880
×45	7.00	29.6	348	57.7	5.15	64.2	50.0	12.4	1.95	19.0	2.23	11.5	1.26	1650
×40	7.77	33.6	307	51.5	5.13	57.0	44.1	11.0	1.94	16.8	2.21	11.4	0.906	1440
W10×112	4.17	10.4	716	126	4.66	147	236	45.3	2.68	69.2	3.07	10.1	15.1	6020
×100	4.62	11.6	623	112	4.60	130	207	40.0	2.65	61.0	3.03	10.0	10.9	5150
×88	5.18	13.0	534	98.5	4.54	113	179	34.8	2.63	53.1	2.99	9.85	7.53	4330
×77	5.86	14.8	455	85.9	4.49	97.6	154	30.1	2.60	45.9	2.95	9.73	5.11	3630
×68	6.58	16.7	394	75.7	4.44	85.3	134	26.4	2.59	40.1	2.91	9.63	3.56	3100
×60	7.41	18.7	341	66.7	4.39	74.6	116	23.0	2.57	35.0	2.88	9.54	2.48	2640
×54	8.15	21.2	303	60.0	4.37	66.6	103	20.6	2.56	31.3	2.86	9.48	1.82	2320
×49	8.93	23.1	272	54.6	4.35	60.4	93.4	18.7	2.54	28.3	2.84	9.42	1.39	2070

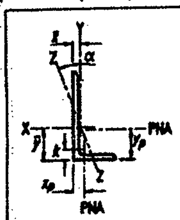


Table 1-7 Angles Properties

Table 1-7 (continued) Angles Properties

L8-L6

Shape	k	Wt.	Area, A	Axis X-X I	S	r	$\bar{y}$	Z	y_p
	in.	lb/ft	in.²	in.⁴	in.³	in.	in.	in.³	in.
L7×4×3/4	1 1/4	26.2	7.69	37.8	8.39	2.21	2.50	14.8	1.87
×5/8	1 1/8	22.1	6.48	32.4	7.12	2.23	2.45	12.5	1.80
×1/2	1	17.9	5.25	26.6	5.79	2.25	2.40	10.2	1.74
×7/16	15/16	15.7	4.62	23.6	5.11	2.26	2.38	9.03	1.70
×3/8	7/8	13.6	3.98	20.5	4.42	2.27	2.35	7.81	1.67
L6×6×1	1 1/2	37.4	11.0	35.4	8.55	1.79	1.86	15.4	0.918
×7/8	1 3/8	33.1	9.75	31.9	7.61	1.81	1.81	13.7	0.813
×3/4	1 1/4	28.7	8.46	28.1	6.84	1.82	1.77	11.9	0.705
×5/8	1 1/8	24.2	7.13	24.1	5.64	1.84	1.72	10.1	0.594
×9/16	1 1/16	21.9	6.45	22.0	5.12	1.85	1.70	9.18	0.538
×1/2	1	19.6	5.77	19.9	4.59	1.86	1.67	8.22	0.481
×7/16	15/16	17.2	5.08	17.6	4.06	1.86	1.65	7.25	0.423
×3/8	7/8	14.9	4.38	15.4	3.51	1.87	1.62	6.27	0.365
×5/16	13/16	12.4	3.67	13.0	2.95	1.88	1.60	5.26	0.306

Shape	Flexural-Torsional Properties J	C_w	$\bar{r}_o$	Axis Y-Y I	S	r	$\bar{x}$	Z	x_p	Axis Z-Z I	S	r	Tan α	Q_s F_y=36 ksi
	in.⁴	in.⁶	in.	in.⁴	in.³	in.	in.	in.³	in.	in.⁴	in.³	in.		
L7×4×3/4	1.47	3.97	3.31	9.00	3.01	1.08	1.00	5.60	0.550	5.64	1.71	0.855	0.324	1.00
×5/8	0.868	2.37	3.34	7.79	2.56	1.10	0.958	4.69	0.464	4.80	1.47	0.860	0.329	1.00
×1/2	0.456	1.25	3.37	6.48	2.10	1.11	0.910	3.77	0.376	3.95	1.21	0.866	0.334	0.965
×7/16	0.310	0.851	3.38	5.79	1.86	1.12	0.886	3.31	0.331	3.50	1.08	0.869	0.337	0.912
×3/8	0.198	0.544	3.40	5.06	1.61	1.12	0.861	2.84	0.286	3.05	0.942	0.873	0.339	0.840
L6×6×1	3.68	9.24	3.18	35.4	8.55	1.79	1.86	15.4	0.918	15.0	3.53	1.17	1.00	1.00
×7/8	2.51	6.41	3.21	31.9	7.61	1.81	1.81	13.7	0.813	13.3	3.13	1.17	1.00	1.00
×3/4	1.61	4.17	3.24	28.1	6.64	1.82	1.77	11.9	0.705	11.6	2.73	1.17	1.00	1.00
×5/8	0.955	2.50	3.28	24.1	5.64	1.84	1.72	10.1	0.594	9.83	2.32	1.17	1.00	1.00
×9/16	0.704	1.85	3.29	22.0	5.12	1.85	1.70	9.17	0.538	8.94	2.11	1.18	1.00	1.00
×1/2	0.501	1.32	3.31	19.9	4.59	1.86	1.67	8.22	0.481	8.04	1.89	1.18	1.00	1.00
×7/16	0.340	0.899	3.32	17.6	4.06	1.86	1.65	7.25	0.423	7.11	1.68	1.18	1.00	0.973
×3/8	0.218	0.575	3.34	15.4	3.51	1.87	1.62	6.26	0.365	6.17	1.45	1.19	1.00	0.912
×5/16	0.129	0.338	3.35	13.0	2.95	1.88	1.60	5.26	0.306	5.20	1.23	1.19	1.00	0.826

Beam LTB formula's

$$\frac{L_p}{r_y} = 1.76\sqrt{\frac{E}{F_y}} = \frac{300}{\sqrt{F_y}\text{, ksi}}$$

$$L_r = 1.95 r_{ts}\frac{E}{0.7F_y}\sqrt{\frac{Jc}{S_x h_o}}\sqrt{1+\sqrt{1+6.76\left(\frac{0.7F_y}{E}\frac{S_x h_o}{Jc}\right)^2}}$$

$$F_{cr} = \frac{C_b \pi^2 E}{\left(\frac{L_b}{r_{ts}}\right)^2}\sqrt{1 + 0.078\frac{Jc}{S_x h_o}\left(\frac{L_b}{r_{ts}}\right)^2}$$

ANNEXURE-2

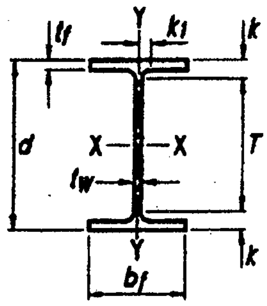
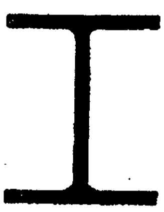


Table 1-1 (continued)
W Shapes
Dimensions

Shape	Area, A	Depth, d		Web Thickness, t_w		Web $\frac{t_w}{2}$	Flange Width, b_f		Flange Thickness, t_f		Distance k k_{des}	Distance k k_{det}	k_1	T	Workable Gage
	in.^{2}	in.		in.		in.	in.		in.		in.	in.	in.	in.	in.
W14×132	38.8	14.7	14 5/8	0.645	5/8	5/16	14.7	14 3/4	1.03	1	1.63	2 5/16	1 9/16	10	5 1/2
×120	35.3	14.5	14 1/2	0.590	9/16	5/16	14.7	14 5/8	0.940	15/16	1.54	2 1/4	1 1/2		
×109	32.0	14.3	14 3/8	0.525	1/2	1/4	14.6	14 5/8	0.860	7/8	1.46	2 3/16	1 1/2		
×99^f	29.1	14.2	14 1/8	0.485	1/2	1/4	14.6	14 5/8	0.780	3/4	1.38	2 1/16	1 7/16		
×90^f	26.5	14.0	14	0.440	7/16	1/4	14.5	14 1/2	0.710	11/16	1.31	2	1 7/16	↓	↓

Table 1-1 (continued)
W Shapes
Properties



W14 – W12

Nominal Wt.	Compact Section Criteria $\frac{b_f}{2t_f}$	Compact Section Criteria $\frac{h}{t_w}$	Axis X-X I	Axis X-X S	Axis X-X r	Axis X-X Z	Axis Y-Y I	Axis Y-Y S	Axis Y-Y r	Axis Y-Y Z	r_{ts}	h_o	Torsional Properties J	Torsional Properties C_w
lb/ft			in.^{4}	in.^{3}	in.	in.^{3}	in.^{4}	in.^{3}	in.	in.^{3}	in.	in.	in.^{4}	in.^{6}
132	7.15	17.7	1530	209	6.28	234	548	74.5	3.76	113	4.23	13.6	12.3	25500
120	7.80	19.3	1380	190	6.24	212	495	67.5	3.74	102	4.20	13.5	9.37	22700
109	8.49	21.7	1240	173	6.22	192	447	61.2	3.73	92.7	4.17	13.5	7.12	20200
99	9.34	23.5	1110	157	6.17	173	402	55.2	3.71	83.6	4.14	13.4	5.37	18000
90	10.2	25.9	999	143	6.14	157	362	49.9	3.70	75.6	4.11	13.3	4.06	16000

ANNEXURE-3

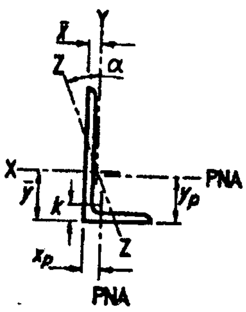


Table 1–7 (continued)
Angles
Properties

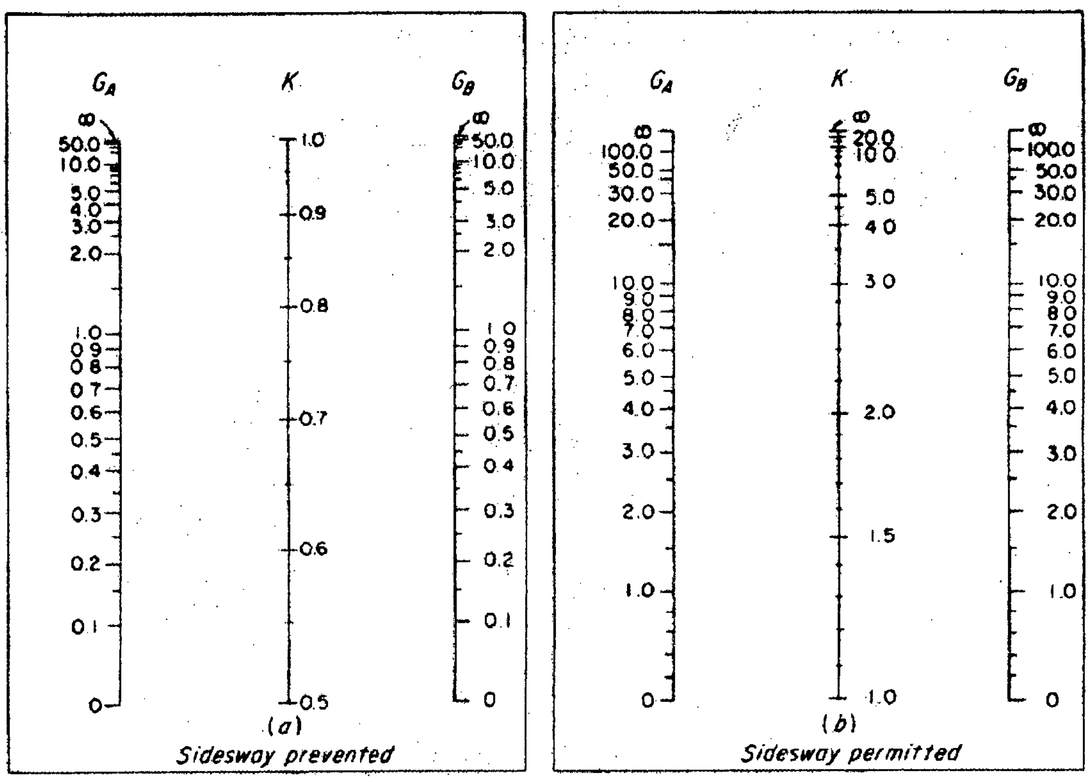
Shape	k	Wt.	Area, A	Axis X-X I	S	r	$\bar{y}$	Z	y_p	Flexural-Torsional Properties J	C_w	$\bar{r}_o$
	in.	lb/ft	in.^{2}	in.^{4}	in.^{3}	in.	in.	in.^{3}	in.	in.^{4}	in.^{6}	in.
L4×4×3/4	1 1/8	18.5	5.44	7.62	2.79	1.18	1.27	5.02	0.679	1.02	1.12	2.10
×5/8	1	15.7	4.61	6.62	2.38	1.20	1.22	4.28	0.576	0.610	0.680	2.13
×1/2	7/8	12.8	3.75	5.52	1.96	1.21	1.18	3.50	0.468	0.322	0.366	2.16
×7/16	13/16	11.3	3.31	4.93	1.73	1.22	1.15	3.10	0.413	0.220	0.252	2.18
×3/8	3/4	9.80	2.86	4.32	1.50	1.23	1.13	2.69	0.357	0.141	0.162	2.19
×5/16	11/16	8.20	2.40	3.67	1.27	1.24	1.11	2.26	0.300	0.0832	0.0963	2.21
×1/4	5/8	6.60	1.94	3.00	1.03	1.25	1.08	1.82	0.242	0.0438	0.0505	2.22

Table 1–7 (continued)
Angles
Properties

L6-L4

Shape	Axis Y-Y I	S	r	$\bar{x}$	Z	x_p	Axis Z-Z I	S	r	Tan α	Q_s F_y = 36 ksi
	in.^{4}	in.^{3}	in.	in.	in.^{3}	in.	in.^{4}	in.^{3}	in.		
L4×4×3/4	7.62	2.79	1.18	1.27	5.01	0.679	3.25	1.15	0.774	1.00	1.00
×5/8	6.62	2.38	1.20	1.22	4.28	0.576	2.76	0.975	0.774	1.00	1.00
×1/2	5.52	1.96	1.21	1.18	3.50	0.468	2.25	0.797	0.776	1.00	1.00
×7/16	4.93	1.73	1.22	1.15	3.10	0.413	2.00	0.706	0.777	1.00	1.00
×3/8	4.32	1.50	1.23	1.13	2.68	0.357	1.73	0.613	0.779	1.00	1.00
×5/16	3.67	1.27	1.24	1.11	2.26	0.300	1.46	0.517	0.781	1.00	0.997
×1/4	3.00	1.03	1.25	1.08	1.82	0.242	1.18	0.419	0.783	1.00	0.912

ANNEXURE-4



Nomograph for effective length of columns.

L-3/T-2/CE Date : 11/01/2015

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2012-2013

Sub : **CE 351** (Transportation Engineering I : Transportation Planning and Traffic Engineering)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) What is meant by "Transportation Planning"? Show with a neat sketch the basic elements of Transportation Planning. **(11)**

(b) Explain diagrammatically the basic movement to categorize travel pattern in a planning area. **(12)**

(c) Calculate the inter zonal trips using a simple gravity model from the following data. Assume the exponent of travel time as 0.6. **(12)**

Production Zone i	Employment Zone	Employments	Travel time from Zone i
$T_i = 450$ work trips	1	750	9 minutes
	2	400	5 minutes
	3	300	7 minutes

2. (a) What are the functions of shoulder and median in a highway? Why roads are widened at highway curves? **(11)**

(b) Explain the factors to be considered in setting warrants for NMV/bicycle facilities. **(12)**

(c) A driver moving at a speed of 65 mph on a 3 percent upgrade section of a highway sights an obstruction 500 ft away and applied the brake. If the coefficient of friction for the pavement is 0.29 and acceleration due to gravity is 32.2 ft/sec^2, would the driver be able to stop the car before hitting the obstruction? **(12)**

3. (a) What are the advantages and disadvantages of a rotary intersection? **(11)**

(b) Show diagrammatically the method of attaining superelevation considering pavement revoled about the centre line. **(12)**

(c) Show with neat sketches the minimum passing sight distance for a two-lane two-way highway for right-hand drive vehicle and keep-to-left convention. **(12)**

4. (a) Define scopes and purpose of Transportation Engineering from system view point. Develop a Transportation system model showing various physical subsystems and their examples. **(20)**

(b) Write down names and examples of five human behavior that are affected by transportation. Also, explain direct impact on human behaviour for fine transport related physical environment. **(15)**

Contd P/2

CE 351

SECTION – B

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

Need plain graph papers.

5. (a) Explain how transport system can be evaluated in terms of three basic attributes with examples. Illustrate with diagrams how urban road classification is related to these basic attributes. Also, develop a new construction and maintenance strategy for an urban road network on above rationale. **(25)**

(b) Briefly explain the factors influencing urban transport system. Based on these, furnish the current challenges faced by Urban Transport Authority. **(10)**

6. (a) Explain various features of Bus Rapid Transit (BRT) and Light Rail Transit (LRT) as mass transit option of urban corridor. Write short notes on ITS, PCU and PIEV. **(10+6=16)**

(b) State the main objectives of following studies: **(8)**

(i) Volume (ii) Speed (iii) Delay (iv) Origin – destination.

(c) Following data was collected while conducting spot speed studies at certain stretch of a road within the urban area. **(11)**

Speed range (kmph)	Frequency (f)
0-5	0
5-10	12
10-15	25
15-20	40
20-25	100
25-30	205
30-35	240
35-40	110
40-45	45
45-50	25
50-55	11
55-60	6
60-65	3
65-70	0

Determine :

(i) Average speed of traffic stream.

(ii) Modal speed and pace of traffic stream.

(iii) Upper and lower speed limits.

(iv) Design speed.

7. (a) Name the common bottlenecks of roadway system. Write down the vehicular characteristics that affect the roadway design. What are the objectives of providing street lighting? **(6+3+3=12)**

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(b) List the locations where parking should be prohibited. What steps should be undertaken for systematic development of parking facilities? Briefly differentiate between 'on-street' parking and 'off-street' parking. **(3+3+6=12)**

(c) An urban central business street, with 50 ft pavement width having a reflectance of 3%, carries a maximum of 1220 vph at night time in both directions. Design the lighting system of the road considering sodium light as a source with mounting height of 35 ft and a maintenance factor of 0.8. Draw the lighting layout. Necessary information is given in Tables 1 to 4 and in Figure 1. **(7)**

(d) Spot speed data were collected at a section of highway during an improvement work. The speed characteristics are given below. Determine whether there was any significant difference between the average speeds at the 95% confidence level. Assume reasonable value for any missing data. **(4)**

U_1 = 41.0 kmph	U_2 = 38.5 kmph
S_1 = 7.8 kmph	S_2 = 9.8 kmph
n_1 = 265 nos.	n_2 = 280 nos.

8. (a) Name the functional classification of traffic signs and give two examples for each. Differentiate between traffic signs and markings. Briefly discuss about the new trend of roadway signs, marking and signal. Write down the importance of retro-reflective marking. **(4+4+4+3=15)**

(b) At what circumstances all-red period is considered in traffic signal design? List different types of signal controller and differentiate between pre-timed signal and vehicle-actuated signal controller. **(3+5=8)**

(c) Design a two-phase signal of an isolated cross-junction for the following data. **(12)**

		N-S phase	E-W phase
Inter-green period	=	7 sec	6 sec
Initial and final lost time	=	3 sec	2 sec

		North	South	East	West
Flow(pcu/hr)	=	730	480	850	650
Saturation flow (pcu/hr)	=	2100	1900	2200	2050

Assume reasonable value for any missing data. Draw the phase and cycle time bar diagram.

TABLE 1 RECOMMENDED AVERAGE ILLUMINATION (LUMENS/FT^2)

Pedestrian traffic[1]	Vehicular traffic[2] (vph)			
	Very light (<150 vph)	Light (150 – 500 vph)	Medium (500 – 1,200 vph)	Heavy (>1,200 vph)
Heavy	-	0.8	1.0	1.2
Medium	-	0.6	0.8	1.0
Light	0.2	0.4	0.6	0.8

Notes:

(1) Heavy: As on main business street
Medium: As on secondary business streets
Light: As on local streets

(2) Night hour flow in both directions

TABLE 2 ADJUSTMENT FACTORS FOR RECOMMENDED AVERAGE ILLUMINATION VALUES

Surface Reflectance	Adjustment Factors
3 % or less	1.5
10%	1.0
20% or more	0.75

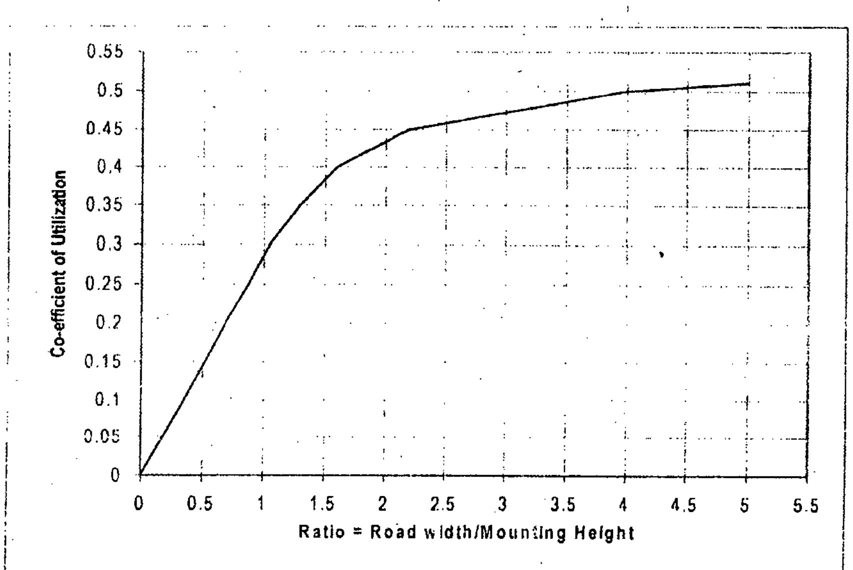
TABLE 3 LIGHTING SOURCE CHARACTERISTICS

Source Types	Expected Life (hrs)	Lighting Efficiency (Lumens/Watt)	Wattage (Watt)
Tungsten	1000	8 – 14	Up to 1000
Fluorescent	6000	50 – 75	Up to 250
Sodium	6000	100 – 120	Up to 160
Mercury	7500	20 – 60	Up to 400

TABLE 4 RECOMMENDED ARRANGEMENT OF STREET LIGHTING

Type of Arrangement	Pavement Width
One side	Width <= 30ft
Both sides – Staggered	30ft > Width <= 60ft
Both sides – Opposite	Width > 60ft

FIGURE 1 CO-EFFICIENT OF UTILIZATION CURVES (FOR LIGHT DISTRIBUTION TYPE III)



Note: Due to poor maintenance, the actual co-efficient of utilization is reduced by a factor usually 0.8 (i.e. taken as 80%).

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L-3/T-2/CE **Date : 16/01/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2012-2013

Sub : **WRE 311** (Open Channel Flow)

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Define Rigid and mobile boundary channel. **(4)**

(b) Define isovel. Draw the qualitative isovels for a natural irregular channel, a trapezoidal channel and a wide channel. **(6⅔)**

(c) Show that for a channel with large slope the pressure distribution is less than hydrostatic pressure. **(6)**

(d) The width of a horizontal rectangular channel is reduced from 3.5 m to 2.5 m and the floor is raised by 0.25 m at a given section. At the upstream section the depth of flow is 2.0 m and kinetic energy correction factor 1.15. If the drop in the water surface at the contraction is 0.2 m, calculate the discharge if the energy loss is one tenth of the upstream velocity head. **(15)**

(e) A structural engineer assumed the water pressure to be hydrostatic while computing the bending moment and shear force acting on the side walls of the spillway chute shown in figure 1. What are the computed values of bending moment and shear force at the invert level? Are the computed values correct? If not compute the percent error. Here, y is the flow depth measured vertically from the water surface. **(15)**

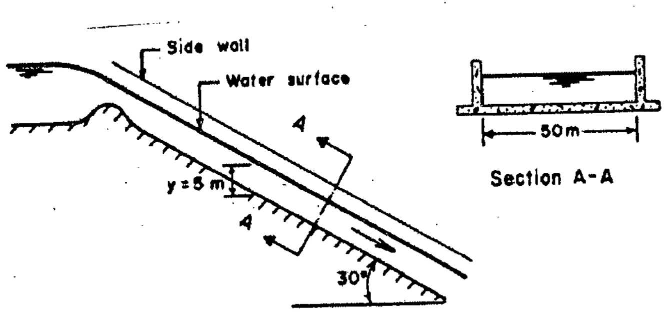

Figure 1 for question 1(e)

2. (a) Explain why subcritical flow is subject to downstream control. **(4)**

(b) Show that the relation between alternate depths y_1 and y_2 for a rectangular channel is given by, **(6⅔)**

$$y_c^3 = \frac{2y_1^2 y_2^2}{y_1 + y_2}$$

where y_c is the critical depth.

(c) Discuss the characteristics of specific energy curve with a neat sketch. **(6)**

Contd P/2

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(d) Derive the expression of hydraulic exponent for critical flow computation. Also calculate the value of this exponent for a parabolic section. **(10)**

(e) A rectangular channel transition involves a negative step and a channel expansion. Calculate the Froud number at the expanded section if the channel is carrying a discharge of 500 m^3/s with an approach water flow depth of 3 m. assume 10% frictional head loss at the expanded section. **(20)**

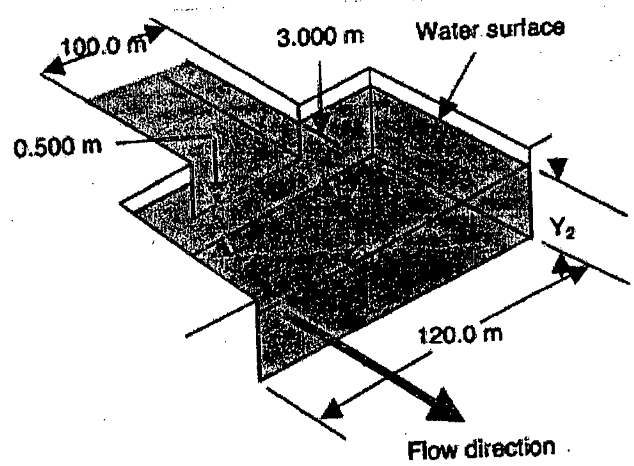

Figure 2 for question 2(e)

3. (a) Describe the different types of hydraulic jumps that occur in sloping channel with neat sketches. **(6⅔)**

(b) Derive the equation of energy loss for hydraulic jump in a horizontal rectangular channel. **(10)**

(c) An over flow spillway has its crest at an elevation 125.40 m and horizontal apron at an elevation of 95.00 m on the downstream side. Find the tail water elevation required to form a hydraulic jump when the elevation of energy line is 127.90 m. The C_d for the flow can be assumed to be 0.735. **(15)**

(d) The values of variables in connection with two hydraulic jumps in a horizontal rectangular channel are given in the following table. Compute the values of the other variables in the table, **(15)**

	Y_1 (m)	V_1(m/s)	Y_2 (m)	V_2(m/s)	q (m^2/s)	F_{r1}	F_{r2}	h_L	L_j (m)
Jump 1	0.30		2.80						
Jump 2		12.90		1.21					

4. (a) Explain why the best hydraulic section is not always the most economic section. **(6⅔)**

(b) A channel lined with concrete is to be laid on a slope of 1 in 3500. The side slope of the channel is to be maintained at 1.5 H : 1 V and the lining material is expected to give a roughness value of 0.014. Design the channel for a discharge of 110 m^3/s and a maximum permissible velocity of 2.25 m/s. **(15)**

Contd P/3

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Contd ... Q. No. 4

(c) A trapezoidal channel is to be laid on a slope of 1 in 1500 and carries a discharge of 30 m^3/s. It is to be excavated in earth containing slightly rounded coarse non-cohesive particles with d_{75} = 2.25 cm and n = 0.022. Design the channel using tractive force method. **(15)**

(d) Design a stable alluvial channel by Lacey's method carrying a discharge of 32 m^3/s through 0.20 mm sand. **(10**

SECTION – B

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

Assume reasonable value of data, if missing data. Symbols have their usual meaning.

5. (a) Discuss the effect of viscous and gravity forces relative to inertial force in open channel flow. **(10)**

(b) Water flows at a depth of 1.5 m and a mean velocity of 2.5 m/s in a triangular channel with side slope of 1 V : 1.5 H. Compute discharge and determine the state of flow in the channel. Assume $\upsilon = 1 \times 10^{-6}$ m^2/s. **(8)**

(c) For a trapezoidal channel with b = 6 m, z = 2, n = 0.025 and S_0 = 0.0025, compute normal depth and velocity if Q = 30 m^3/s. **(10)**

(d) Show that for a wide, hydraulically rough channel, Manning's roughness coefficient may be expressed by the following equation where r indicates the ratio between the measured velocities at two-tenths and eight-tenths of flow depth: **(18⅔)**

$$n = \frac{(r-1)y^{1/6}}{5.57(r+0.95)}$$

6. (a) Derive Chezy formula for uniform flow stating necessary assumptions. **(7)**

(b) Write down the steps for computation of flood discharge by slope-area method. Also mention the points that must be considered for selecting the channel reach. **(8+3=11)**

(c) Prove that the hydraulic exponent for uniform flow computation for a circular channel is given by the following equation where conveyance is computed by Manning's formula.

$$N = \frac{16y}{3d_0}\left(\frac{5\sin\frac{\omega}{2}}{\omega - \sin\omega} - \frac{1}{\omega.\sin\frac{\omega}{2}}\right)$$ **(12)**

(d) An unlined irrigation canal (n = 0.025) is trapezoidal and has a bottom width of 6 m, side slope of 1 : 1 and a depth of flow of 2 m. The longitudinal slope of the canal is 0.0005. Compute discharge carried by the canal under uniform flow condition. With a view to minimize the seepage loss, it is proposed to line the canal with concrete having n = 0.013. Compute discharge that would be carried by the canal when only the bed of the canal is lined. **(16⅔)**

Contd P/4

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7. (a) Prove that specific energy of S2 profile increases in the downstream direction. **(7)**

(b) Explain the behavior of flow profile when $y \rightarrow y_c$. **(4⅔)**

(c) Draw the possible flow profiles in the following serial arrangement of channels: **(4×5=20)**

(i) Mild-Horizontal-Critical

(ii) Steep-Mild-Milder

(iii) Mild-critical-Steep

(iv) Horizontal-Adverse-Steep-Free Overall.

(d) A rectangular channel with b = 6 m, α = 1.12 and n = 0.02 has three reaches arranged serially. The bottom slopes of these reaches are 0.0085, 0.0052 and 0.0040, respectively. For a discharge of 24 m^3/s in the channel, sketch the resulting flow profiles. **(9)**

(e) There is a free overfall at the end of a mild slope channel. Draw all the possible flow profiles for different water levels downstream of the channel. **(6)**

8. (a) What types of data are generally required for computation of flow profile? **(5)**

(b) A wide rectangular channel of slope 0.0004 and n = 0.02 connects two reservoirs 1.5 km apart. The upstream reservoir level is constant at an elevation of 104.00 m. At the intake the bed of the channel is at an elevation of 101.00 m. The intake is free and the loss of energy at the intake can be neglected. **(28)**

(i) What should be the downstream reservoir level to cause uniform flow in the entire length of the channel?

(ii) If the downstream reservoir level is 103.50 m, will it affect the uniform flow condition?

(c) Deduce the expression for the length of the flow profile between two sections in a horizontal channel. **(13⅔)**

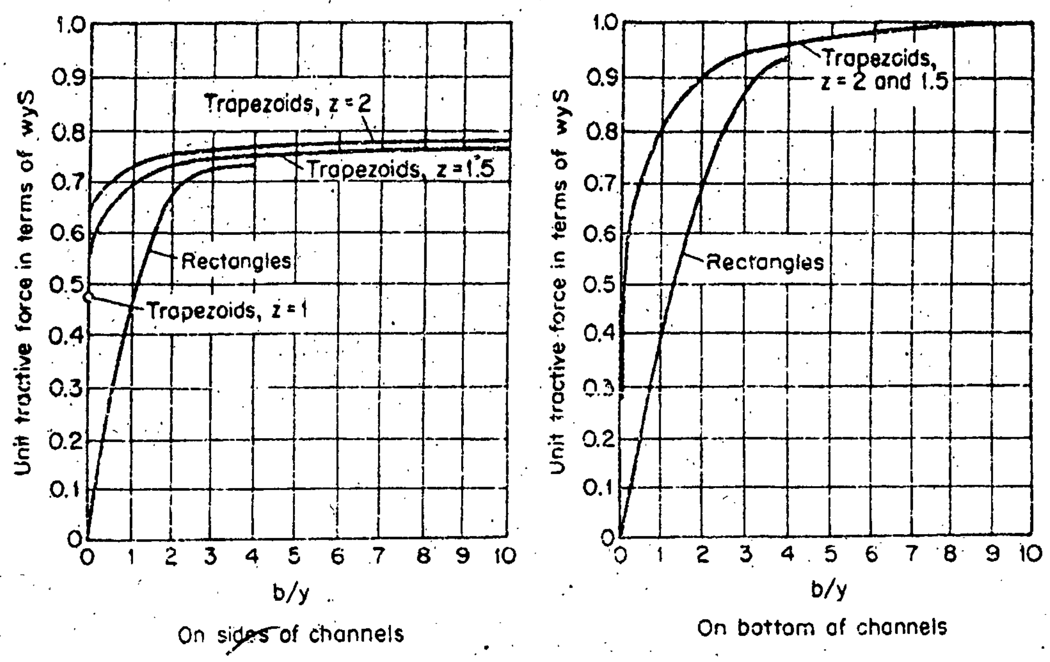

figure 3 for question 4 (c)

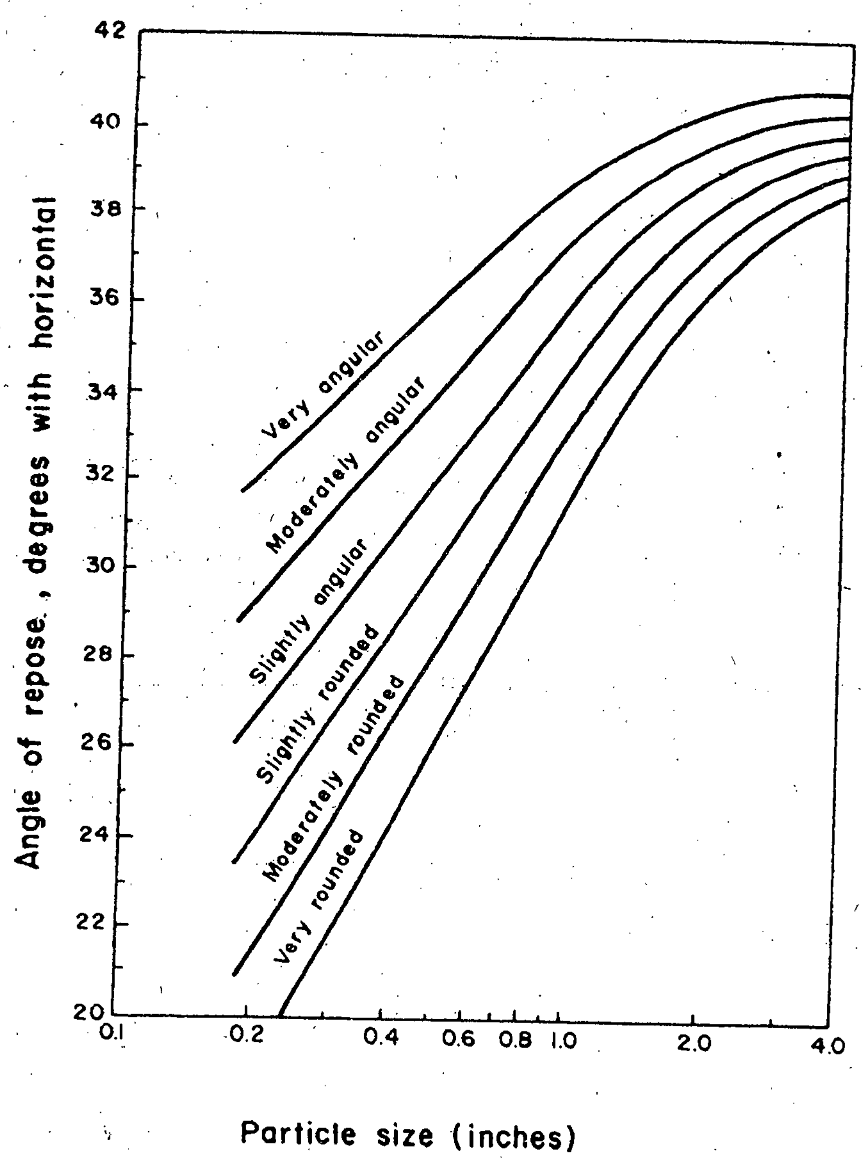

figure 4 for question 4 (c)