L-3/T-2/CE **Date : 07/08/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2014-2015

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

Full Marks: 280 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

Assume reasonable value if data is not given.

SECTION – A

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

1. (a) (i) How uniform flow can be established and identified? Answer with sketch. **(10+6⅔)**

   (ii) Deduce the Chezy equation for uniform flow.

   (b) For uniform flow, find the elation between the Chezy **C**, Manning's **n** and friction factor, **f** (10)

   (c) A trapezoidal channel has bottom width 5 m and side slope z = 1 carrying discharge 10.0 m^3/s. The channel laid on a longitudinal slope S = 0.0001. Compute the normal depth. Assume Manning's roughness value n = 0.02. **(20)**

2. (a) (i) Deduce the Horton's expression of equivalent roughness. **(10+10)**

   (ii) An artificial trapezoidal channel (z = 1) has a glass (n = 0.009) sided sides and its bottom is made of steel sheet (n = 0.03). If the measured channel depth is 1.5 m, calculate the flow rate through the channel. The channel longitudinal slope is 0.001.

   (b) Write stepwise procedure of flood discharge calculation by slope area method. **(10)**

   (c) Derive the general expression of hydraulic exponent (N) for computation of uniform flow. Find the value of exponent for a wide rectangular channel. **(10+6⅔)**

3. (a) (i) Derive dynamic equation of gradually varied flow (GVF) in a channel and express in terms of depths for a wide rectangular channel. **(10+7)**

   (ii) For a wide rectangular channel, given that Q = 15 m^3/s, b = 5 m, S_o = 0.0001, n = 0.02, and the normal depth is 2.00 m. If the channel drops at critical depth, calculate the influence distance of the GVF profile. What is the type of profile?

   (b) Sketch and name the possible flow profiles separately in practical channel configurations for Mild and for Steep slopes. **(9)**

   (c) A trapezoidal channel with a bottom of 4 m and side slopes of 2H:1V carries a discharge of 30 m^3/s. The channel has a constant bed slope of 0.001. A dam back up the water to a depth of 3.0 m just behind the dam. Compute the backwater profile of depth 2.5% greater than normal depth (y_n =1.95). Use any suitable method. Take n = 0.02. Use at least five steps. **(20⅔)**

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4. (a) Show that the wetted area of best hydraulic trapezoidal channel section is $A = 1.732\ y^2$, where y is the depth flow. **(15)**

(b) (i) What is practical lined channel? **(5+10)**

(ii) A rectangular section has to be built on rough concrete. The channel longitudinal slope is 2 m/1 km. Design a most efficiency channel section for the flow rate 1.5 m^3/s. Assume reasonable value if not given.

(c) Design a non-erodible channel section to convey 10 m^3/s of water. The median particle size of soil is 0.20 mm. **(16⅔)**

SECTION – B

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

5. (a) Define Prismatic, Non-prismatic and Mobile boundary channels. **(6)**

(b) Discuss the effect of viscous and gravity forces relative to inertial force in open channel. **(10⅔)**

(c) Define the types of open channel flow for: **(4×2=8)**

(i) Flow at a channel entrance

(ii) Flow at the end of a long prismatic channel

(iii) Flow in a storm sewer during a large storm

(iv) Flow in a power canal when the turbines have been producing constant power.

(d) In a wide river the velocity varies along a vertical as $v = 1 + 2(z/y)$, where y is the total depth and v is the velocity at a distance z from the channel bottom. The river is 5 m deep. If elementary waves are created in this channel, determine (i) the speed of wave fronts upstream and downstream (ii) discharge per unit width (iii) state of flow (iv) values of α and β. **(12)**

(e) A stream gauging operation is required to calculate discharge at a certain river section as given in Table 1. Find the width and current meter location/s from water surface to complete the operation. If current meter is operated for 2 minutes at velocity 0.293 m/s and 0.342 m/s when the number of revolutions were 105 and 125, respectively, find the values of current meter coefficients. **(10)**

6. (a) Derive an expression for total pressure head in case of curvilinear flow. **(10)**

(b) Calculate the pressure intensities at point 1,2,3,4 for the overflow spillway (Fig. 1). Given that the discharge over the spillway is 6.5 m^3/s, r_1 = 20 m and r_2 = 30 m and depth of flow although the spillway is 1 m. **(16⅔)**

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

(d) Show the relation between alternate depths y_1 and y_2 for a rectangular channel is given by **(10)**

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

Where y_c is the critical depth. Also show that the width of the channel will be equal to 4/3 times the critical depth when the wetted perimeter is minimum.

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7. (a) Do you agree with the following statements? Justify your answers. **(12)**

   (i) At the critical state of flow, the discharge is maximum for a given specific energy.

   (ii) All transitions are controls and vice versa.

   (b) Draw the qualitative specific energy curve and corresponding change in water level for the following conditions. **(6)**

   (i) $b_2 > b_1$ (ii) $b_2 > b_c$ (iii) $b_2 = b_c$ (iv) $b_2 < b_c$

   Where b_1, b_2, b_c are the u/s, d/s and critical widths of a rectangular channel respectively.

   (c) Compute the critical depth and velocity in a circular channel with diameter 3 m and discharge 5 m^3/s by trial and error method, where the velocity distribution is uniform. If this circular channel is replaced with a trapezoidal channel whose depth of flow is identical with the critical depth of flow of this circular section but the cross sectional area is double of this circular section. Find the width of the trapezoidal section. **(12)**

   (d) Water is flowing at a velocity 2 m/s and a depth of 2.5 m in a long rectangular channel of 6 m wide. Compute (i) the height of a smooth upward step in the channel bed to produce critical flow, and (ii) the depth and change in water level produced by (I) a smooth upward step of 0.8 m and (II) a smooth Downward step of 0.4 m. In all cases, neglect energy losses and take $\alpha = 1$. **(16⅔)**

8. (a) What is a hydraulic jump? How the location of the hydraulic jump is determined? Derive the equation of efficiency of the hydraulic jump in a horizontal rectangular channel. **(18⅔)**

   (b) Describe the considerations of tail water conditions required for designing a USBR stilling basin. **(6)**

   (c) A spillway discharges a flood flow at a rate of 7.75 $m^3/s/m$. at the downstream horizontal apron the depth of flow was found to be 0.50 m. Find the length and type of the hydraulic jump if a jump is formed in this condition. **(6)**

   (d) Design a USBR stilling basin II for the overflow spillway section having a crest length of 75 m, the design discharge is 2265 cumec. The channel floor elevation is at 5 m from mean sea level. The velocity of flow at the foot of the spillway is 24 m/s and the tailwater elevation is at 15 m from mean sea level. Draw a neat sketch for the final designed basin. **(16)**

Table :1 for Q. 5 (e)

Distance from left bank (m)	Total depth (m)
0	0
3	0.58
6	2.5
8	6.3
10	0.80
12	0

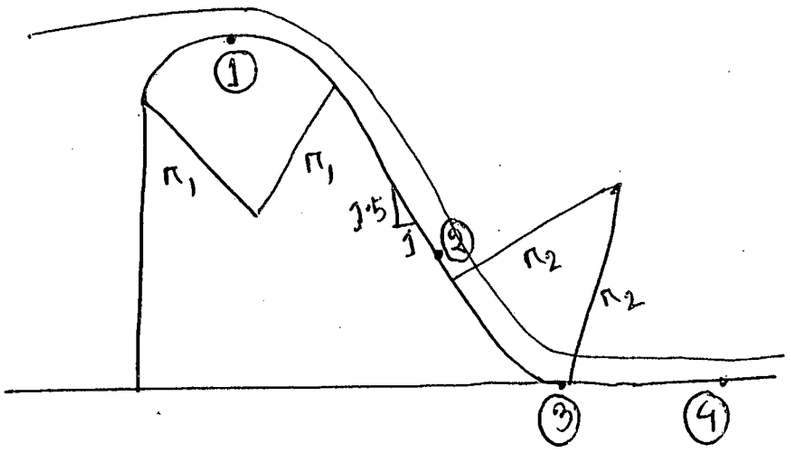


Fig. 1 for Q. 6(b)

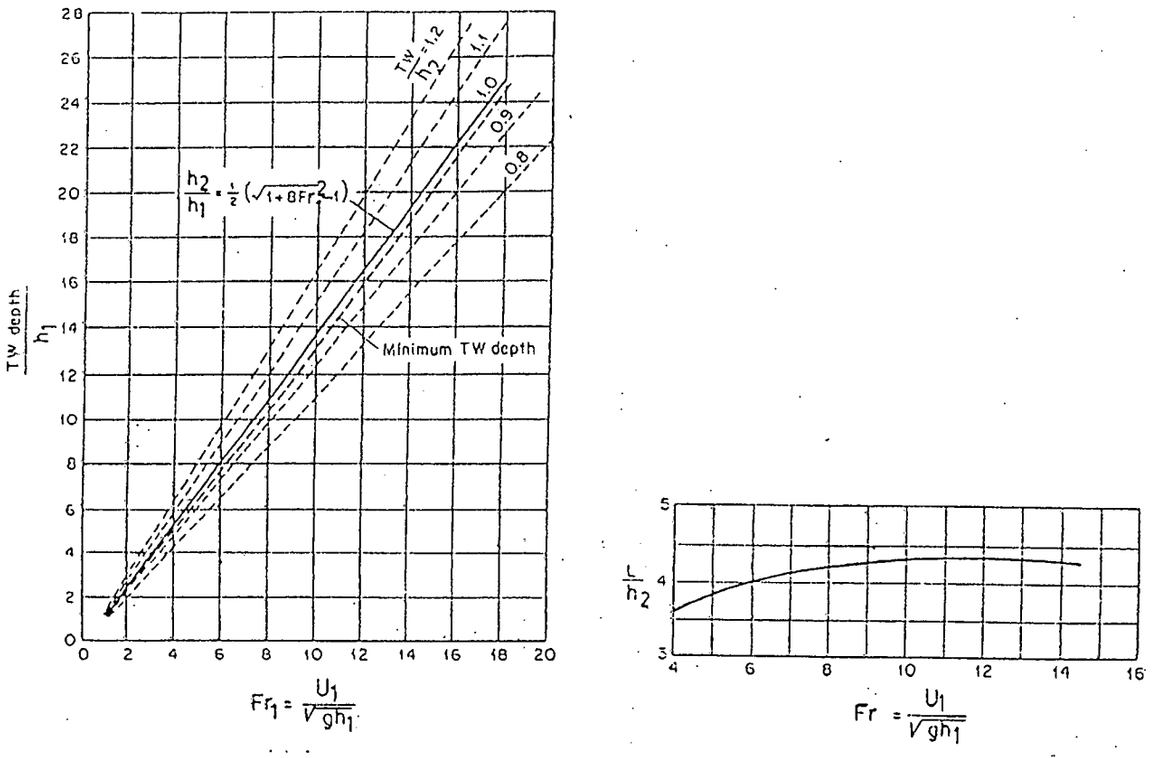


fig.2 for Q.8 (d)

L-3/T-2/CE **Date : 17/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2014-2015

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.

Annexure are provided to facilitate design.

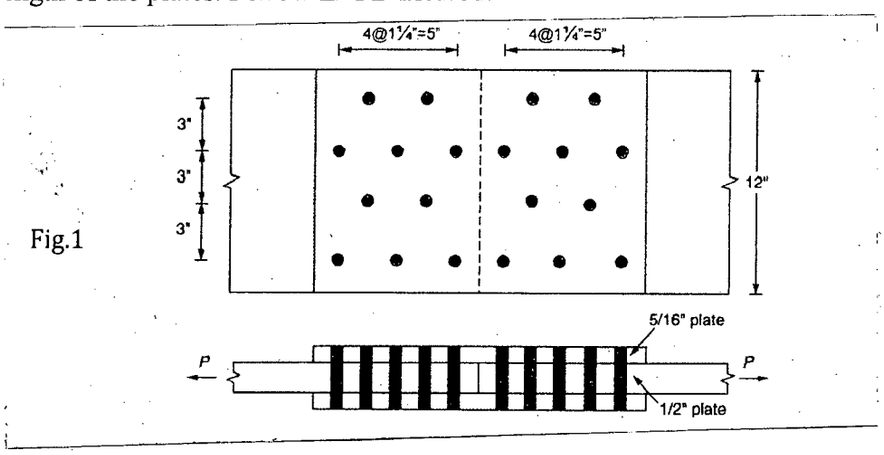
USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

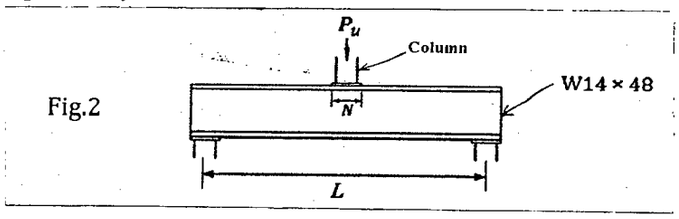
1. (a) The spliced joint shown in Fig. 1 is connected with $\frac{3}{4}$-in diameter bolts in standard holes. The plate material is A36 steel (F_y = 36 ksi, F_u = 58 ksi). Assuming that the bolts are satisfactory and that block shear does not govern, determine the available tensile strength of the plates. Follow LRFD method. **(15)**

Fig.1



(b) A W14×48(F_y = 50 ksi, F_u = 65 ksi) section on a simply supported span of L = 7′-0″ has to support a point load P_u = 150 kip at mid-span (Fig. 2). The size of the column is 6″ along the span on the beam. Determine the width of the bearing plate, N, to transfer the load to the beam. Also check adequacy of the beam against web crippling at the location of the point load and provide your recommendation. Follow LRFD method. **(20)**

Fig.2



2. (a) Determine the maximum nominal tension (T_n) that may be transmitted through the bolted connection shown in Fig. 3 below. Consider bolt bearing and bolt shear limit states only. All bolts are $\frac{7}{8}$″ diam. A325 bolts (F_y = 90 ksi, F_u = 120 ksi) on standard holes. All plates are A36 material (F_y = 36 ksi, F_u = 58 ksi). **(15)**

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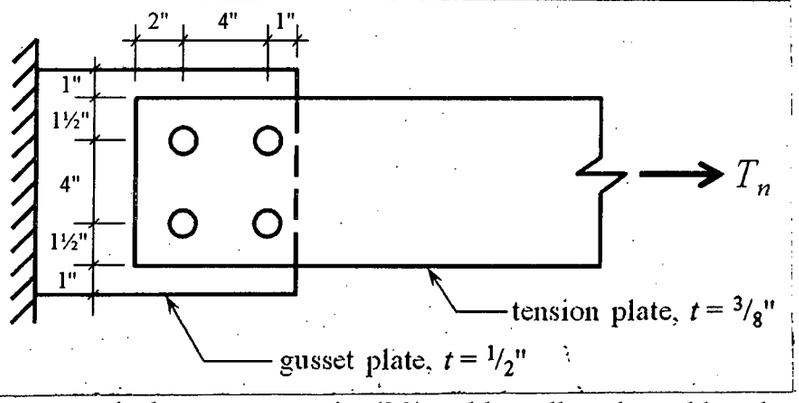
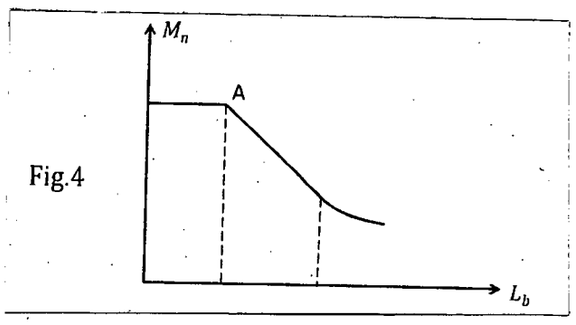
Contd ... Q. No. 2(a)

Fig.3



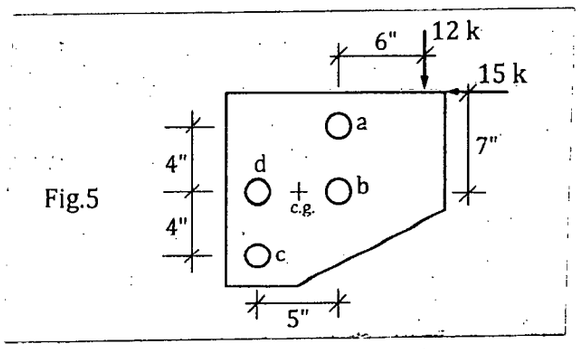
(b) The interaction between nominal moment capacity (M_n) and laterally unbraced length (L_b) of a *W* section beam may be represented graphically as shown in Fig. 4. For a *W*18×50 section with (F_y = 50 ksi), determine the moment and unbraced length corresponding to point *A* in Fig. 4. **(20)**

Fig.4



3. (a) Determine the resultant shear force in each bolt in the eccentrically loaded bolted connection shown in the Fig. 5. **(15)**

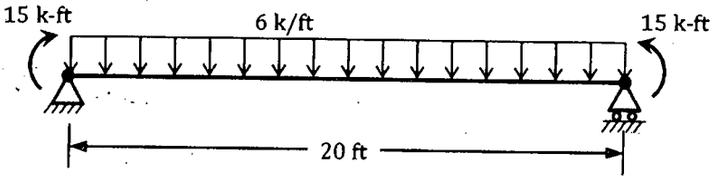
Fig.5



(b) Select the lightest and compact *W* section of *A*572 steel (F_y = 50 ksi, F_u = 65 ksi) to serve as a column of height 20′-0″with both ends fixed to carry an axial compressive dead load of 100 kip and live load of 180 kip. Follow ASD approach. **(20)**

4. (a) For the beam shown in Fig. 6, determine the value of beam parameter C_b. The beam is laterally unsupported except at the ends. **(15)**

Fig.6



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(b) The beam-column shown in the Fig. 7, is made of *A*992 steel (F_y = 50 ksi) pinned at both ends and is subjected to the loads shown. Bending is about the storage axis. Determine whether this member satisfies the approach and AISC Specification beam-column interaction equation. Follow LRFD approach and consider AISC moment amplification. The column is not braced except at the ends. Take for C_b = 1.32 flexure. **(20)**

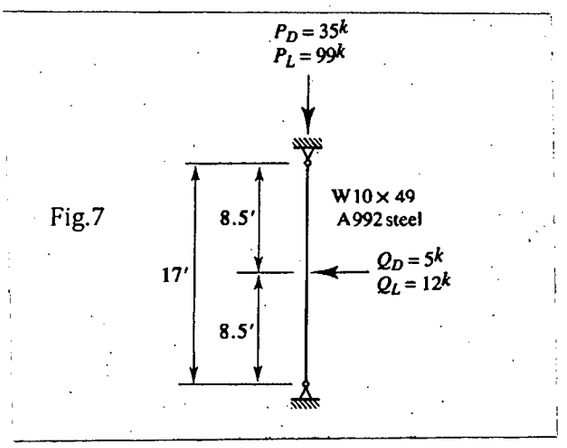

Fig.7

SECTION – B

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

5. (a) Name the basic types of welds, illustrating with neat sketches and mentioning their principal advantages in use. **(10)**

(b) The long leg of a L6 × 4 × 5/16 angle is to be welded to a $\frac{3}{8}''$ thick gusset plate Fig. 8 minimizing the effect of eccentricity and minimizing overlap. Design the fillet weld using E60 electrode and LRFD method to develop the full strength of the gusset plate or angle, which one controls, considering tension limit states (block shear strengths are not required to be considered). The angle is made of ASTM A992 steel (F_y = 50 ksi, F_u = 65 ksi) and the gusset plate is of ASTM A36 steel (F_y = 36 ksi, F_u = 58 ksi). Minimum size of fillet weld as per AISC Table J-2.4 is $\frac{3}{16}''$. U for the angle is to be determined from connection details and U for gusset plate is 1. Show your results on a sketch, complete with dimensions. Annexure-1 is provided to facilitate the design. **(25)**

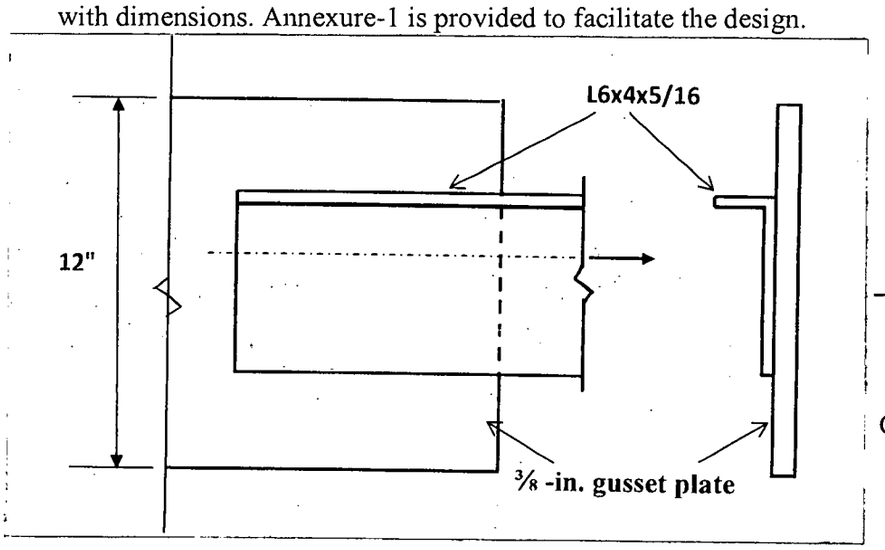

Fig. 8

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6. (a) In the connection shown in Fig. 9, the bolts are ¾-inch in diameter holes, and A36 steel is used for all components. Compute the design block shear strength of the connection in LRFD (Other limit states are not required to be considered). Hence determine the service load capacity in block shear, if service live load is three times the service dead load. Assume uniform tension. The gusset plate is $\frac{3}{8}''$ thick and the main plate is $\frac{7}{16}''$ thick. **(17)**

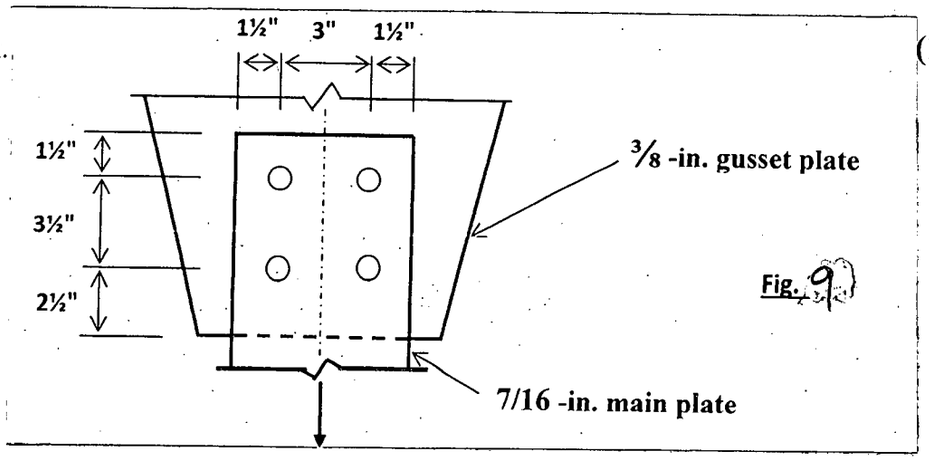

Fig. 9

(b) A standard hot-rolled W24 × 84 shape of A992 steel (F_y = 50 ksi, F_u = 65 ksi, E = 29000 ksi) is used for a simply supported beam of 30 ft span carrying a uniformly distributed service live load of 3.75 k/ft in addition to dead load. The beam has continuous lateral support and the maximum permissible live load deflection is L/240. Determine what maximum uniformly distributed service dead load it can carry in addition to is self weight to satisfy both strength and serviceability limit states. Use LRFD method. Beam bends about major axis. Annexture-2 is provided to facilitate the design. **(18)**

7. (a) Calculate the allowable strength (in ASD) of a W12 × 58 column section with a strong axis unbraced length of 24 ft and weak axis unbraced length of 12 ft. Assume ends of unbraced lengths as pinned. The material is ASTM A36 (F_y = 36 ksi, F_u = 58 ksi, E = 29000 ksi);. Annexure-2 is provided to facilitate design. **(17)**

(b) Using AISC LRFD method, design a square base plate for a W14 × 145 column (b_f = 15.5″ and d = 14.78″) carrying service axial loads of 398 kips dead load and 275 kips live load. Assume that a geometrically similar and concentric concrete pedestal will be under the base plate and the pedestal will have an area 2.25 times as that of the base plate. The material of the base plate is ASTM A36 steel (F_y = 36 ksi, F_u = 58 ksi, E = 29000 ksi); and the concrete has f'_c = 3 ksi. **(18)**

8. (a) Determine the effective length coefficients for the columns of the frame shown in Fig. 10. The moments of inertia for members in inch^4 are shown alongside the members. The correction factors for beam stiffnesses with far end of the beam hinged are ½ with

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

sideway and ¾ without sideway. Column BC and beam CF are rigidly connected at joint C, while beam HC is hinged at C. Annexure-3 provides necessary nomographs. **(17)**

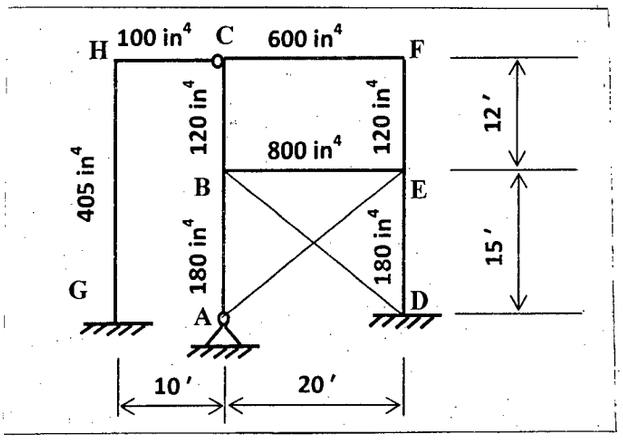


Fig. 10

(b) Compute the yield moment and plastic moment capacities and shape factor for major axis bending of the section shown in Fig. 11. Given F_y = 50 ksi, **(18)**

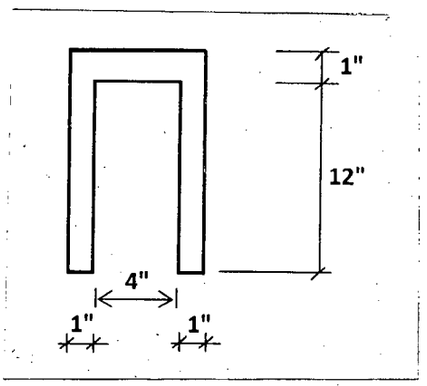


Fig. 11

Annex-A:

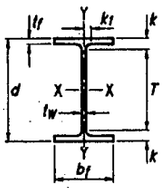


Table 1–1 (continued)
W Shapes
Dimensions

Table 1–1 (continued)
W Shapes
Properties

W14 – W12

Shape	Area, A	Depth, d	Web Thickness, t_w	Flange Width, b_f	Flange Thickness, t_f	Distance k_{des}	Distance k_{det}	Distance k_1	Distance T	Distance Workable Gage	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
	in.^{2}	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.^{4}	in.^{3}	in.	in.^{3}	in.^{4}	in.^{3}	in.	in.^{3}	in.	in.	in.^{4}	in.^{6}
W21×201	59.2	23.0	23	0.910	15/16	12.6	12 5/8	1.63	1 5/8	2.13	2 1/2	1 5/16	18	5 1/2	5310	461	9.47	530	542	86.1	3.02	133	3.55	21.4	40.9	62000
×182	53.6	22.7	22 3/4	0.830	13/16	12.5	12 1/2	1.48	1 1/2	1.98	2 3/8	1 1/4			4730	417	9.40	476	483	77.2	3.00	119	3.51	21.2	30.7	54400
×166	48.8	22.5	22 1/2	0.750	3/4	12.4	12 3/8	1.36	1 3/8	1.86	2 1/4	1 3/16			4280	380	9.36	432	435	70.0	2.99	108	3.48	21.1	23.6	48500
×147	43.2	22.1	22	0.720	3/4	12.5	12 1/2	1.15	1 1/8	1.65	2	1 3/16			3630	329	9.17	373	376	60.1	2.95	92.6	3.45	20.9	15.4	41100
×132	38.8	21.8	21 7/8	0.650	5/8	12.4	12 1/2	1.04	1 1/16	1.54	1 15/16	1 1/8			3220	295	9.12	333	333	53.5	2.93	82.3	3.42	20.8	11.3	36000
×122	35.9	21.7	21 5/8	0.600	5/8	12.4	12 3/8	0.960	15/16	1.46	1 13/16	1 1/8			2960	273	9.09	307	305	49.2	2.92	75.6	3.40	20.7	8.98	32700
×111	32.7	21.5	21 1/2	0.550	9/16	12.3	12 3/8	0.875	7/8	1.38	1 3/4	1 1/8			2670	249	9.05	279	274	44.5	2.90	68.2	3.37	20.6	6.83	29200
×101[c]	29.8	21.4	21 3/8	0.500	1/2	12.3	12 1/4	0.800	13/16	1.30	1 11/16	1 1/16			2420	227	9.02	253	248	40.3	2.89	61.7	3.35	20.6	5.21	26200
W21×93	27.3	21.6	21 5/8	0.580	9/16	8.42	8 3/8	0.930	15/16	1.43	1 5/8	15/16	18 3/8	5 1/2	2070	192	8.70	221	92.9	22.1	1.84	34.7	2.24	20.7	6.03	9940
×83[c]	24.3	21.4	21 3/8	0.515	1/2	8.36	8 3/8	0.835	13/16	1.34	1 1/2	7/8			1830	171	8.67	196	81.4	19.5	1.83	30.5	2.21	20.6	4.34	8630
×73[c]	21.5	21.2	21 1/4	0.455	7/16	8.30	8 1/4	0.740	3/4	1.24	1 7/16	7/8			1600	151	8.64	172	70.6	17.0	1.81	26.6	2.19	20.5	3.02	7410
×68[c]	20.0	21.1	21 1/8	0.430	7/16	8.27	8 1/4	0.685	11/16	1.19	1 3/8	7/8			1480	140	8.60	160	64.7	15.7	1.80	24.4	2.17	20.4	2.45	6760
×62[c]	18.3	21.0	21	0.400	3/8	8.24	8 1/4	0.615	5/8	1.12	1 5/16	13/16			1330	127	8.54	144	57.5	14.0	1.77	21.7	2.15	20.4	1.83	5960
×55[c]	16.2	20.8	20 3/4	0.375	3/8	8.22	8 1/4	0.522	1/2	1.02	1 3/16	13/16			1140	110	8.40	126	48.4	11.8	1.73	18.4	2.11	20.3	1.24	4980
×48[c,f]	14.1	20.6	20 5/8	0.350	3/8	8.14	8 1/8	0.430	7/16	0.930	1 1/8	13/16			959	93.0	8.24	107	38.7	9.52	1.66	14.9	2.05	20.2	0.803	3950
W18×71	20.8	18.5	18 1/2	0.495	1/2	7.64	7 5/8	0.810	13/16	1.21	1 1/2	7/8	15 1/2	3 1/2[g]	1170	127	7.50	146	60.3	15.8	1.70	24.7	2.05	17.7	3.49	4700
×65	19.1	18.4	18 3/8	0.450	7/16	7.59	7 5/8	0.750	3/4	1.15	1 7/16	7/8			1070	117	7.49	133	54.8	14.4	1.69	22.5	2.03	17.6	2.73	4240
×60[c]	17.6	18.2	18 1/4	0.415	7/16	7.56	7 1/2	0.695	11/16	1.10	1 3/8	13/16			984	108	7.47	123	50.1	13.3	1.68	20.6	2.02	17.5	2.17	3850
×55[c]	16.2	18.1	18 1/8	0.390	3/8	7.53	7 1/2	0.630	5/8	1.03	1 5/16	13/16			890	98.3	7.41	112	44.9	11.9	1.67	18.5	2.00	17.5	1.66	3430
×50[c]	14.7	18.0	18	0.355	3/8	7.50	7 1/2	0.570	9/16	0.972	1 1/4	13/16			800	88.9	7.38	101	40.1	10.7	1.65	16.6	1.98	17.4	1.24	3040
W14×132	38.8	14.7	14 5/8	0.645	5/8	14.7	14 3/4	1.03	1	1.63	2 5/16	1 9/16	10	5 1/2	1530	209	6.28	234	548	74.5	3.76	113	4.23	13.6	12.3	25500
×120	35.3	14.5	14 1/2	0.590	9/16	14.7	14 5/8	0.940	15/16	1.54	2 1/4	1 1/2			1380	190	6.24	212	495	67.5	3.74	102	4.20	13.5	9.37	22700
×109	32.0	14.3	14 3/8	0.525	1/2	14.6	14 5/8	0.860	7/8	1.46	2 3/16	1 1/2			1240	173	6.22	192	447	61.2	3.73	92.7	4.17	13.5	7.12	20200
×99[f]	29.1	14.2	14 1/8	0.485	1/2	14.6	14 5/8	0.780	3/4	1.38	2 1/16	1 7/16			1110	157	6.17	173	402	55.2	3.71	83.6	4.14	13.4	5.37	18000
×90[f]	26.5	14.0	14	0.440	7/16	14.5	14 1/2	0.710	11/16	1.31	2	1 7/16			999	143	6.14	157	362	49.9	3.70	75.6	4.11	13.3	4.06	16000
W14×82	24.0	14.3	14 1/4	0.510	1/2	10.1	10 1/8	0.855	7/8	1.45	1 11/16	1 1/16	10 7/8	5 1/2	881	123	6.05	139	148	29.3	2.48	44.8	2.85	13.5	5.07	6710
×74	21.8	14.2	14 1/8	0.450	7/16	10.1	10 1/8	0.785	13/16	1.38	1 5/8	1 1/16			795	112	6.04	126	134	26.6	2.48	40.5	2.82	13.4	3.87	5990
×68	20.0	14.0	14	0.415	7/16	10.0	10	0.720	3/4	1.31	1 9/16	1 1/16			722	103	6.01	115	121	24.2	2.46	36.9	2.80	13.3	3.01	5380
×61	17.9	13.9	13 7/8	0.375	3/8	10.0	10	0.645	5/8	1.24	1 1/2	1			640	92.1	5.98	102	107	21.5	2.45	32.8	2.78	13.2	2.19	4710
W14×53	15.6	13.9	13 7/8	0.370	3/8	8.06	8	0.660	11/16	1.25	1 1/2	1	10 7/8	5 1/2	541	77.8	5.89	87.1	57.7	14.3	1.92	22.0	2.22	13.3	1.94	2540
×48	14.1	13.8	13 3/4	0.340	5/16	8.03	8	0.595	5/8	1.19	1 7/16	1			484	70.2	5.85	78.4	51.4	12.8	1.91	19.6	2.20	13.2	1.45	2240
×43[c]	12.6	13.7	13 5/8	0.305	5/16	8.00	8	0.530	1/2	1.12	1 3/8	1			428	62.6	5.82	69.6	45.2	11.3	1.89	17.3	2.18	13.1	1.05	1950
W12×58	17.0	12.2	12 1/4	0.360	3/8	10.0	10	0.640	5/8	1.24	1 1/2	15/16	9 1/4	5 1/2	475	78.0	5.28	86.4	107	21.4	2.51	32.5	2.82	11.6	2.10	3570
X53	15.6	12.1	12	0.345	3/8	10.0	10	0.575	9/16	1.18	1 3/8	15/16	9 1/4	5 1/2	425	70.6	5.23	77.9	95.8	19.2	2.48	29.1	2.79	11.5	1.58	3160
W12×50	14.6	12.2	12 1/4	0.370	3/8	8.08	8 1/8	0.640	5/8	1.14	1 1/2	15/16	9 1/4	5 1/2	391	64.2	5.18	71.9	56.3	13.9	1.96	21.3	2.25	11.6	1.71	1880
×45	13.1	12.1	12	0.335	5/16	8.05	8	0.575	9/16	1.08	1 3/8	15/16			348	57.7	5.15	64.2	50.0	12.4	1.95	19.0	2.23	11.5	1.26	1650
×40	11.7	11.9	12	0.295	5/16	8.01	8	0.515	1/2	1.02	1 3/8	7/8			307	51.5	5.13	57.0	44.1	11.0	1.94	16.8	2.21	11.4	0.906	1440
W12×35[c]	10.3	12.5	12 1/2	0.300	5/16	6.56	6 1/2	0.520	1/2	0.820	1 3/16	3/4	10 1/8	3 1/2	285	45.6	5.25	51.2	24.5	7.47	1.54	11.5	1.79	12.0	0.741	879
×30[c]	8.79	12.3	12 3/8	0.260	1/4	6.52	6 1/2	0.440	7/16	0.740	1 1/8	3/4			238	38.6	5.21	43.1	20.3	6.24	1.52	9.56	1.77	11.9	0.457	720
×26[c]	7.65	12.2	12 1/4	0.230	1/4	6.49	6 1/2	0.380	3/8	0.680	1 1/16	3/4			204	33.4	5.17	37.2	17.3	5.34	1.51	8.17	1.75	11.8	0.300	607
W12×22[c]	6.48	12.3	12 1/4	0.260	1/4	4.03	4	0.425	7/16	0.725	15/16	5/8	10 3/8	2 1/4[g]	156	25.4	4.91	29.3	4.66	2.31	0.848	3.66	1.04	11.9	0.293	164
×19[c]	5.57	12.2	12 1/8	0.235	1/4	4.01	4	0.350	3/8	0.650	7/8	9/16			130	21.3	4.82	24.7	3.76	1.88	0.822	2.98	1.02	11.8	0.180	131
×16[c]	4.71	12.0	12	0.220	1/4	3.99	4	0.265	1/4	0.565	13/16	9/16			103	17.1	4.67	20.1	2.82	1.41	0.773	2.26	0.982	11.7	0.103	96.9
×14[c,v]	4.16	11.9	11 7/8	0.200	3/16	3.97	4	0.225	1/4	0.525	3/4	9/16			88.6	14.9	4.62	17.4	2.36	1.19	0.753	1.90	0.962	11.7	0.0704	80.4
W10×112	32.9	11.4	11 3/8	0.755	3/4	10.4	10 3/8	1.25	1 1/4	1.75	1 15/16	1	7 1/2	5 1/2	716	126	4.66	147	236	45.3	2.68	69.2	3.07	10.1	15.1	6020
×100	29.4	11.1	11 1/8	0.680	11/16	10.3	10 3/8	1.12	1 1/8	1.62	1 13/16	1			623	112	4.60	130	207	40.0	2.65	61.0	3.03	10.0	10.9	5150
×88	25.9	10.8	10 7/8	0.605	5/8	10.3	10 1/4	0.990	1	1.49	1 11/16	15/16			534	98.5	4.54	113	179	34.8	2.63	53.1	2.99	9.85	7.53	4330
×77	22.6	10.6	10 5/8	0.530	1/2	10.2	10 1/4	0.870	7/8	1.37	1 9/16	7/8			455	85.9	4.49	97.6	154	30.1	2.60	45.9	2.95	9.73	5.11	3630
×68	20.0	10.4	10 3/8	0.470	1/2	10.1	10 1/8	0.770	3/4	1.27	1 7/16	7/8			394	75.7	4.44	85.3	134	26.4	2.59	40.1	2.91	9.63	3.56	3100
×60	17.6	10.2	10 1/4	0.420	7/16	10.1	10 1/8	0.680	11/16	1.18	1 3/8	13/16			341	66.7	4.39	74.6	116	23.0	2.57	35.0	2.88	9.54	2.48	2640
×54	15.8	10.1	10 1/8	0.370	3/8	10.0	10	0.615	5/8	1.12	1 5/16	13/16			303	60.0	4.37	66.6	103	20.6	2.56	31.3	2.86	9.48	1.82	2320
×49	14.4	10.0	10	0.340	5/16	10.0	10	0.560	9/16	1.06	1 1/4	13/16			272	54.6	4.35	60.4	93.4	18.7	2.54	28.3	2.84	9.42	1.39	2070

Note: Use decimal values of t_w, b_f, t_f etc. in your calculations.

Annex-B

Beam LTB formulae:

$$\frac{L_p}{r_y} = 1.76\sqrt{\frac{E}{F_y}}$$

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

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

Beam web crippling formulae:

For interior loads, (i.e., point load acts at $d/2$ or more from member end)

$$R_n = 0.80 t_w^2\left[1+3\left(\frac{N}{d}\right)\left(\frac{t_w}{t_f}\right)^{1.5}\right]\sqrt{\frac{EF_{yw}t_f}{t_w}}$$

$$= 136 t_w^2\left[1+3\left(\frac{N}{d}\right)\left(\frac{t_w}{t_f}\right)^{1.5}\right]\sqrt{\frac{F_{yw}t_f}{t_w}}$$

For exterior loads, (i.e., point load acts at less than $d/2$ distance from end)

For $N/d \le 0.2$

$$R_n = 0.40 t_w^2\left[1+3\left(\frac{N}{d}\right)\left(\frac{t_w}{t_f}\right)^{1.5}\right]\sqrt{\frac{EF_{yw}t_f}{t_w}}$$

$$= 68 t_w^2\left[1+3\left(\frac{N}{d}\right)\left(\frac{t_w}{t_f}\right)^{1.5}\right]\sqrt{\frac{F_{yw}t_f}{t_w}}$$

For $N/d > 0.2$

$$R_n = 0.40 t_w^2\left[1+\left(\frac{4N}{d}-0.2\right)\left(\frac{t_w}{t_f}\right)^{1.5}\right]\sqrt{\frac{EF_{yw}t_f}{t_w}}$$

$$= 68 t_w^2\left[1+\left(\frac{4N}{d}-0.2\right)\left(\frac{t_w}{t_f}\right)^{1.5}\right]\sqrt{\frac{F_{yw}t_f}{t_w}}$$

ANNEXURE-1

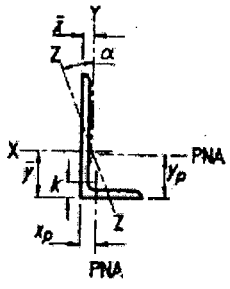


Table 1–7 (continued)
Angles
Properties

Shape	k	Wt.	Area, A	Axis X-X						Flexural-Torsional Properties		
				I	S	r	$\bar{y}$	Z	y_p	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.
L6×4×7/8	1 3/8	27.2	7.98	27.7	7.13	1.86	2.12	12.7	1.44	2.03	4.04	2.82
×3/4	1 1/4	23.6	6.94	24.5	6.23	1.88	2.07	11.1	1.38	1.31	2.64	2.85
×5/8	1 1/8	20.0	5.86	21.0	5.29	1.89	2.03	9.44	1.31	0.775	1.59	2.88
×9/16	1 1/16	18.1	5.31	19.2	4.81	1.90	2.00	8.59	1.28	0.572	1.18	2.90
×1/2	1	16.2	4.75	17.3	4.31	1.91	1.98	7.71	1.25	0.407	0.843	2.91
×7/16	15/16	14.3	4.18	15.4	3.81	1.92	1.95	6.81	1.22	0.276	0.575	2.93
×3/8	7/8	12.3	3.61	13.4	3.30	1.93	1.93	5.89	1.19	0.177	0.369	2.94
×5/16	13/16	10.3	3.03	11.4	2.77	1.94	1.90	4.96	1.16	0.104	0.217	2.96

Shape	Axis Y-Y						Axis Z-Z				Q_s
	I	S	r	$\bar{x}$	Z	x_p	I	S	r	Tan α	$F_y = 36$ ksi
	in.^{4}	in.^{3}	in.	in.	in.^{3}	in.	in.^{4}	in.^{3}	in.		
L6×4×7/8	9.70	3.37	1.10	1.12	6.26	0.665	5.82	1.90	0.854	0.421	1.00
×3/4	8.63	2.95	1.12	1.07	5.42	0.578	5.08	1.66	0.856	0.428	1.00
×5/8	7.48	2.52	1.13	1.03	4.56	0.488	4.32	1.42	0.859	0.435	1.00
×9/16	6.86	2.29	1.14	1.00	4.13	0.442	3.94	1.30	0.861	0.438	1.00
×1/2	6.22	2.06	1.14	0.981	3.69	0.396	3.55	1.17	0.864	0.440	1.00
×7/16	5.56	1.83	1.15	0.957	3.24	0.349	3.14	1.04	0.867	0.443	0.973
×3/8	4.86	1.58	1.16	0.933	2.79	0.301	2.73	0.908	0.870	0.446	0.912
×5/16	4.13	1.34	1.17	0.908	2.33	0.252	2.31	0.769	0.874	0.449	0.826

ANNEXURE-2

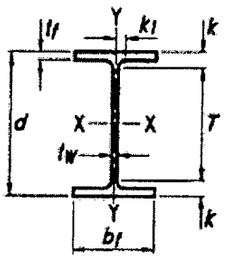
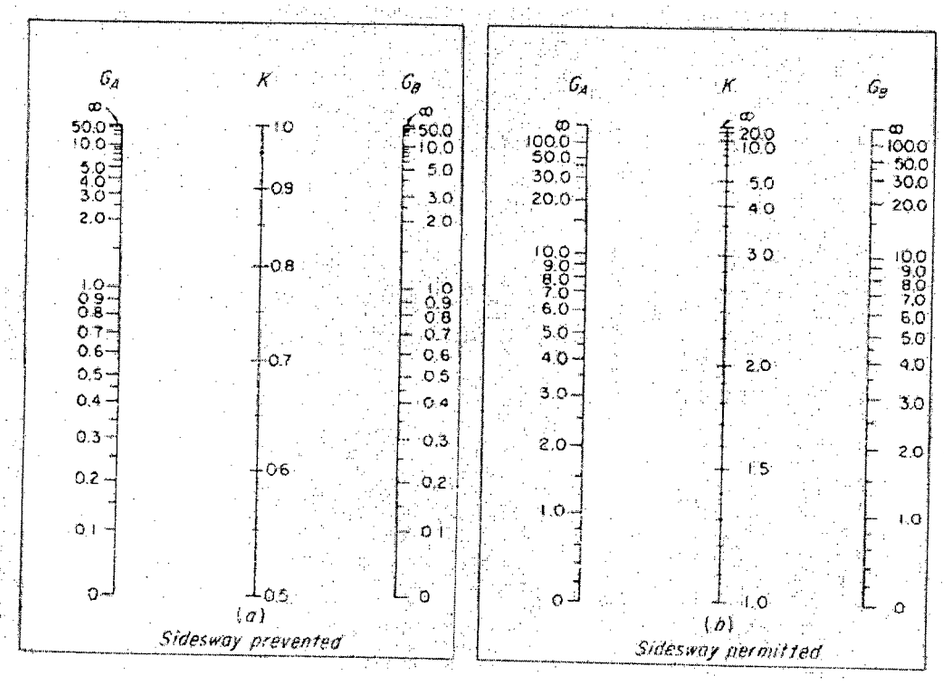


Table 1–1 (continued)
W Shapes
Dimensions

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}	Distance: k_1	Distance: T	Distance: Workable Gage
	in.^{2}	in.	in.		in.	in.		in.		in.	in.	in.	in.	in.
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		
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

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}
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
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

ANNEXURE-3



Nomograph for effective length of columns.

L-3/T-2/CE **Date : 23/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2014-2015

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** questions.

1. (a) "In terms of involvement of Environmental Engineers, environment can take global, local or contained dimension"-Explain the statement. **(9)**

   (b) State the health effects of environmental pollution. **(15⅔)**

   (c) What are the consequences of global warming? **(8)**

   (d) How will you ensure no risk of contamination of water supply to a building? **(6)**

   (e) List the principles of design of water supply piping of a building. **(8)**

2. (a) Given:

   - 40-story building 11 ft floor to floor.
   - 60 psi at public main.
   - Flush-valve fixture except on the top most two floors where flush-tank fixtures are used.
   - Maximum pressure at any fixture is not to exceed 50 psi.
   - Fixture pressure varies from 4 psi to 7 psi for flush-tank fixtures.
   - Fixture pressure varies from 8 psi to 15 psi for flush-valve fixtures
   - Pressure loss in the water meter is 5 psi.
   - Public main is 65 ft away from the foot of the riser.
   - The pressure loss is 9 psi/100 ft for a 3-inch main and that is 2 psi/100 ft for a 4-inch main

   Assume reasonable values for missing data if required. Determine zoning of the building for water supply. **(15)**

   (b) What are the salient features of the principal systems of plumbing drainage? Which system do you prefer and why? Explain. **(10)**

   (c) Show in a diagram the global intervention logic concerning public health, economy and sustainable eco-system. **(10)**

   (d) Discuss the criteria to measure sustainable performance of water supply and sanitation systems. **(11⅔)**

Contd P/2

CE 333

3. (a) A waste stabilization pond system is to be designed for treatment of a municipal wastewater having a flow rate of 30 m^3/h and an initial BOD_5 = 180 mg/L. There will be one anaerobic, one facultative and two maturation ponds in series. The BOD_5 removal efficiency in the anaerobic pond is 40%. Design the facultative pond of the system to ensure influent BOD_5 = 50 mg/L to the first maturation pond. Show adequate checks for volumetric loading rate (λ_v) and surface loading rate (λ_s) for the facultative pond. Draw relevant plan and section views of the pond. **(20)**

Given: BOD rate constant (base e), $k_1 = 0.23d^{-1}$ at 20°C. Design temperature, T = 30°C. Assume reasonable value of any missing data if required.

(b) What are the purposes of aeration in an activated sludge system? Which F/M ratio is desirable in treatment of municipal wastewaters and why? Explain. **(8)**

(c) Draw a schematic diagram for a Trickling Filter System. "Although a trickling filter is considered as an aerobic treatment device, it is not a true aerobic system" – Explain the statement. **(18⅔)**

4. (a) State and derive Marai's Theorem related to efficiency of wastewater treatment in a series of ponds. **(10)**

(b) Name different primary units used in domestic wastewater treatment facilities. What are the functions of screen and communitor? Where are these units usually placed in the treatment flow diagram of wastewaters? **(10)**

(c) Classify bacteria based on energy source and carbon source for cell synthesis. Describe the differential steps involved in bacterial metabolism. **(11⅔)**

(d) What is the difference between CBOD and NBOD? Explain with necessary diagram. For a BOD test at 25°C, initial DO = 7.5 mg/L. DO_5 = 2.8 mg/L. Dilution factor = 50, k_1 (base e) = $0.20d^{-1}$ at 20°C, and $\theta = 1.047$. **(15)**

Calculate : (i) BOD_5 at 20°C.

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

SECTION – B

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

5. (a) From the data given below calculate the portions of individual grab samples to be combined into an 8-hr composite. The desired volume of the composite is 4000 mL. Also plot the wastewater flows and determine the mean and standard deviation of the flow data. **(16⅔)**

Time (hr)	0700	0900	1100	1300	1500	1700	1900	2100	2300	0100	0300	0500	0700
Flow Meter Reading (m^3)	48205	48243	48280	48334	48414	48483	48544	48606	48651	48675	48699	48710	48720

Contd... P/3

CE 333

Contd ... Q. No. 5

(b) Draw a schematic diagram representing an ETP of a Textile Industry employing only the Physico-chemical processes. On a certain workday it was observed that the flocs are breaking up at the flocculation chamber. Being the Environmental Engineer in charge of ETP operations, it is your responsibility to identify the reasons for the above problem. List the probable reasons for such occurrence, and locate on your schematic diagram the sampling locations to identify the problem. **(14)**

(c) Draw the sectional view and plan of a Bell mouth junction where two different sized circular sewers meet an acute angle. **(8)**

(d) From an engineer's point of view, explain how a sewer system design differs from the design of a water supply system. Where should one start laying out the sewer network? Why? **(8)**

6. (a) Design a suitable latrine for a family of 9 members in a village where tubewell based water supply is available, but mechanical desludging facilities are not available. Estimated water use for the latrine is 10 lpcd; and long-term infiltration capacity of soil is 25 L/m^2.day. The groundwater table is 3.5 m below ground surface. The pit is to be constructed with concrete rings. Two types of concrete rings are available in the market: 1.0 m diameter and 1.5 m diameter; all rings are 0.3 m in depth. **(26⅔)**

(i) What type of latrine would you suggest for the family? Explain.

(ii) Design the latrine (including venting system) using one of the two types of concrete rings that satisfy the design criteria, and estimate its design life.

(iii) Draw a neat sketch (both plan and section) showing all elements of the designed latrine.

(iv) Draw a neat sketch of the same latrine considering that it is located in a high water table area (but not flood-prone area).

[Assume reasonable values for parameters not given]

(b) What do you understand by small bore sewerage (SBS) system? How does sewer network design of SBS system differ from that of conventional sewerage system? Explain. **(10)**

(c) What do you know about the present status of sanitation coverage in Bangladesh? Discuss briefly. What do you understand by fecal sludge, septage, and fecal sludge management (FSM)? What are the system elements of a FSM system? Show with a neat sketch. **(10)**

Contd P/4

CE 333

7. (a) Plot the following effluent data of a wastewater treatment plant collected over a 24 month period on the attached graph paper using Boom's Transformation and answer the following: **(22⅔)**

(i) How many days in a year the COD value will exceed 20 mg/L.

(ii) What are the geometric mean and corresponding standard deviation?

(iii) What are the coefficients of skewness and kurtosis? Comment on their values

Month	COD (mg/L)	Month	COD (mg/L)	Month	COD (mg/L)
1	15.00	9	18.75	17	17.90
2	11.25	10	37.50	18	11.35
3	35.35	11	27.00	19	25.20
4	13.60	12	23.30	20	16.10
5	14.0	13	46.60	21	16.75
6	15.75	14	36.25	22	15.80
7	16.80	15	30.00	23	19.50
8	15.20	16	25.75	24	9.40

(b) What is a hydraulic element diagram? Describe the special features of a hydraulic element diagram along with their use. **(8)**

(c) Draw a definition sketch showing the different types of sewers in a collection system. Also, define each type of sewer. **(8)**

(d) What are the advantages of using Glassfiber Reinforced Pipes (GRP) over RCC pipes in sewer system? Also briefly explain what protection measures are taken to protect against sulfide attack in these two types of sewer pipes. **(8)**

8. (a) Design a "septic tank system" for a family of 11 members. The estimated wastewater flow rate is 80 lpcd and the tank is to be desludged every 3 years. The hydraulic detention time of the tank should be at least 1 day in order to maintain acceptable effluent quality. The long-term infiltration capacity of soil is 50 L/m^2.day. **(26⅔)**

Draw:

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

(ii) A section showing depths of different zones of the septic tank, and

(iii) A section showing the positions and dimensions/sizes of inlet and outlet devices.

[Consider a design temperature of 26°C; assume reasonable values for parameters not given]

(b) Draw neat sketches of a "simple pit latrine" and a "VIP latrine". Explain the relative advantages of a VIP latrine over a pit latrine. Why do we expect reduced insect nuisance in a VIP latrine? Explain. **(10)**

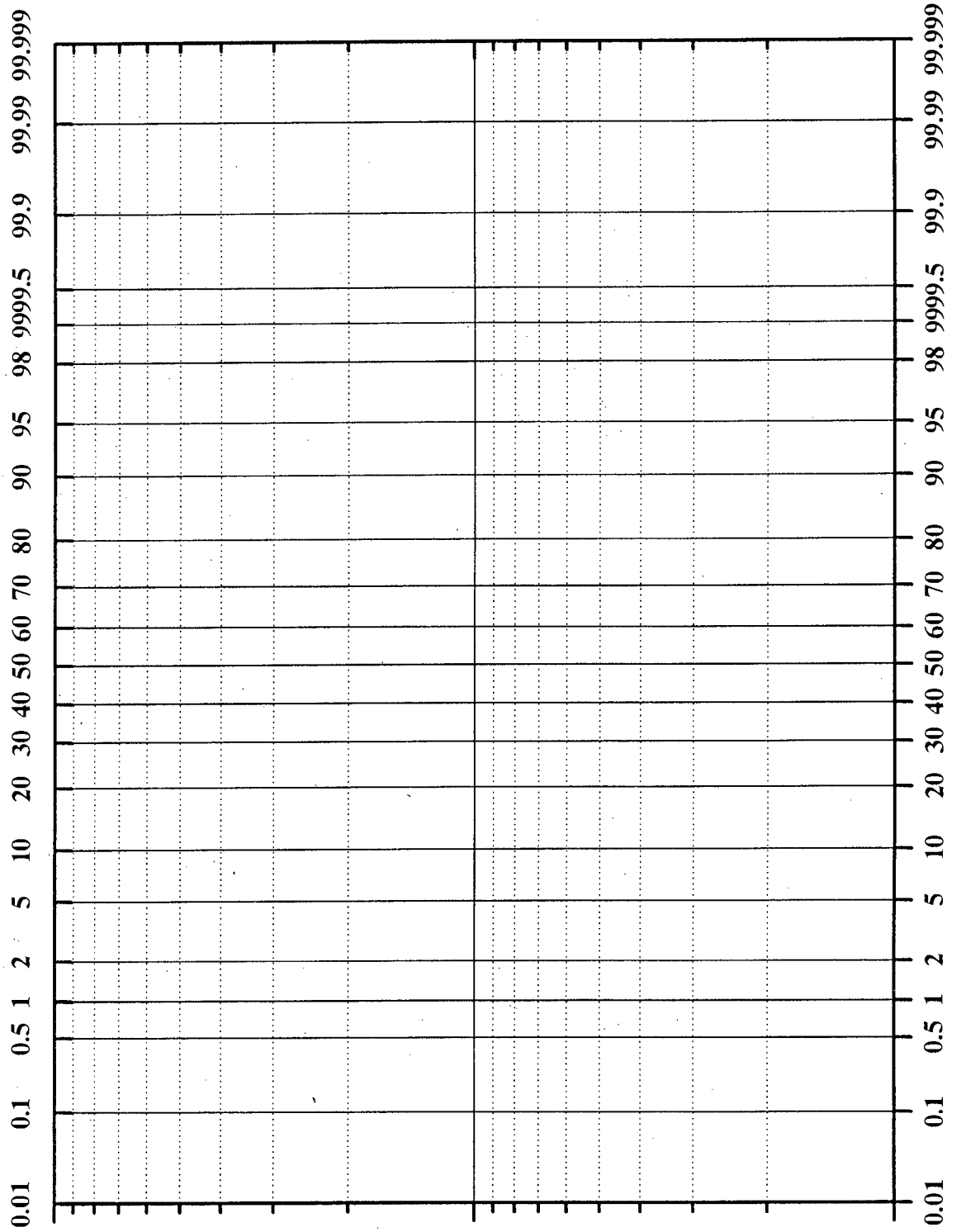
Contd P/5

CE 333

Contd ... Q. No. 8

(c) What do you understand by "hard to reach" (HtR) areas and "hard to reach people" in the context of water supply and sanitation in Bangladesh? Identify the hard to reach areas in Bangladesh. **(5)**

(d) What are the most common reasons of fecal contamination of water drawn from shallow tubewells in Bangladesh? What is the "Thumb rule" for locating a latrine with respect to a tubewell? **(5)**



Graph paper for Ques. 7(a)

L-3/T-2/CE **Date : 27/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2014-2015

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

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

Use USD Method of Design. Assume reasonable value for any missing data.

1. (a) Why is φ value for compression lower than those for flexure or shear? What does the horizontal cut-off in the ACI/BNBC design strength interaction diagram signify? **(7)**

(b) A 16 × 28 inch column is reinforced with Ten No. 9 bars as shown in Fig. 1. Construct the nominal strength interaction diagram for the column with fiver points corresponding to pure axial load, pure bending, balance condition, $\varepsilon_s = 0.001$ (tensile) and $\varepsilon_s = 0.004$ (tensile). Also find corresponding ϕ for the above points. Assume bending about Y-Y axis. Given: $f_c' = 4$ ksi and $f_y = 60$ ksi. **(28)**

2. (a) A ground floor column of a 12-storied building is to be designed for the following load combinations (axial force and uniaxial bending)- **(17)**

Gravity load combination	$P_u = 3000$ kip, $M_u = 100$ kip-ft
Lateral load combination	$P_u = 2000$ kip, $M_u = 1000$ kip-ft

Architectural considerations require that a circular tied column of 40 in. diameter is to be used. Material strengths are $f_c' = 4$ ksi and $f_y = 60$ ksi.

Find the required column reinforcement and show in sketch. Use supplied column strength interaction design chart assuming reinforcement distributed along the perimeter and $\gamma = 0.9$.

(b) A $60'' \times 60''$ square pier of a bridge is reinforced with seventy-two No-9 bars arranged uniformly around the 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: **(18)**

$$P_u = 4000 \text{ kip}, M_{ux} = 4000 \text{ kip - ft}, M_{uy} = 5000 \text{ kip - ft}$$

Use supplied column strength interaction diagram chart assuming $\gamma = 0.9$.

3. (a) A circular spirally reinforced column carries unfactored working loads: $P_{DL} = 800$ kip and $P_{LL} = 500$ kip. Design the column with about 2.5% reinforcement. Also design the ACI spiral. Given: $f_c' = 4.5$ ksi and $f_y = 72.5$ ksi. **(11)**

Contd P/2

CE 317

Contd... Q. No. 3

(b) A shear wall of a 18-storey building is subjected to following factored loads: **(17)**

$P_u = 700$ kip

$V_u = 500$ kip

$M_u = 6000$ kip-ft

The wall is 20 ft long, 180 ft high and 12 inch thick. Design the shear wall with $f_c' = 4$ ksi and $f_y = 60$ ksi. Ignore axial force as it is less than balanced load of the section.

(c) Explain the Seismic design philosophy under different levels of earthquakes. **(7)**

4. (a) Write the seismic detailing provisions of a two-way slab without beam, which is part of an IMRF system, as per BNBC. **(10)**

(b) Describe briefly the different stages of loading in which a prestressed concrete member is often subjected. **(8)**

(c) A section of a composite beam is shown in Fig. 2. The effective prestress is 2000 kN assuming the total loss as 20%. Compute the stresses in concrete various stages, if the bending moments at the section are as follows: **(17)**

(i) due to self weight of precast portion = 150 kN-m

(ii) due to self weight of top slab (cast-in-place) = 50 kN-m

(iii) due to live load (composite section) = 200 kN-m

SECTION – B

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

5. (a) A commercial building is to be designed using a flat plate floor system. The interior columns are $24'' \times 24''$ and they are spaced 20 ft c/c in one direction and 24 ft c/c in other direction. Design an interior panel slab ($24' \times 20'$) and show the reinforcements with neat sketches. Specified live load = 60 psf; Floor finish and partition wall load = 50 psf in addition to the self weight of floor slab. Given: $f_c' = 3.5$ ksi and $f_y = 60$ ksi. **(20)**

(b) Compute the stresses in concrete at section 1-1 of the beam shown in Fig. 3. The prestressing tendon is straight and located as shown. It produces an effective prestress F = 2000 kN. Follow any method (concept) for your calculation. **(15)**

6. (a) Design a square footing for an interior column that carries total working DL = 500 kip and LL = 400 kips. The columns are $24'' \times 24''$ in cross-section. Allowable bearing capacity of soil is 4.0 ksf. The bottom of the footing is 6 ft below existing ground level. Show the reinforcements in plan and section with neat sketches. **(18)**

Contd P/3

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Contd... Q. No. 6

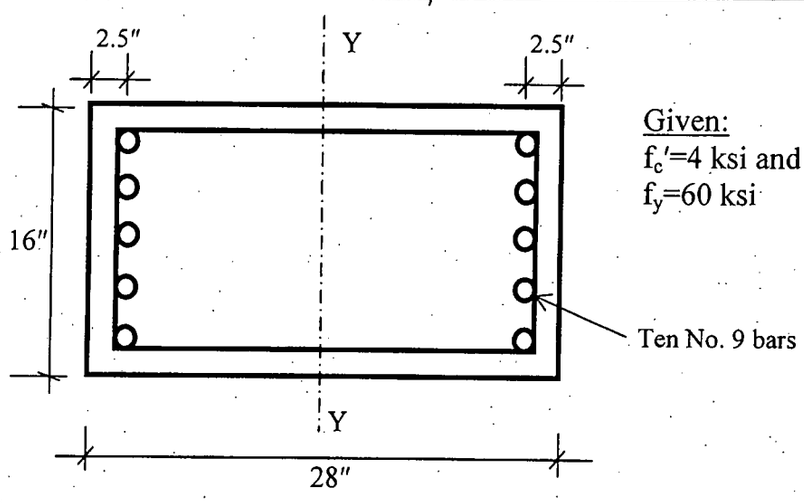
(b) A flat plate floor has thickness h = 7″ and is supported by 18″×18″ columns spaced 21 ft on centers each way. The floor will carry a DL = 170 psf (including self wt) and LL = 100 psf. Check the adequacy of the slab in resisting punching shear. If found inadequate, design the punching shear reinforcement. Material strengths are: $f_c' = 3.5$ ksi and $f_y = 60$ ksi. **(17)**

7. (a) Compare in brief, prestressed concrete with reinforced concrete with respect to serviceability, safety and economy. **(10)**

(b) Two interior columns for a high rise building are spaced 14 ft apart and each carries service DL = 450 kip and LL = 300 kip. The columns are 24″×24″ in cross-section and they 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 6000 psf. The bottom of the footing will be 6 ft below grade. Design the footing for these columns, using $f_c' = 3$ ksi and $f_y = 60$ ksi. Show the reinforcements in plan and sections. **(25)**

8. (a) The plan of the pile cap with 12 Nos. 20″ diameter cast-in-situ piles with the column (30″×30″) is shown in Fig. 4. The column carries a DL = 1000 kip and LL = 600 kip (working). Individual pile capacity is adequate. Design the pile cap. Given: $f_c' = 3.5$ kip and $f_y = 60$ ksi. **(17)**

(b) A post-tensioned concrete member shown in Fig. 5 is prestressed with 820 mm^2 of steel wires which are anchored with a stress of 1300 MPa. Compute the loss of prestress at sec 1-1 of the beam due to elastic shortening of concrete. Use n = 6 and solve the problem using both gross and transformed area of the beam section. Consider self wt. of the beam for your calculation. **(18)**



Given:
f_c'=4 ksi and
f_y=60 ksi

Fig. 1

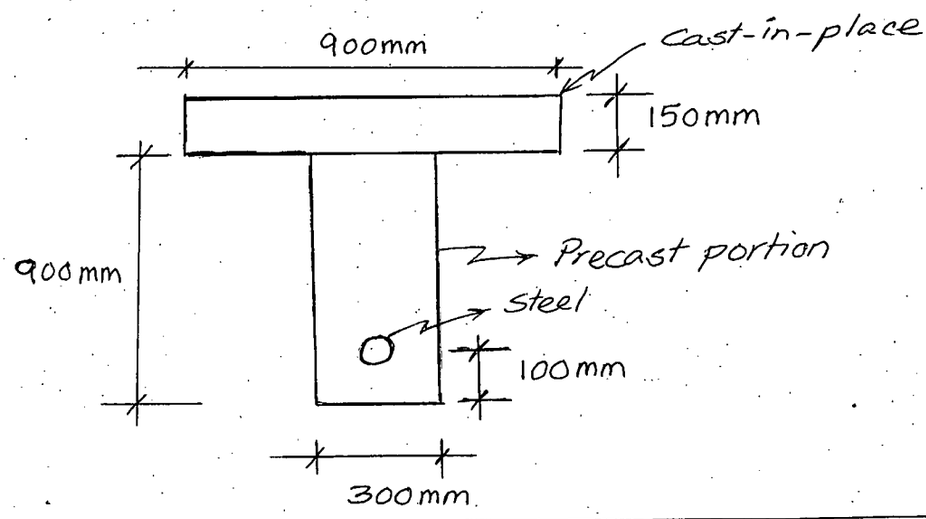


Fig. 2

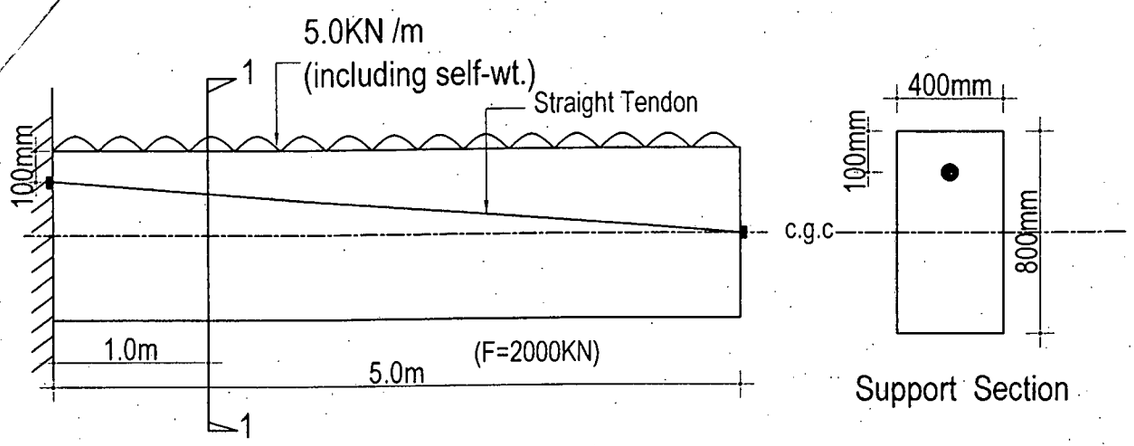
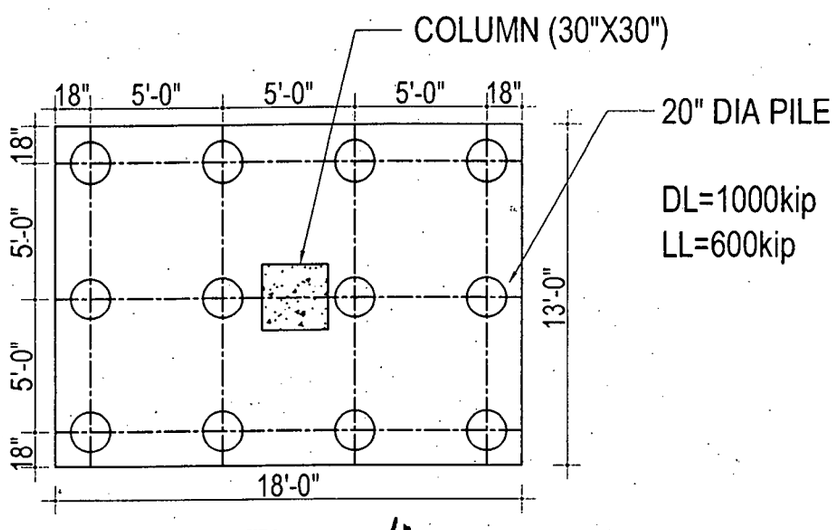


Fig- 3



DL=1000kip
LL=600kip

Fig- 4

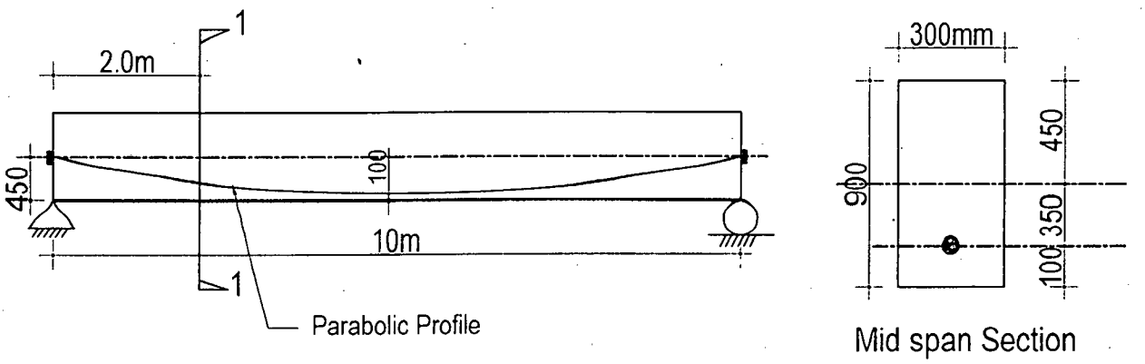
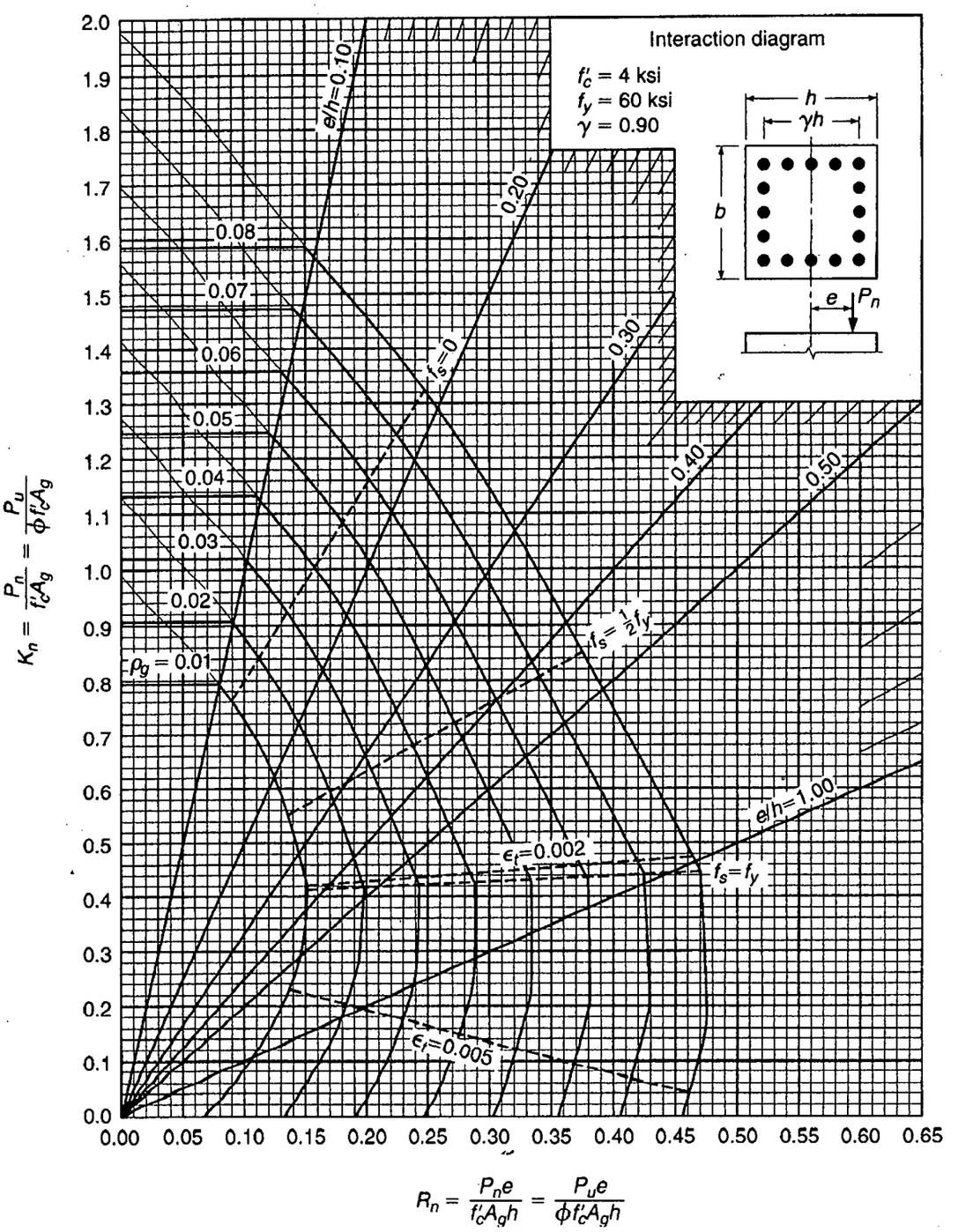
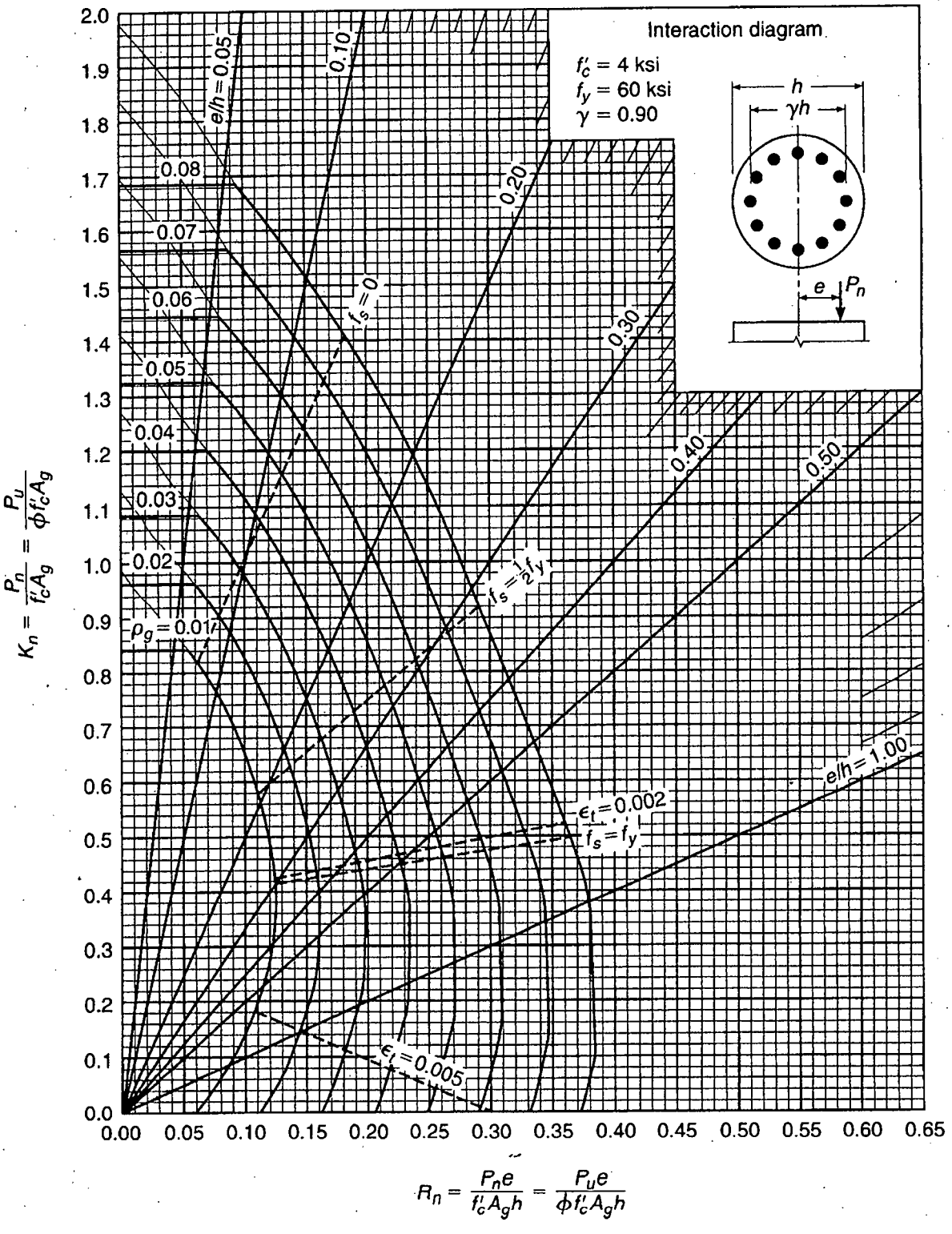


Fig- 5



GRAPH A.8
Column strength interaction diagram for rectangular section with bars on four faces and $\gamma = 0.90$.

Design of Concrete structures, 14th Ed
— Nilson, Darwin, Dolan



GRAPH A.16
Column strength interaction diagram for circular section with $\gamma = 0.90$.

L-3/T-2/CE **Date : 01/08/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2014-2015

Sub : **CE 351** (Transportation Engineering I)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) What is meant by "Transportation Planning"? Explain 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) Determine the minimum passing sight distance for a two-lane, two-way highway for the following conditions: **(12)**

Average speed of the passing vehicle	51mph
Average speed of the passed vehicle	41mph
Time of preliminary delay for passing vehicle	4 sec
Average acceleration rate for passing vehicle	1.43 mph ps
Time passing vehicle occupies the opposite lane	10 sec
Safe clearance distance	180 ft.

2. (a) Explain the followings: **(12)**

   (i) Design Speed (ii) Design Designation (iii) Pavement Crown (iv) Shoulder

   (b) Explain with diagram the general classification of road traffic islands. **(12)**

   (c) A new office building is expected to add 1000 pedestrians to a 20 ft. sidewalk during the peak 10 min. period. The sidewalk already has a flow of 1200 pedestrians during the peak period. Around 3 ft. of the width of the sidewalk is used for light posts and other obstructions. Make your comment on the level of service for the sidewalk. **(11)**

3. (a) Explain the factors involved in transportation crashes. **(12)**

   (b) Explain recognized bicycle facilities in a roadway for safe bicycle movement. **(12)**

   (c) A calibration study resulted in the following utility equation for different modes in a particular city: **(11)**

$$U_k = a_k - 0.25X_1 - 0.032X_2 - 0.015X_3 - 0.002X_4$$

where, a_k = mode specific constant

X_1 = access plus egress time in minutes

X_2 = waiting time in minutes

X_3 = line-haul time in minutes

X_4 = out-of-pocket-cot in cents

	a_k	X_1	X_2	X_3	X_4
Automobile	–0.12	5	0	20	100
Bus	–0.22	10	15	40	50

From the above characteristics of two modes find the share of two modes or forecasted trips of 5000 using a legit model.

Contd P/2

CE 351

4. (a) Explain emerging transportation tools/technologies as used for intelligent transportation system (ITS). Explain ITS user services for public transport and commercial vehicle operation. **(11)**

(b) What are the salient features of Bus Rapid Transit (BRT)? Explain how capacity of BRT system can be analyzed using US Highway Capacity Manual formulation. **(12)**

(c) Write down eight identified important railway corridor of Bangladesh. Explain railway service potential, constraints and opportunities along these corridors. **(12)**

SECTION – B

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

5. (a) Draw transportation system model showing input/output and internal sub-systems. Relevant to this, explain the steps of system analysis. **(18)**

(b) Explain nine categories of human behavior that are affected by transportation. Also discuss eight properties of transport physical environment that that have direct impact on human behavior. **(17)**

6. (a) Write down six key transportation related problems. Write short notes on Traffic engineering, PCU, PIEV and VMS. What are the specific uses of "before-after" spot speed studies? **(6+8+2)**

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

(i) Volume (iii) Speed - delay

(ii) Speed (iv) Origin - destination

(c) Differentiate between: **(6)**

(i) Contra flow and tidal flow

(ii) Fixed delay and operational delay

(iii) Time-mean speed and space-mean speed

(d) A traffic engineer urgently needs to determine AADT on a rural primary road that has the volume distribution characteristics shown in Table 1, 2 and 3. The engineer collected following data on a Tuesday during the month of June. Determine the AADT of the road. **(5)**

Hour	Volume
6:00-7:00 a.m.	600
7:00-8:00 a.m.	800

Contd P/3

CE 351

7. (a) List the locations where parking should be prohibited. What steps should be undertaken for systematic development of parking facilities? Why roadway capacity and flow-fluctuation information are required for proper implementation of on-street schemes? Briefly differentiate between 'on-street' parking and 'off-street' parking. **(3+3+2+2)**

(b) Name the common bottlenecks of roadway system. What are the objectives of providing street lighting? Write down the problems associated with the larger sized vehicles and state what sorts of regulations are needed to ensured to proper functioning and effective use of a terminal? **(5+4+5)**

(c) An urban central business street, with 70 ft pavement width having a reflectance of 20%, carries a maximum of 1250 vph at night time in both directions. Design the lighting system of the road considering mercury light as a source with mounting height of 45 ft and a maintenance factor of 0.8. Draw the lighting layout. Necessary information are given in Tables 4 to 7 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. **(4)**

$U_1 = 40.0$ mph	$U_2 = 38.4$ mph
$S_1 = 8.5$ mph	$S_2 = 7.8$ mph
$n_1 = 285$ no.	$n_2 = 300$ no.

8. (a) What does it mean by traffic control devices and state the general requirements of them. Mention the main objectives of traffic control devices. Differentiate between traffic signs and markings. Briefly discuss about the new trend of roadway sign and marking. **(8+2+4+4)**

(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. **(2+5)**

(c) Design a two-phase signal of an isolated cross-junction for the following data. **(10)**

	N-S phase	E-W phase
Inter-green period =	3 sec	5 sec
Initial and final lost time =	3 sec	2 sec

	North	South	East	West
Flow (pcu/hr) =	700	450	800	650
Saturation flow (pcu/hr) =	2000	1900	2200	2100

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

FOR Q.6(d)

Table 1 Hourly Expansion Factors for a Rural Primary Road

Hour of Day	Volume	HEF	Hour	Volume	HEF
6:00-7:00 a.m.	294	42.01	6:00-7:00 p.m.	743	16.62
7:00-8:00 a.m.	426	28.99	7:00-8:00 p.m.	706	17.49
8:00-9:00 a.m.	560	22.05	8:00-9:00 p.m.	606	20.38
9:00-10:00 a.m.	657	18.8	9:00-10:00 p.m.	489	25.26
10:00-11:00 a.m.	722	17.11	10:00-11:00 p.m.	396	31.19
11:00-12:00 p.m.	667	18.52	11:00-12:00 a.m.	360	34.31
12:00-1:00 p.m.	660	18.71	12:00-1:00 a.m.	241	51.24
1:00-2:00 p.m.	739	16.71	1:00-2:00 a.m.	150	82.33
2:00-3:00 p.m.	832	14.84	2:00-3:00 a.m.	100	123.5
3:00-4:00 p.m.	836	14.77	3:00-4:00 a.m.	90	137.22
4:00-5:00 p.m.	961	12.85	4:00-5:00 a.m.	86	143.6
5:00-6:00 p.m.	892	13.85	5:00-6:00 a.m.	137	90.15

Table 2 Daily Expansion Factors for a Rural Primary Road

Day of Week	Volume	DEF
Sunday	7895	9.515
Monday	10714	7.012
Tuesday	9722	7.727
Wednesday	11413	6.582
Thusrday	10714	7.012
Friday	13125	5.724
Saturday	11539	6.51

Table 3 Monthly Expansion Factors for a Rural Primary Road

Month of Year	ADT	MEF
January	1350	1.756
February	1200	1.976
March	1450	1.635
April	1600	1.482
May	1700	1.395
June	2500	0.948
July	4100	0.578
August	4550	0.521
September	3750	0.632
October	2500	0.948
November	2000	1.186
December	1750	1.355

FOR Q.7(C)

TABLE 4 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 5 ADJUSTMENT FACTORS FOR RECOMMENDED AVERAGE ILLUMINATION VALUES

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

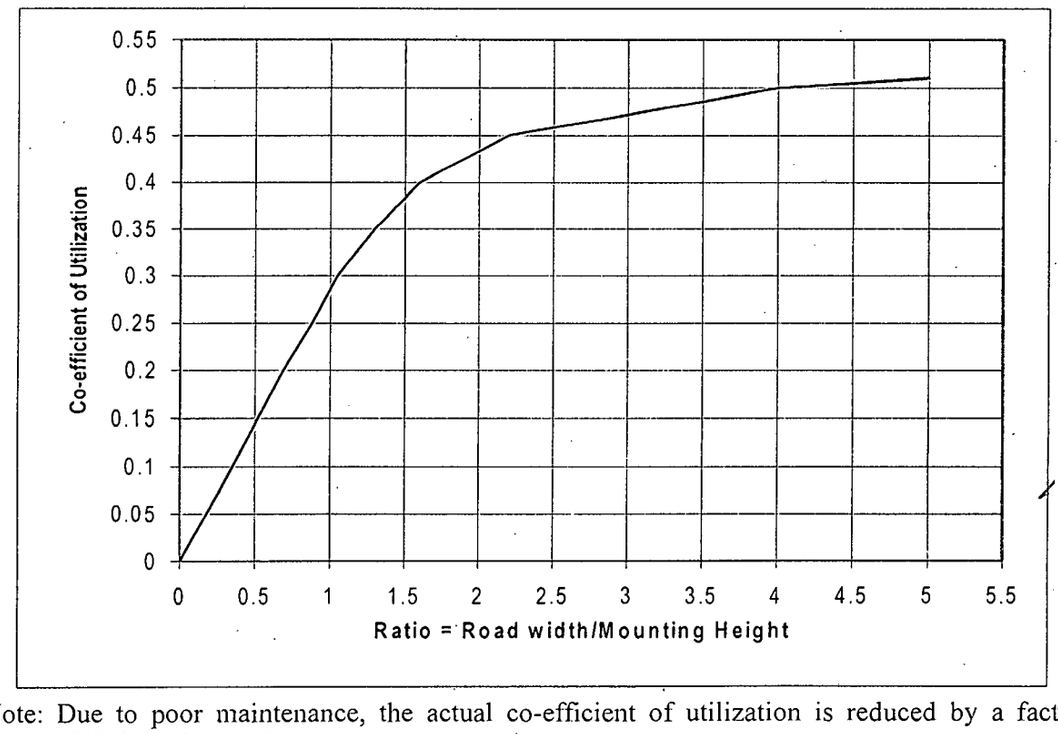
TABLE 6 LIGHTING SOURCE CHARACTERISTICS

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 7 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%).