L-3/T-2/CE **Date : 20/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2015-2016

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.

SECTION – A

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

1. (a) Classify and explain the following open channel flow situation: **(8)**

   (i) Dry season flow in a river without rainfall

   (ii) Tidal bore.

   (b) Derive the equation: $U = CR^{1/2}S_f^{1/2}$ where the notations have this usual meaning. **(8)**

   (c) A trapezoidal channel has a bottom width of 6m, side slopes of 1.5 H: 1V, $\alpha = 1$ and n = 0.025. Determine the critical slope when the discharge is 20 m^3/s. **(12⅔)**

   (d) Water flows in an open channel at a depth of 1m and a mean velocity of 4 m/s. Compute discharge and determine the state of flow for the section shown in Fig. 1. If elementary waves are created in this channel, determine the speed of the wave fronts upstream and/or downstream. **(18)**

2. (a) Define: (i) Relative roughness, (ii) Hydraulic rough boundary. **(8)**

   (b) Deduce the expression for normal depth in a triangular channel using Manning formula. **(8)**

   (c) A trapezoidal channel has a bottom width of 6m, side slopes of 2V:1H and is laid on a slope of 0.0001. The channel is made of concrete (K_s = 2mm) and carries water at a depth of 1m. Compute: (i) mean velocity of flow and (ii) Manning's n. **(12⅔)**

   (d) For a channel shown in Fig.2 with n = 0.025 and S_0 = 0.001, compute the normal depth by Newton-Raphson method if Q = 20 m^3/s. Assume an initial value of water level of 1 m. **(18)**

3. (a) Derive the equation: $\frac{dh}{dx} = S_0 \cdot \frac{1-(h_n/h)^Y}{1-(h_c/h)^M}$, where the notations have this usual meaning. **(8)**

   (b) Explain the behavior of a flow profile when $h \to h_c$. **(8)**

   (c) A trapezoidal channel having side slopes of 1.5 H : 1 V, n = 0.02 and S_0 = 0.0002 carries a discharge of 25 m^3/s at a normal depth of 2m. Compute the bottom width. **(12⅔)**

   (d) Draw flow profiles for the following serial arrangement of channels: **(18)**

   (i) Critical-steep-Mild

   (ii) Steep- Critical- Mild

   (iii) Mild-Adverse- Critical-Free over fall

   (iv) Mild-Milder-Steep.

Contd P/2

WRE 311

4. (a) Derive the equation: $u^* = \sqrt{ghS_0}$ for a wide channel where the notations have their usual meaning. **(8)**

(b) Explain why H1 profile is not possible. **(8)**

(c) Compute the hydraulic exponent for uniform flow computation for rectangular channel where the conveyance is computed by Manning equation. **(12⅔)**

(d) Prove that S2 profile is a drawdown curve. **(9)**

(e) Prove that, **(9)**

(i) C1 and C3 profiles in a wide channel are exactly horizontal, and

(ii) C1 and C3 profiles in any channel are approximately horizontal.

SECTION-B

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

5. (a) Define Prismatic, Non-prismatic, Natural and Artificial channels. **(6)**

(b) Why velocity distribution coefficients are used in open channel flow problems? **(4⅔)**

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

(d) The velocity distribution in a very wide river 3.0 m deep is found to be approximately in accordance with the equation $v = 1+2\ (y/y_0)^{1/2}$, where y_0 is the depth of the river and v is the velocity at depth y measured from the bed. Calculate α and β. **(15)**

(e) The following data were obtained in a stream gauging operation. A current meter with a calibration equation, $v = 0.3N + 0.03$ where N = revolutions per second, was used to measure the velocity at 0.6 depth. Calculate the discharge. **(15)**

Distance, m	0	2	4	6	9	12	15	18	20	22	23	24
Depth, h	0	0.5	1.2	1.9	2.3	1.8	1.7	1.6	1.5	1.2	0.8	0
No. of revolution, N	0	75	80	125	140	120	110	105	90	85	70	0
Time, s	0	150	120	120	120	120	120	120	120	120	150	0

6. (a) Define section factor and control. **(6)**

(b) Find out the formula of the critical depth for a triangular channel. **(4⅔)**

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

(d) Compute the critical depth and velocity in a (i) wide rectangular channel with $q = 4$ m^2/s, (ii) rectangular channel with $b = 6$ m and $Q = 35$ m^3/s, (iii) triangular channel with $s = 1$ and $Q = 5$ m^3/s. In all cases assume $\alpha = 1.12$. **(15)**

Contd P/3

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Contd... Q. No. 6

(e) Water is flowing at a velocity of 2 m/s and a depth of 2.5 m in a long rectangular channel 6 m wide. Compute (i) the contraction in width of the channel for producing critical flow, and (ii) the depth and change in water level produced by a smooth contraction in width to 5m, and a smooth expansion in width to 8 m. In all cases neglect energy losses and take $\alpha = 1.0$. **(15)**

7. (a) What is stilling basin? Write down the various appurtenances of stilling basin. **(6)**

(b) Describe the different types of hydraulic jumps that occur in horizontal slopping channel with neat sketches. **(6)**

(c) Derive the equation of sequent depth for hydraulic jump in a horizontal rectangular channel. **(4⅔)**

(d) Design a USB stilling basin II for the overflow spillway section having a crest length of 76m, the design discharge is 2265 cumec. The channel floor elevation is at 4 m from mean sea level. The velocity of flow at the toe of the spillway is 24m/s and the tailwater elevation is at 15m from mean sea level. (Figure 3) **(15)**

(e) The values of variables in connection with two hydraulic jumps in 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)	Y_2 (m)	V_2 (m/s)	q (m^2/s)	F_{r1}	F_{r2}	H_L	L_J
Jump 1	0.3		2.8						
Jump 2		12.9		1.21					

8. (a) Show that the best hydraulic trapezoidal section is one half of a regular hexagon. **(6)**

(b) What is the difference between Kennedy's and Lacey's approach in alluvial channel design? **(4⅔)**

(c) What is lining? What are the lining materials? **(6)**

(d) A channel lined with concrete is to be laid on a slope of 1 in 3500. The side slope of the channel to be maintained at 1.5 H : 1 V and the lining material is expected to give a n values of 0.014. Design the channel for a discharge of 100 m^3/s and a maximum permissible velocity of 2.5 m/s. **(15)**

(e) Design stable alluvial channel by Lacey's method carrying a discharge of 30 m^3/s through 0.2 mm sand. **(15)**

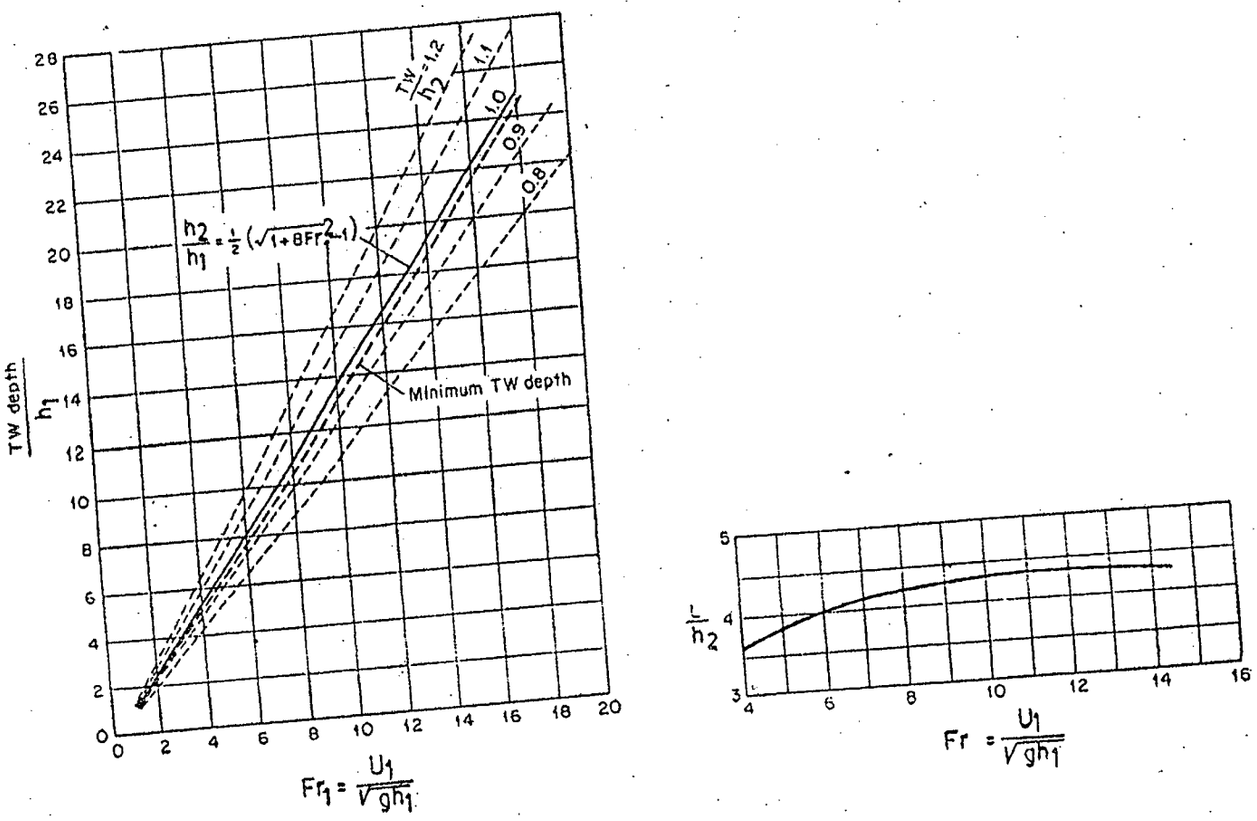

Figure 3 for Ques NO 7(d)

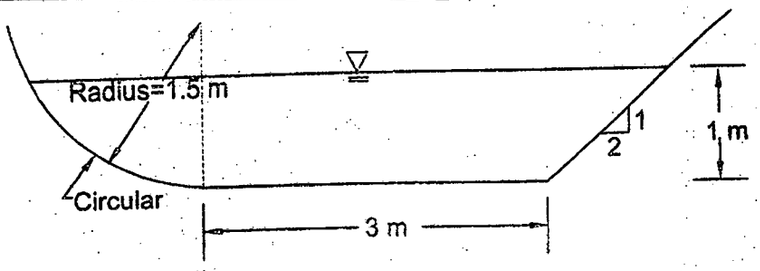

Fig. 1 for Q. No. 1(d)

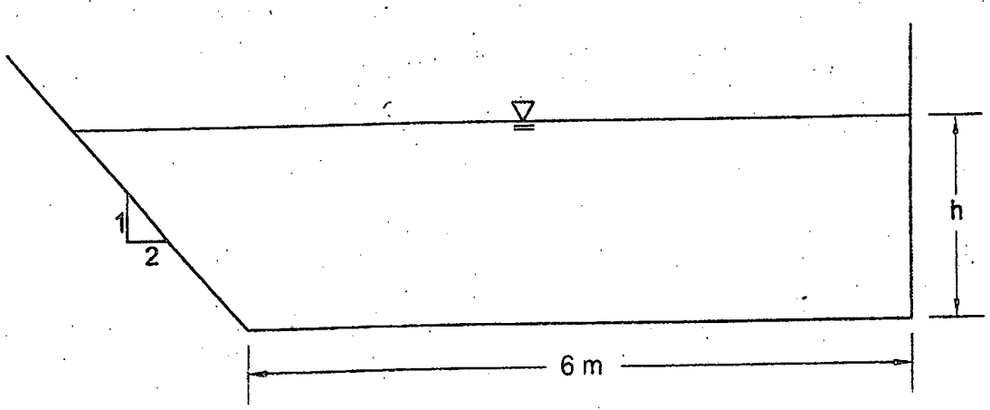

Fig. 2 for Q. No. 2(d)

L-3/T-2/CE **Date : 16/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2015-2016

Sub : **CE 351** (Transportation Engg.-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) Explain schematically the relationship between access and movement functions of street. **(11)**

   (b) Explain different types of traffic that are generally considered in transportation planning process in relation to land use and transport development. **(12)**

   (c) Calculate the inter zonal trips using a simple gravity model from the following data. Assume 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) 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)**

   (c) What is the difference between the terms "Accident" and "Crash" in road safety study? Show the following actions with collision diagram: **(12)**

   (i) Rear-end, (ii) Right angle, (iii) Sideswipes and (iv) Head-on.

3. (a) State the advantages and disadvantages of a rotary intersection. **(11)**

   (b) Show diagrammatically the method of attaining super elevation considering pavement revolved about the centre line. **(12)**

   (c) A driver moving at a speed of 65 mph on a 3 percent upgrade section of a highway sights an object 500 ft away on the highway 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 object? **(12)**

4. (a) Briefly describe the importance of Traffic Engineering. Write down the ways of classifying roadway system. Name the common tools that are available to traffic engineer to tackle congestion and road safety problems. Write a short note on PIEV. **(2+4+4+4=14)**

Contd P/2

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Contd... Q. No. 4

(b) Differentiate between: **(3×5=15)**

(i) Interrupted flow and Un-interrupted flow rate.

(ii) Fixed delay and operational delay

(iii) Recurrent Congestion and Non-Recurrent Congestion

(iv) Conventional sign and variable message sign (VMS)

(v) Progressive signal and simultaneous signal.

(c) 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 any missing data. **(6)**

$U_1 = 40.2\,\text{kmph}$ $U_2 = 37.4\,\text{kmph}$

$S_1 = 8.4\,\text{kmph}$ $S_2 = 7.9\,\text{kmph}$

$n_1 = 285$ $n_2 = 300$

SECTION-B

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

5. (a) What do you mean by Transportation System? Explain the conceptual outline of interdisciplinary subject areas of Transportation System. Also, give an overview of Transportation System characteristics. **(17½)**

(b) Explain 10 properties of physical environment that have direct impact on human behavior. Compare Highway, Railway, Waterway and Air Transport in terms of three basic evaluation parameters. **(17½)**

6. (a) List the common problems associated with uncontrolled on-street parking. Compare parallel parking with angular parking. In which locations parking should be prohibited? State the problems associated with larger sized vehicles and mention important requirements of a truck terminal. What sorts of regulations are needed to ensure proper functionary and effective use of a bus terminal? **(17½)**

(b) Explain (with global data trend/graphics) why it is utmost important to keep the capacity of arterial roads intact while it is not that urgent for collector/feeder and local roads. Discuss your point with respect to current traffic operation of Dhaka city road network. **(17½)**

7. (a) Explain the importance of following key points on Transport System: Competitions; Queing and Storage; Capacity and Operations policy; Cost vs. Level of service trade-off & Peak vs. Design Capacity trade-off. Explain use of eight new technology/tools for Intelligent Transport System (ITS) application. **(17½)**

Contd P/3

CE 351

Contd... Q. No. 7

(b) What is national ITS architecture? Give details of six ITS sub-systems. Also, in schematic diagram show ITS sub-systems and communications. **(17½)**

8. (a) State the general requirements of traffic control devices. Name the functional classification of traffic signs and give two examples for each. List different types of signal controllers with comparison. Mention the problems associated with traffic signals in Bangladesh. **(17½)**

(b) Explain potential, constraints and opportunities of following business sector for Bangladesh Railway: **(17½)**

Containers, Other freight, Commuter services and Intercity services. Draw (along with geometric details) the typical cross-sections of six highway geometric templates as adopted by Roads and Highway Departments of Bangladesh.

L-3/T-2/CE **Date : 16/07/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2015-2016

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

Full Marks: 280 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) The following data have been obtained from a settling column analysis carried out with a 2 m column. Estimate the suspended solids (SS) removal efficiency in a settling basin with surface overflow rate of 25 m/day. **(26⅔)**

Time (min)	0	60	80	100	130	200	240	420
SS Concentration (mg/l)	300	189	180	168	156	111	78	27

(b) Classify wastewater treatment systems and identify the pollutants that are removed in each system. Also list the typical unit operations for each treatment system. **(10)**

(c) State Marai's Theorem. With an appropriate figure show the different processes occurring in different zones of a facultative pond. **(10)**

2. (a) Design an anaerobic-facultative-maturation pond system to treat 8,000 m^3 / day of domestic sewage with BOD_5 of 500 mg/l and fecal coliform (FC) of 4×10^7 cfu/100 ml. The design temperature is 20° C and the effluent standards are as follows: BOD_5 < 25 mg/l, FC < 5,000 cfu/100 ml. Assume values of k and k_b to be 0.25/ day and 2.5 / day, respectively. **(24⅔)**

(b) Describe with appropriate equations, the different components/steps of bacterial metabolism. **(8)**

(c) Draw a flow diagram showing activated sludge process of wastewater treatment. Discuss the significance of F/M ratio in the operation of activated sludge process. **(14)**

3. (a) Design a suitable latrine for a family of 7 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 11 lpcd; and long-term infiltration capacity of soil is 18 L/m^2.day. The groundwater table is 4.0 m below ground surface. The pit is to be constructed with concrete rings of 1.1 m diameter and 0.3 m depth. **(26⅔)**

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

(ii) Design the latrine (including venting system), 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 flood-prone area.

Contd P/2

CE 333

Contd... Q. No. 3

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

(c) What do you understand by a "hygienic latrine"? Why "pit latrines" are not always hygienic latrines? Explain. Discuss the advantages and disadvantages of VIP and ROEC latrines. **(10)**

4. (a) Design "septic tank system" (i.e., septic tank and soakage pit) for a family of 12 members. The estimated wastewater flow rate is 90 lpcd and the tank is to be desludged every 3 years. The hydraulic detention time of the tank should be atleast 1 day in order to maintain acceptable effluent quality. The long-term infiltration capacity of soil is 50 L/m^2.day. **(28⅔)**

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 decvices.

[Consider a design temperatures of 25 °C; assume reasonable values for parameters not given]

(b) With an appropriate figure, show how disease is transmitted from excreta via different routes, along with sanitation barriers to prevent such transmission. **(10)**

(c) 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? **(8)**

SECTION-B

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

5. (a) List the different means of inflow and infiltration in to the Sanitary Sewer Systems. **(10)**

(b) List the effects of Sanitary Sewer Overflow (SSO) on the environment and public health. **(10)**

(c) A trunk sewer is to be sized for a 25 km^2 (2,500 ha) city with a naturally sloped towards the major river with a gradient of 1 in 1000. It will be 60% residential, 30% commercial, and 10% industrial. The residential area will have 40% large lots, 55% small single family lots, and 5% multi-story apartments. **(26⅔)**

Contd P/3

CE 333

Contd... Q. No. 5(c)

The average domestic wastewater flow rate is 800 L/d/capita (9.26×10^{-6}m^3/sec/person), the average commercial flow rate is 25,000 L/d/ha (2.89×10^{-4}m^3/sec/ha), and the average industrial flow rate is 40,000 L/d/ha (4.63×10^{-4}m^3/sec/ha). I&I is 1,000 L/d/ha for the entire area. Estimate the peak and minimum flows to be handled by the trunk sewer. Given: Qpeak / Qavg = $5.5/\left(p^{0.18}\right)$ andQmin/Qavg = $0.2/\left(p^{0.16}\right)$, where *'p'* is the total city population in thousands. Also design the sewer based on the estimated flow and the saturation densities for the residential areas given in the table below:

Type of area	Desnsity(persons/ha)
Large lots	**5-7**
Small lots, single-family	**75**
Small lots, two-family	**125**
Multistory apartments	**2,500**

6. (a) Explain with a neat sketch listing the chemical reactions resulting in corrosion caused by Hydrogen Sulfide generation in a sewer pipe carrying wastewater with DO > 1mg/L. **(10)**

(b) An engineering handbook lists "minimum" sewer slopes as presented below. The general design practice is to provide sewer slope similar to the ground slope. However, this is not mandatory. If situation warrants a designer should provide higher slope. **(18⅓)**

Sewer Dia. (inch)	6	8	10	12	15	18	21	24
Sewer Dia. (mm)	150	200	250	300	375	450	525	600
Minimum Slope	0.0043	0.0033	0.0025	0.0019	0.0014	0.0011	0.00092	0.00077

In area with a ground slope of 0.0015, a 100m long sanitary sewer is required to carry 0.50m^3/min (0.29 ft^3/sec). What sewer size and slope should be used (Provide at least two sewer sizes nearest to the one required as per design)? Also, provide difference in elevation between the crown at the upper end and the invert at the lower end of sewers of both the sizes.

(c) To alleviate the water-logging problem a relief sewer is designed for Kathalbagan area. A 100 mm thick, 450 mm dia. RCC pipe is to be laid in a trapezoidal trench with side slope 1:1 (V:H). The pipe rests on 150mm thick hardcore overlain by 150mm sand bed. The RL of the finished level (Road) is +7.500m PWD. The invert level of the sewer is +3.60m PWD. The trench is backfilled with wet sand and damp clay (density 1920 kg/m^3). Determine the load on the sewer pipe. Neatly draw the trench section with every detail along with the RL of each level in the section. Assume reasonable values for missing data. Justify your assumption of the missing data. **(18⅓)**

What should be the load on the sewer pipe if the trench is rectangular in shape instead of trapezoidal as mentioned above?

Contd P/4

CE 333

7. (a) What is house water services? Draw a neat sketch. List the underlying principles of water supply piping of a building. **(10)**

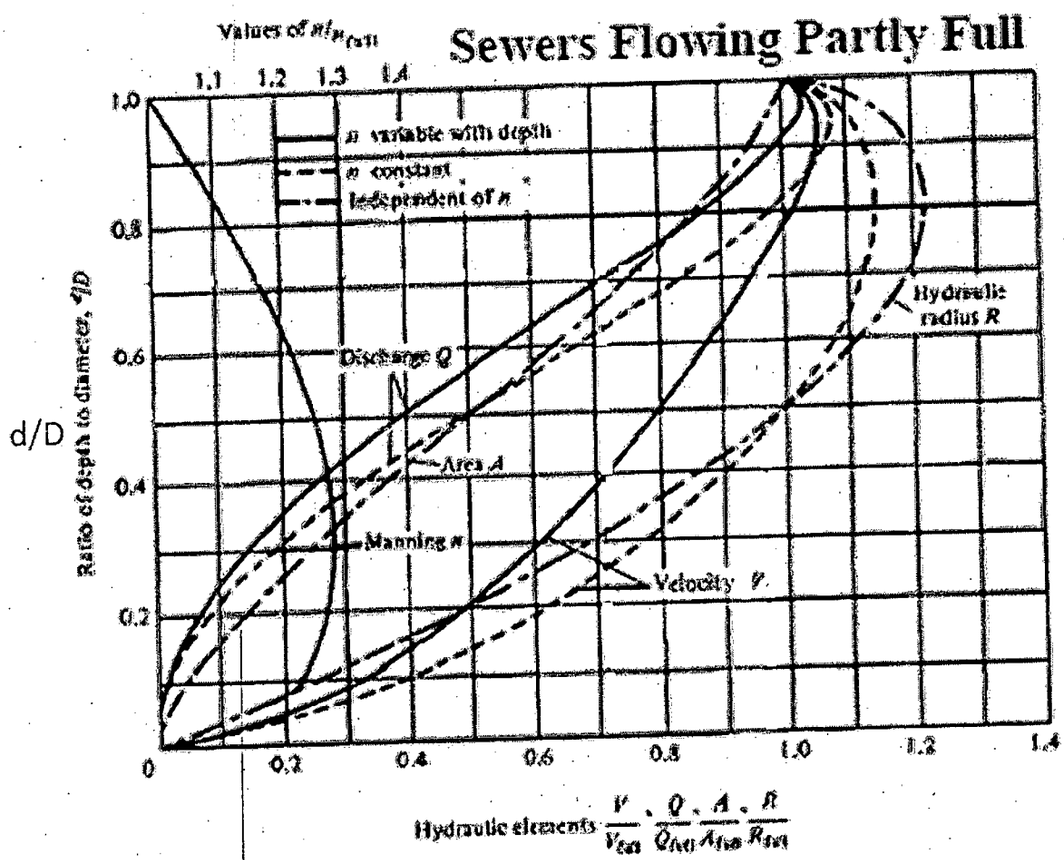
(b) In a down-feed zone of water supply, the pressure available in the riser at a certain floor is 8 psi. Calculate the permissible pressure drop per 100 ft of riser to supply for a floor 22 ft floor below where the pressure requirement is 14 psi. **(10)**

(c) A 2000 mm dia. RCC pipe is laid with a slope of 0.0015 for a design flow of 0.6 m^3/sec when flowing partially full having a width of 1.414m at the top. The sewer pipe provided is designed to carry domestic sewage having BOD_5 of 200 mg/L and a maximum temperature of 30 °C. Determine the potential for Sulfide Generation (Z). Check the Z values for both high flow and low flow conditions. Specify the appropriate measures to be taken for stability of the sewer. **(26⅔)**

8. (a) Define 'Fixture Trap'. What does 'Strength of a Trap' mean and how is it determined? Differentiate between fixture unit of water supply and fixture unit of plumbing drainage. **(15)**

(b) Name the principle plumbing systems of drainage. Which system is usually preferred? Why? **(15)**

(c) What is sustainability of water and sanitation services? How is sustainability of rural sanitation ensured? **(16⅔)**


Sewers Flowing Partly Full
Values of n/n_{full}
1.1
1.2
1.3
1.4
n variable with depth
n constant
Independent of n
Hydraulic radius R
Discharge Q
Area A
Manning n
Velocity V
Ratio of depth to diameter, d/D
1.0
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Hydraulic elements $\frac{V}{V_{full}}, \frac{Q}{Q_{full}}, \frac{A}{A_{full}}, \frac{R}{R_{full}}$

d/D

L-3/T-2/CE **Date : 09/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2015-2016

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

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**.

Annex is provided with charts, tables and equations to facilitate computations.

1. (a) The interaction between moment capacity, M_n, and unbraced length, L_b, of a W section beam is typically represented as shown in Fig.1. For a W14x90 section with $F_y = 50\,\text{ksi}$ and $C_b = 1.0$, determine the value of moment and unbraced length corresponding to point A in Fig.1. **(20)**

   (b) The tension member shown in Fig.2 is an $L6\times3\,\frac{1}{3}\times\frac{5}{16}$. it is connected to a $\frac{5}{16}$-inch-thick gusset plate with $\frac{3}{4}$-inch-diameter, A325 bolts $(F_y = 90\,\text{ksi}, F_u = 120\,\text{ksi})$. Both the tension member and the gusset plate are of A36 steel $(F_y = 36\,\text{ksi}, F_u = 58\,\text{ksi})$. Determine nominal tension capacity based on bolt shear and bearing. **(15)**

2. (a) Use an elastic analysis and determine the maximum load in the weld shown in Fig.3 (in kips per inch of length). **(20)**

   (b) Determine the value of C_b for the beam shown in Fig.4 based on the loads as shown. The beam is laterally braced only at ends. **(15)**

3. (a) A W18×50 girder $(F_y = 36\,\text{ksi}, F_u = 58\,\text{ksi})$ of span 20-ft. on center to center of supports (Fig. 5) is simply supported at both ends on 10-in. thick concrete walls of $f'_c = 4000\,\text{psi}$. At each end, the girder reaction is transferred on the wall through a bearing plate. The support reaction consists of a shear due to dead load of $V_D = 15\,\text{kips}$ and a shear due to live load of $V_L = 20\,\text{kips}$. Using LRFD load combinations, determine the required bearing plate dimensions and thickness. **(20)**

   (b) In the frame of Fig.6, all beams are W14×53 and all columns are W10×68. All beams and columns are active in strong axis bending. Determine effective length factor, K, for columns AD, DG and EH using alignment charts. **(15)**

Contd P/2

CE 319

4. (a) A W10×88 beam has to transfer a shear force of 150 kip. What percentage of shear force is carried by the web? What is the ratio of average and maximum shear stress? **(20)**

(b) The beam-column (W10×54) shown in the Fig.7 is pinned at both ends and is subjected to the loads as shown. Bending is about the strong axis and the beam material is A992 steel $(F_y = 50\,\text{ksi}, F_u = 65\,\text{ksi})$. Determine whether this member satisfies the appropriate AISC Specification interaction equation. Follow LRFD approach and consider moment amplification. The column is not braced except at the ends. Take $C_b = 1.32$ for flexure. **(15)**

SECTION-B

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

5. (a) Determine the maximum tension (T_n) that may be transmitted through the bolted connection shown in Figure 8. Consider bolt bearing and bolt shear limit states only. All bolts are $\frac{1}{2}''$ diameter A325 bolts (F_y = 90 ksi), F_u = 120 ksi) on standard holes. All plates are A36 (F_y = 36 ksi, F_u = 58 ksi). **(17½)**

(b) Determine the size and length of the fillet weld for the lap joint shown in Figure 9. All plates A36 steel(F_y = 36 ksi, F_u = 58 ksi). **(17½)**

6. (a) Determine the resultant shear force in each bolt in the eccentrically loaded bolted connection shown in the Figure 10. **(17½)**

(b) Select the lightest W section to carry a uniform dead load of 0.5 kip/ft and a live load of 1.0 kip/ft on a simply supported span of 42 ft. Adequate lateral support is provided. The live load deflection is limited to L/360. Use A572 Grade 50 and ASD method. (Use Annex A). **(17½)**

7. (a) Determine the allowable compressive load carrying capacity of a column consists of W10×45 section (A = 13.3 in^2, r_x = 4.32 in, r_y = 2.01 in) having A992 (F_y = 50 ksi) steel. The column length is 20″ and it is hinge supported at both ends. Use ASD approach. Given, **(17½)**

$$F_{cr} = \left[0.658^{F_y/F_e}\right] F_y \text{ for } \frac{KL}{r} \le 4.71\sqrt{\frac{E}{F_y}} \text{ Or } F_e \ge 0.44F_y$$

$$F_{cr} = 0.877F_e \text{ for } \frac{KL}{r} > 4.71\sqrt{\frac{E}{F_y}} \text{ Or } F_e < 0.44F_y$$

$$F_e = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2}$$

Contd P/3

CE 319

Contd... Q. No. 7

(b) A W14×159 column (b_f = 15.6″, d = 15″) transmits an axial compressive live load of 650 kip and dead load of 400 kip on to a concrete base having a top surface of 35in by 70in. Determine the size and thickness of base plate using A36 material. The concrete base has f'c = 4 ksi. Follow ASD method. **(17½)**

8. (a) In the Figure 11, due to presence of residual stress the average stress strain behavior follows path a-b-c-d-e-f. The transition from c to e can be covered by one parabolic curve $f = K_1\epsilon^2 + K_2\epsilon + K_3$. Determine the stress for a strain of 0.00124 when the residual stress is present. **(17½)**

(b) (i) What are the advantages of structural steel? (ii) What are the differences between steel and concrete structure design? **(17½)**

Fig.1

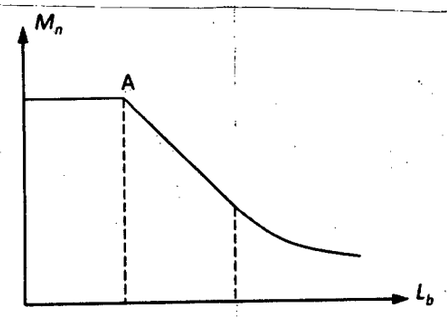


Fig.2

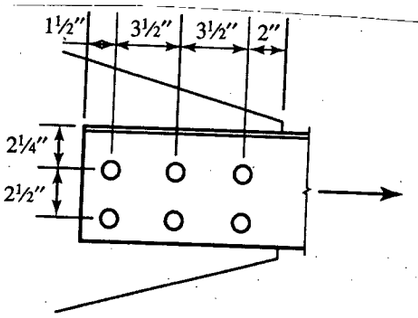


Fig.3

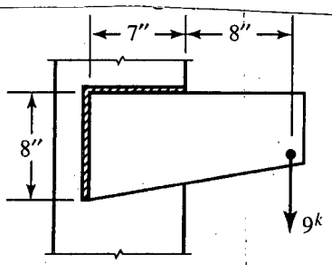


Fig.5

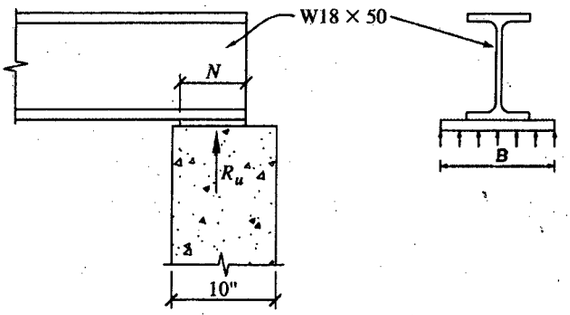


Fig.4

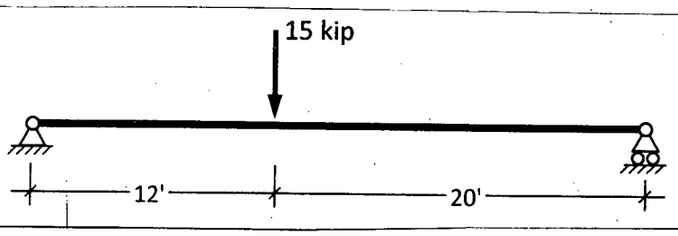
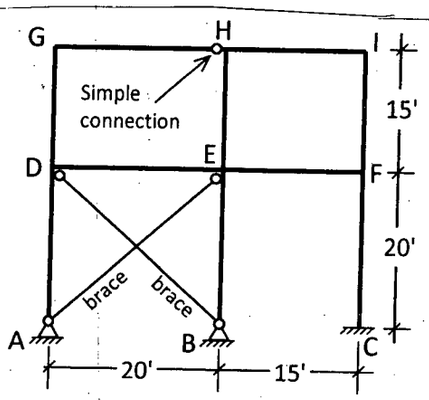
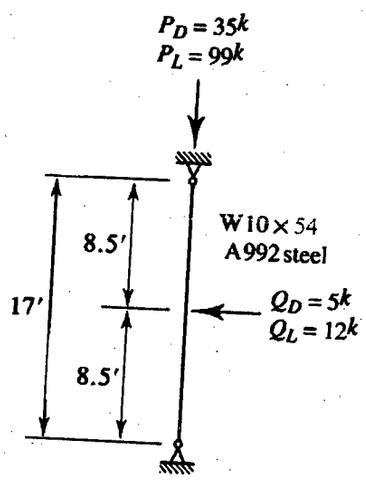


Fig.6



Note:
Attach the alignment chart with your answer script showing the graphical determination of *K* if question 3(b) is answered.

Fig.7



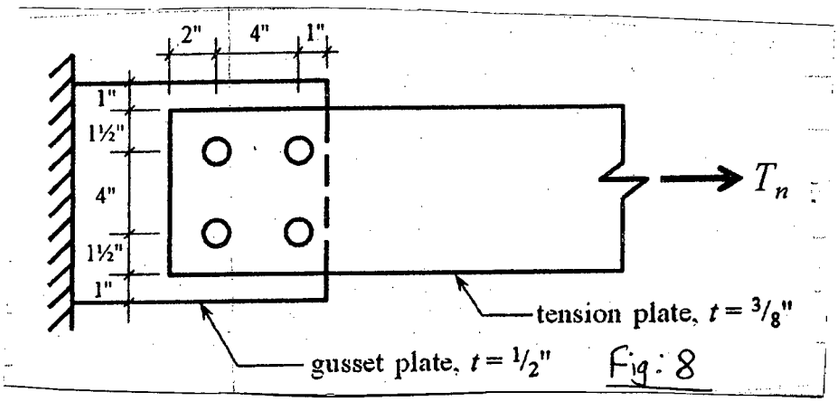


Fig: 8

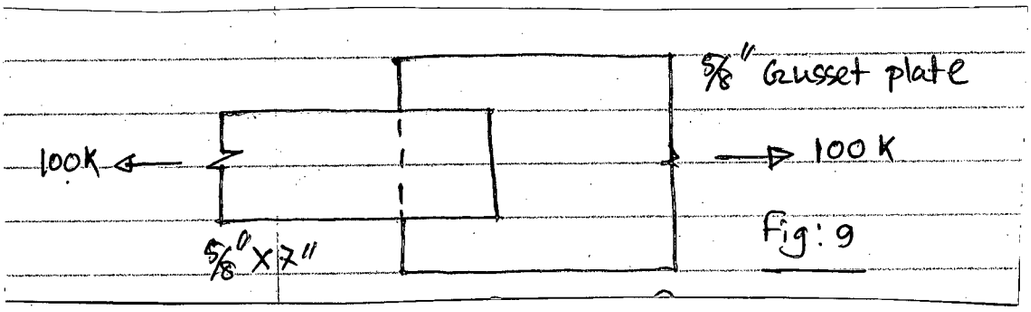


Fig: 9

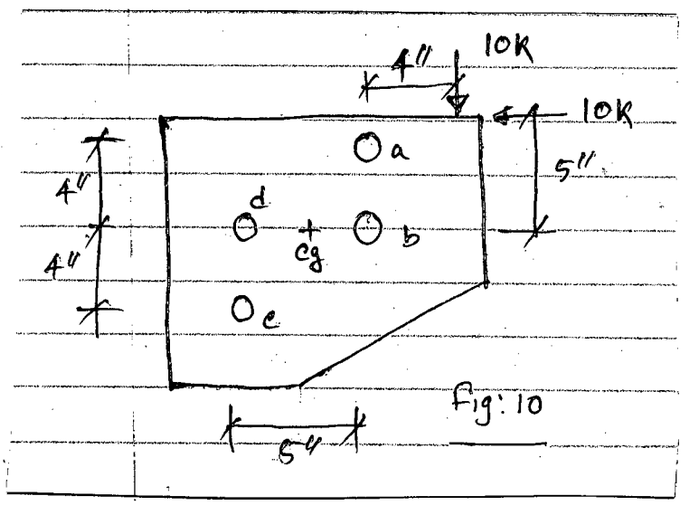


Fig: 10

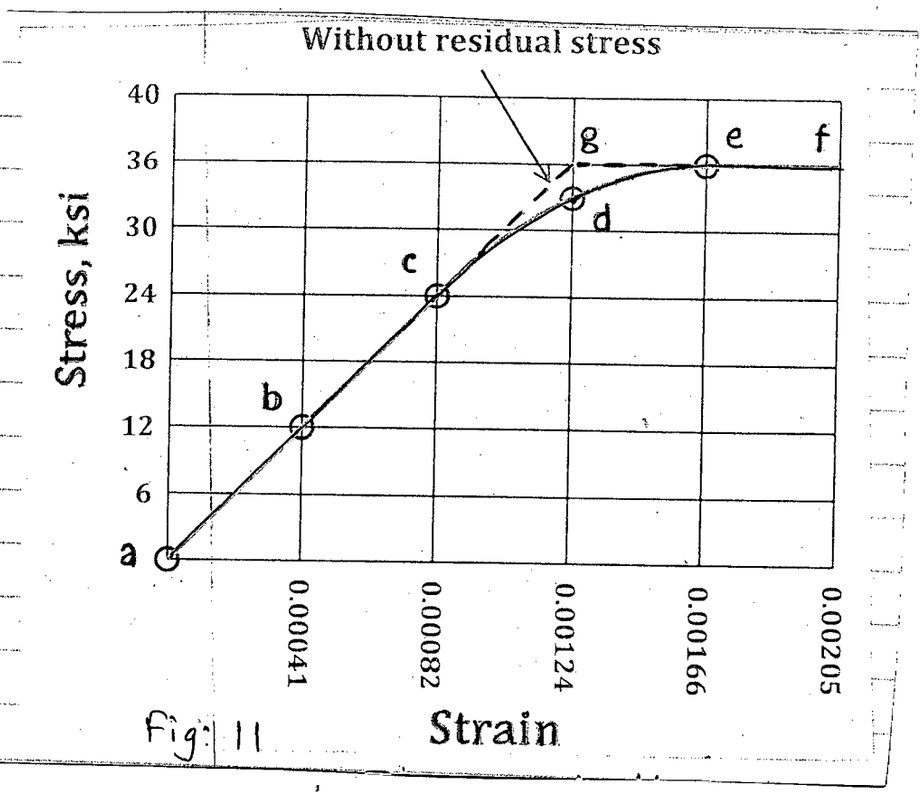


Fig: 11

Annex – A

W section properties chart

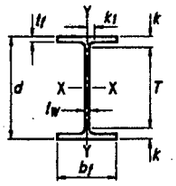


Table 1–1 (continued)
W Shapes
Dimensions

Table 1–1 (continued)
W Shapes
Properties

Shape	Area, A	Depth, d	Web Thickness, t_w	Flange Width, b_f	Flange Thickness, t_f	Distance k		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.	k_{des} in.	k_{det} 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	0.910	12.6	1.63	2.13	2 1/2	15/16	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	0.830	12.5	1.48	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	0.750	12.4	1.36	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	0.720	12.5	1.15	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	0.650	12.4	1.04	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	0.600	12.4	0.960	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	0.550	12.3	0.875	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	0.500	12.3	0.800	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	0.580	8.42	0.930	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	0.515	8.36	0.835	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	0.455	8.30	0.740	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	0.430	8.27	0.685	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	0.400	8.24	0.615	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	0.375	8.22	0.522	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,j]	14.1	20.6	0.350	8.14	0.430	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	0.495	7.64	0.810	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	0.450	7.59	0.750	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	0.415	7.56	0.695	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	0.390	7.53	0.630	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	0.355	7.50	0.570	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	0.645	14.7	1.03	1.63	2 5/16	19/16	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	0.590	14.7	0.940	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	0.525	14.6	0.860	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	0.485	14.6	0.780	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	0.440	14.5	0.710	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	0.510	10.1	0.855	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	0.450	10.1	0.785	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	0.415	10.0	0.720	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	0.375	10.0	0.645	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	0.370	8.06	0.660	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	0.340	8.03	0.595	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	0.305	8.00	0.530	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	0.360	10.0	0.640	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
×53	15.6	12.1	0.345	10.0	0.575	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	0.370	8.08	0.640	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	0.335	8.05	0.575	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	0.295	8.01	0.515	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	0.300	6.56	0.520	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	0.260	6.52	0.440	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	0.230	6.49	0.380	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	0.260	4.03	0.425	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	0.235	4.01	0.350	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	0.220	3.99	0.265	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	0.200	3.97	0.225	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	0.755	10.4	1.25	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	0.680	10.3	1.12	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	0.605	10.3	0.990	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	0.530	10.2	0.870	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	0.470	10.1	0.770	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	0.420	10.1	0.680	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	0.370	10.0	0.615	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	0.340	10.0	0.560	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

Angle section properties chart

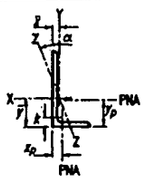


Table 1-7 (continued)
Angles
Properties

Shape	k	Wt.	Area, A	Axis X-X						Flexural-Torsional Properties			Axis Y-Y						Axis Z-Z				Q_s
				I	S	r	$\bar{y}$	Z	y_p	J	C_w	$\bar{r}_o$	I	S	r	$\bar{x}$	Z	x_p	I	S	r	Tan α	F_y=36 ksi
	in.	lb/ft	in.²	in.⁴	in.³	in.	in.	in.³	in.	in.⁴	in.⁶	in.	in.⁴	in.³	in.	in.	in.³	in.	in.⁴	in.³	in.		
L6×4×7/8	1 3/8	27.2	8.00	27.7	7.13	1.86	2.12	12.7	1.43	2.03	4.04	2.82	9.70	3.37	1.10	1.12	6.26	0.667	5.82	2.91	0.854	0.421	1.00
x 3/4	1 1/4	23.6	6.94	24.5	6.23	1.88	2.07	11.1	1.37	1.31	2.64	2.85	8.63	2.95	1.12	1.07	5.42	0.578	5.08	2.51	0.856	0.428	1.00
x 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	7.48	2.52	1.13	1.03	4.56	0.488	4.32	2.12	0.859	0.435	1.00
x 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	6.86	2.29	1.14	1.00	4.13	0.443	3.94	1.92	0.861	0.438	1.00
x 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	6.22	2.06	1.14	0.981	3.69	0.396	3.55	1.72	0.864	0.440	1.00
x 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	5.56	1.83	1.15	0.957	3.24	0.348	3.14	1.51	0.867	0.443	0.973
x 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	4.86	1.58	1.16	0.933	2.79	0.301	2.73	1.31	0.870	0.446	0.912
x 5/16	13/16	10.3	3.03	11.4	2.77	1.94	1.90	4.96	1.15	0.104	0.217	2.96	4.13	1.34	1.17	0.908	2.33	0.253	2.31	1.10	0.874	0.449	0.826
L6×3 1/2×1/2	1	15.3	4.50	16.6	4.23	1.92	2.07	7.49	1.50	0.386	0.779	2.88	4.24	1.59	0.968	0.829	2.88	0.375	2.58	1.34	0.756	0.343	1.00
x 3/8	7/8	11.7	3.44	12.9	3.23	1.93	2.02	5.74	1.41	0.168	0.341	2.90	3.33	1.22	0.984	0.781	2.18	0.287	2.00	1.02	0.763	0.349	0.912
x 5/16	13/16	9.80	2.89	10.9	2.72	1.94	2.00	4.84	1.38	0.0990	0.201	2.92	2.84	1.03	0.991	0.756	1.82	0.241	1.70	0.859	0.767	0.352	0.826

Table 1-7 (continued)
Angles
Properties

Beam Formulae

$$M_n = C_b\left[M_p - (M_p - 0.7F_yS_x)\left(\frac{L_b - L_p}{L_r - L_p}\right)\right] \le M_p \qquad M_n = M_p - (M_p - 0.7F_yS_x)\left(\frac{\lambda - \lambda_{pf}}{\lambda_{rf} - \lambda_{pf}}\right)$$

$$\frac{L_p}{r_y} = 1.76\sqrt{\frac{E}{F_y}} = \frac{300}{\sqrt{F_y,\ \text{ksi}}} \qquad L_r = 1.95r_{ts}\frac{E}{0.7F_y}\sqrt{\frac{Jc}{S_xh_o}}\sqrt{1 + \sqrt{1 + 6.76\left(\frac{0.7F_y}{E}\frac{S_xh_o}{Jc}\right)^2}}$$

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

AISC LRFD beam-column interaction formula

$$\frac{P_u}{\phi_c P_n} + \frac{8}{9}\left[\frac{M_{ux}}{\phi_b M_{nx}} + \frac{M_{uy}}{\phi_b M_{ny}}\right] \le 1.0 \quad \text{For} \quad \frac{P_u}{\phi_c P_n} \ge 0.2 \qquad B = \frac{1}{1 - \frac{P_u}{P_e}}$$

$$\frac{P_u}{2\phi_c P_n} + \left[\frac{M_{ux}}{\phi_b M_{nx}} + \frac{M_{uy}}{\phi_b M_{ny}}\right] \le 1.0 \quad \text{For} \quad \frac{P_u}{\phi_c P_n} < 0.2$$

Web Crippling formulae

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

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

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

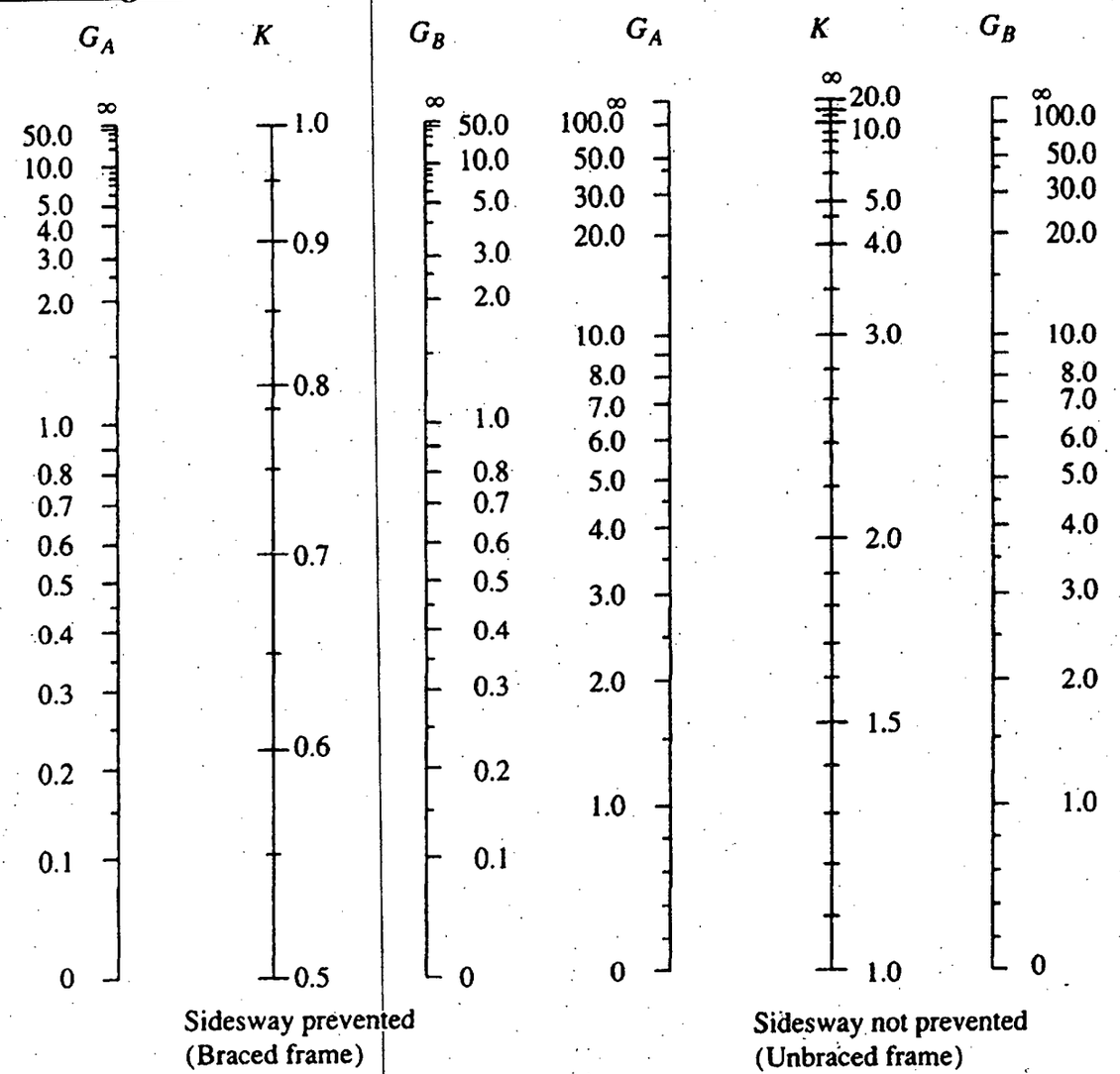
For $N/d \le 0.2$

$$R_n = 0.40t_w^2\left[1 + 3\left(\frac{N}{d}\right)\left(\frac{t_w}{t_f}\right)^{1.5}\right]\sqrt{\frac{EF_{yw}t_f}{t_w}} = 68t_w^2\left[1 + 3\left(\frac{N}{d}\right)\left(\frac{t_w}{t_f}\right)^{1.5}\right]\sqrt{\frac{F_{yw}t_f}{t_w}}$$

For $N/d > 0.2$

$$R_n = 0.40t_w^2\left[1 + \left(\frac{4N}{d} - 0.2\right)\left(\frac{t_w}{t_f}\right)^{1.5}\right]\sqrt{\frac{EF_{yw}t_f}{t_w}} = 68t_w^2\left[1 + \left(\frac{4N}{d} - 0.2\right)\left(\frac{t_w}{t_f}\right)^{1.5}\right]\sqrt{\frac{F_{yw}t_f}{t_w}}$$

Column alignment charts



Note: Students shall attach the above alignment chart with their answer script showing the graphical determination of K if the relevant question is answered.

L-3/T-2/CE **Date : 05/08/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2015-2016

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.

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 X 30 inch column is reinforced with ten No. 10 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, $\varepsilon_s = 0.001$ (tensile) and $\varepsilon_s = 0.004$ (tensile). **(28)**

   Also find corresponding ϕ for the above points. Assume bending about Y-Y axis.

   Given: $f_c' = 4.0\text{ksi}$ and $f_y = 60\,\text{ksi}$.

2. (a) A ground floor column of a 7-storied building is to be designed for the following load combinations (axial force and unaxial bending)-

   Gravity load combination $P_u = 1200\,\text{kip}, M_u = 200$ kip-ft

   Lateral load combination $P_u = 800\,\text{kip}, M_u = 700$ kip-ft **(17)**

   Architectural considerations require that a 25in. x 25in. square tied column is to be used. Material strengths are $f_c' = 4.0\text{ksi}$ and $f_y = 60\,\text{ksi}$.

   Find the required column reinforcement and show in sketch. Use supplied column strength interaction design chart assuming reinforcement distributed along the perimeter and γ=0.8.

   (b) A 60″ diameter circular tied pier of a bridge is reinforced with seventy-two No-8 bars arranged uniformly around the perimeter. Material strengths are $f'_c = 4.0\,\text{ksi}$ and $f_y = 60\,\text{ksi}$.

   Check adequacy of the short column using Load Contour Method for: **(18)**

   $$P_u = 5200\,\text{kip}, M_{ux} = 2500 \text{ kip-ft}, \; M_{uy} = 2000 \text{ kip-ft}$$

   Use supplied column strength interaction diagram chart assuming γ=0.9.

3. (a) Design a square tied column with about 2.5% reinforcement to support working unfactored loads: $P_{DL} = 2000\,\text{kip}$ and $P_{LL} = 1200\,\text{kip}$. Given: $f'_c = 5.0\,\text{ksi}$ and $f_y = 72.5\,\text{ksi}$. Also, design the ties required. **(10)**

Contd P/2

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

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

$P_u = 400\,\text{kip}$

$V_u = 700\,\text{kip}$

$M_u = 5000\,\text{kip - ft}$ **(20)**

The wall is 15 ft long, 150 ft high and 12 inch thick. Design the shear wall with $f_c' = 4\text{ksi}$ and $f_y = 60\,\text{ksi}$. Ignore axial force as it is less than balanced load of the section.

(c) What is ACI spiral? Explain the failure behavior of ACI spirally reinforced column. **(5)**

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

(b) Write the seismic detailing provisions for beams and columns which are part of IMRF system, as per BNBC. **(10)**

(c) The plan of a pile cap with 12 nos. 20 in. diameter cast-in-situ piles with the column (30in x 30in) is shown in Fig. 2. The column carries a DL = 1200 kip and a LL = 500 kip (working). The individual pile capacity is adequate. Design the pile cap. Given: $f_c' = 3.0\text{ksi}$ and $f_y = 60\,\text{ksi}$. **(18)**

SECTION-B

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

Assume appropriate values for any missing data.

5. (a) Name different types of reinforced concrete floor slabs commonly used in Bangladesh with proper sketches. **(7)**

(b) What are the code provisions for drop panels of flat slab floor system? **(8)**

(c) A 10-storied office building at Khulna is to be designed using flat plate floor system. The columns are 24″ × 24″ in size and they are spaced 25′-0″ c/c. Using direct design method, design an interior slab panel and show the reinforcements with proper sketches. Consider LL = 80 psf and superimposed DL = 70 psf in addition to self wt of slab. Use $f_c' = 4\text{ksi}$, $f_y = 60\,\text{ksi}$ and USD method of design. **(20)**

6. (a) Describe briefly the different stages of loadings to which a prestressed concrete member is often subjected. **(15)**

(b) Compute the value of the live load that the beam of Fig. 3 can carry without producing crack at midspan section. Assume that the concrete can take tension up to the formation of first crack. **(20)**

Given: $t_r = 3.0\,\text{MPa}$; n = 8 and effective prestress = 800 kN.

Contd P/3

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7. (a) Describe briefly the different sources which cause loss of prestress in a prestessed concrete member. **(15)**

(b) Compute the loss of prestress in steel at see 1-1 of Fig. 4 due to elastic shortening of concrete. The prestress in steel at transfer is 1200 MPa. **(20)**

Given: Aps = 800 mm^2; $E_s = 2.5 \times 10^5$ MPa; $E_c = 2.5 \times 10^4$ MPa and $f'_{ci} = 30$ MPa. The symbols have their usual meaning.

8. (a) Write down the ACI/BNBC code provisions for opening in flat plate structures. **(7)**

(b) Explain, why prestressed concrete beams are either I, T or box section? **(8)**

(c) A 20′ × 20′ square slab is fixed along all sides and is isotropically reinforced at top and bottom to provide a resistance to positive bending ϕM_n = 5.0 kip-ft/ft and to negative bending ϕM_n = 5.0 kip-ft/ft. Determine the ultimate load capacity when uniformly distributed load is applied to the slab. **(20)**

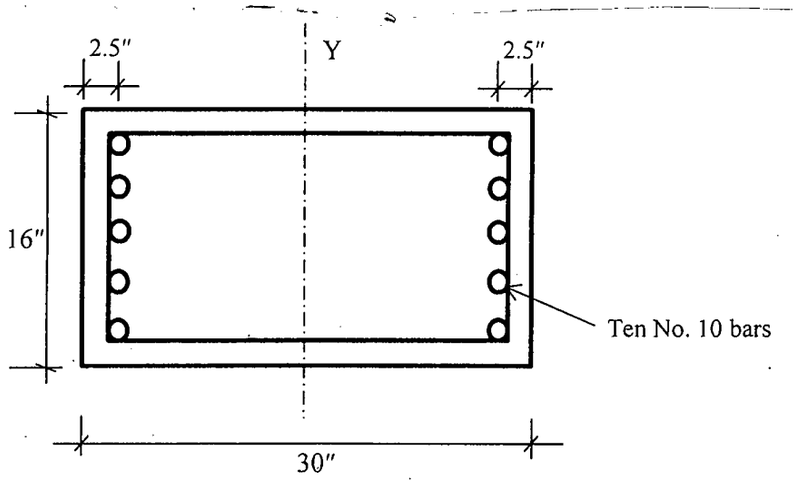


Fig. 1

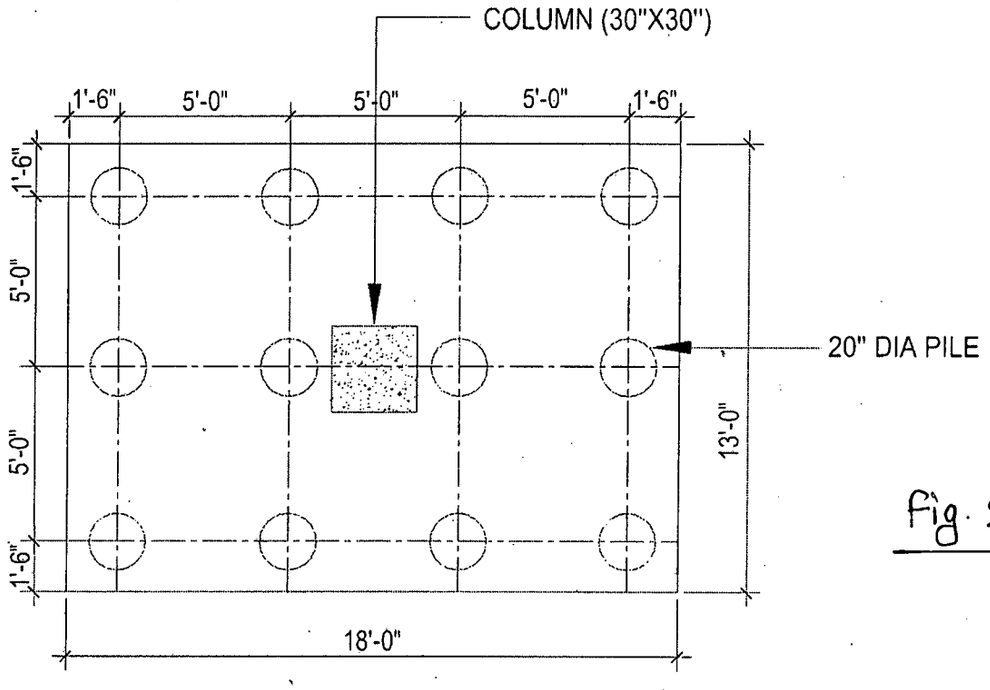


Fig. 2

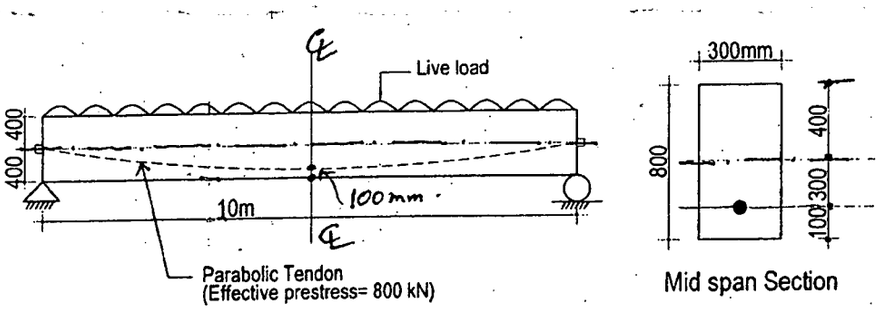


Fig- 3

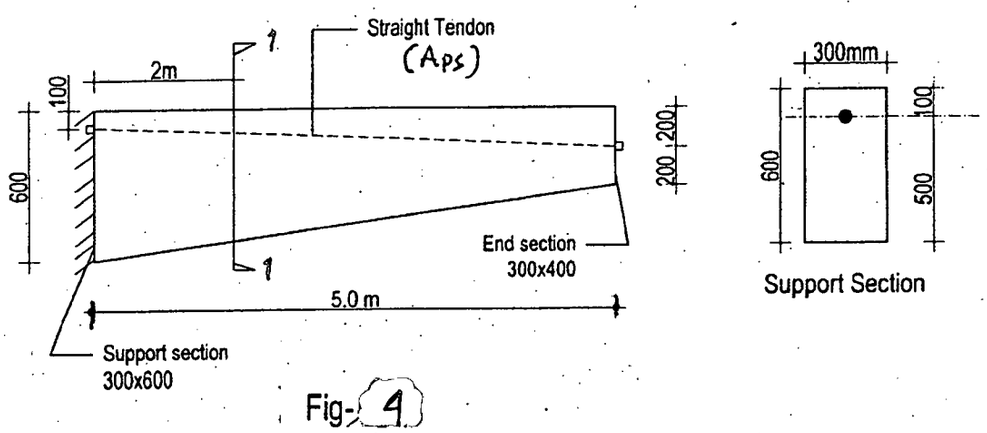
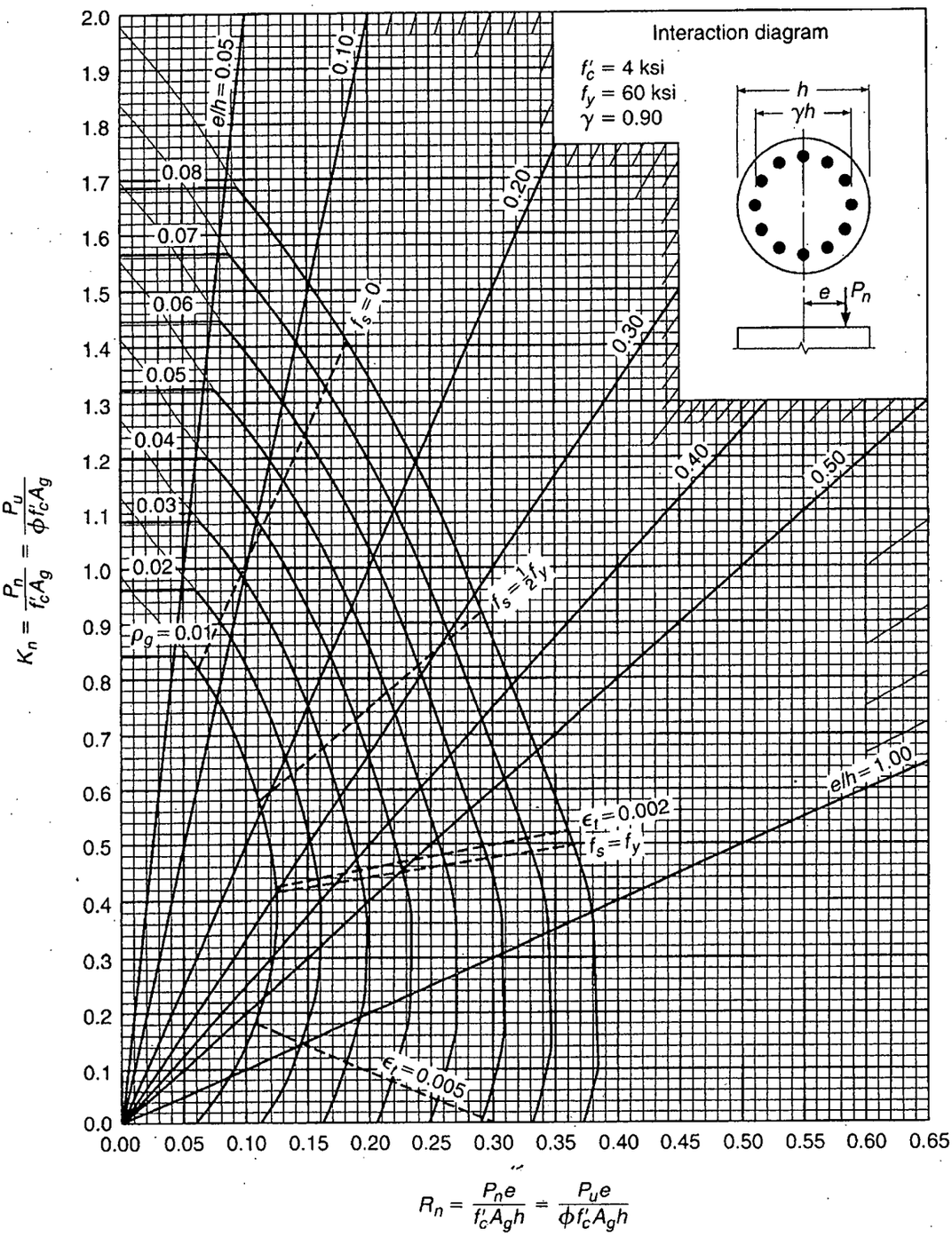
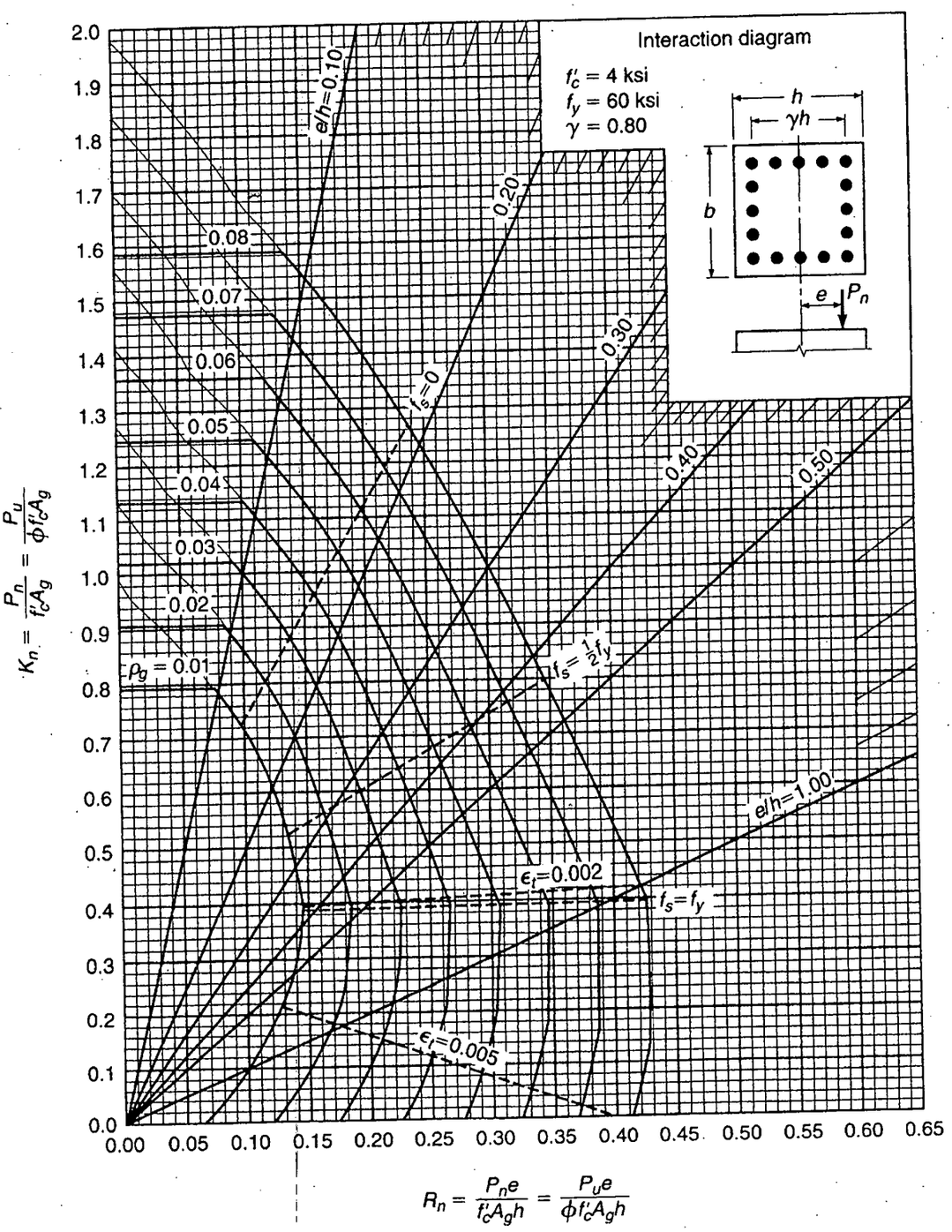


Fig- 4



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



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