L-3/T-2/CE **Date : 18/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

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) Design a suitable latrine for a family of 8 members living in a rural area where tube well based water supply is available, but mechanical desludging facility is not available. Estimated water use for the latrine is 11 lpcd; and long-term infiltration capacity of soil is 20 L/m^2, day. The groundwater table is 3.9 m below ground surface. Two types of concrete rings are available for construction of toilet pits: 1.0 m in diameter, and 1.2 m in 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 suitable concrete rings that would satisfy the design criteria, and estimate its design life. Show design calculations for both ring sizes.

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

[assume reasonable values for parameters not given]

(b) What do you understand by on-site and off-site sanitation system? Give examples. What do you understand by a "hygienic latrine"? Is VIP latrine a hygienic latrine? Explain. **(10)**

(c) What do you understand by small bore sewerage (SBS) system? What are the major technical advantages of SBS system over conventional sewerage system? **(10)**

2. (a) Design a "septic tank" for 6 families living in a building; each family has 6 members. The estimated wastewater flow rate is 85 lpcd and the tank is to be desludged every 2 years. The hydraulic detention time of the tank should be at least 1 day in order to maintain acceptable effluent quality. Draw: **(26⅔)**

(i) A plan view of the designed septic tank system (consider two-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 25°C; assume reasonable values for parameters not given]

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(b) What do you understand by "fecal sludge management (FSM)"? With an appropriate figure/flow diagram, show the major FSM system elements? **(8)**

(c) What are the most common options to reduce risk of groundwater pollution from pit/pour-flush latrines, and to keep these latrines operational during floods in "high water table areas"? Explain with appropriate figures/sketches. **(12)**

3. (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 28.8 m/day. **(26⅔)**

Time (min)	0	60	75	90	120	180	270	390
SS Concentration (mg/l)	350	189	175	158	140	105	56	35

(b) What do you understand by BOD? Differentiate between CBOD and NBOD. What are the major objectives of wastewater treatment? **(10)**

(c) Describe "symbiosis between bacteria and algae" in a facultative pond. What are the advantages of stabilization pond system of wastewater treatment? **(10)**

4. (a) Design an anaerobic-facultative-maturation pond system to treat 12,000 m^3/day of domestic sewage with BOD_5 of 450 mg/l and fecal coliform (FC) of 4×10^7cfu/100 ml. The effluent standards are as follows $BOD_5 < 25$ mg/l, FC < 5,000 cfu/100 ml. Assume a design temperature of 20 °C and values of k and k_b to be 0.24/day and 2.7/day, respectively. **(26⅔)**

[assume reasonable values for parameters not given]

(b) Write down typical biochemical reactions representing metabolism of "heterotrophic anaerobic" bacteria and "autotrophic chemosysthetic anaerobic" bacteria. Draw typical bacterial growth pattern and identify the different phases in the diagram. What is "endogenous respiration"? **(10)**

(c) With a flow diagram, describe the activated sludge processes of wastewater treatment. Discuss the significance of F/M ratio in the operation of activated sludge process. **(10)**

SECTION – B

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

5. (a) Water-logging at the intersection of Dhanmondi Road # 27 and Mirpur Road was at its worst in April, 2017. The highest rainfall was recorded at 100 mm in 24 hrs. A relief sewer needs to be constructed extending from this intersection to the Shanker Intersection

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(Total length 1000 m). Surface run-off from the catchment area (198 acres) to be drained through this storm sewer (inlet at Road # 27 intersection) may be estimated by the Rational Formula; Q = CIA where, Q = Flow in cfs, C = run-off coefficient (assumed to be 0.85), I = rainfall intensity (inch/hr) and A = Catchment Area (Acres). Design the relief sewer with the capacity to carry the run-off generated for the above rainfall event. Following information are available: **(19⅔)**

(i) Minimum Allowable slope = 0.001

(ii) Invert level of the manhole at the Shankar intersection is at +2.0 m.

(iii) RL of the road at the Mirpur Road intersection is +5.0 m PWD.

(iv) At least 2 m clear cover needs to be ensured.

(b) Wastewater flow pattern at the STP of a small town is given in the table below. An 8-hr. Composite Sample needs to be collected based on the waste flow pattern for further analysis at the laboratory. If 5000 mL sample is required, prepare the sampling chart for the 8-hr Composite Sample. Also, draw both the wastewater flow pattern and the bar diagram of the Composite Sample on the same graph. **(18)**

Time	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM
Flow (GPM)	490	420	360	310	290	310	390	560	620	900	1040	1130
Time	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM
Flow (GPM)	1160	1120	1060	1000	950	910	820	800	760	690	630	540

(c) Define: **(9)**

(i) Self-cleansing Velocity (ii) Saturation-Population Density (iii) Combined Sewer System

6. (a) Weekly effluent flow rates and the corresponding BOD_5 concentrations for 13 consecutive weeks are as shown in the following Table. Calculate the weekly BOD_5 loading rates for these 13 weeks. Plot the data on a Log-probability paper provided using the Blom's Transformation and determine the Geometric Mean and Standard Deviation from the GRAPH. Also determine the annual maximum BOD5 loading rate of the said STP. How many weeks in a year the BOD_5 loading rate exceed 100 kg/week? **(18⅔)**

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Week #	1	2	3	4	5	6	7	8	9	10	11	12	13
Q (m^3/wk)	3810	2230	3010	4100	3270	4080	2880	2380	2100	3560	2000	3180	3700
C (mg/l)	29.3	28	36	40	27	27.9	33	33.6	35.7	28.7	34.5	57	62

(b) Neatly draw (and label) the schematic diagram of an ETP using the Physico-Chemical followed by Activated Sludge processes. Identify the reasons for each of the following problems occurring at different occasions and suggest appropriate remedial measures. **(18)**

(i) Flocs breaking-up in flocculation chamber

(ii) Excessive red-colored sludge in the sedimentation tank

(iii) Presence of flocs/solids in he treated effluent from final clarifier/sedimentation tank

(iv) Presence of high level of organic in the final effluent at the outlet

(v) Formation of foam blanket at the aeration tank.

(c) Neatly draw the four different Bedding Conditions for Concrete Pipes and write corresponding design criteria for each condition. **(10)**

7. (a) What is plumbing? List the objectives of water supply system and drainage system of plumbing. What is a clean-out? Where is it placed? **(15)**

(b) List the underlying principles of design of water supply piping in a building. What are the special conditions to be satisfied in the design of the down-feed zones of the water supply in a tall building? What is the difference between waste stack and soil stack? **(15)**

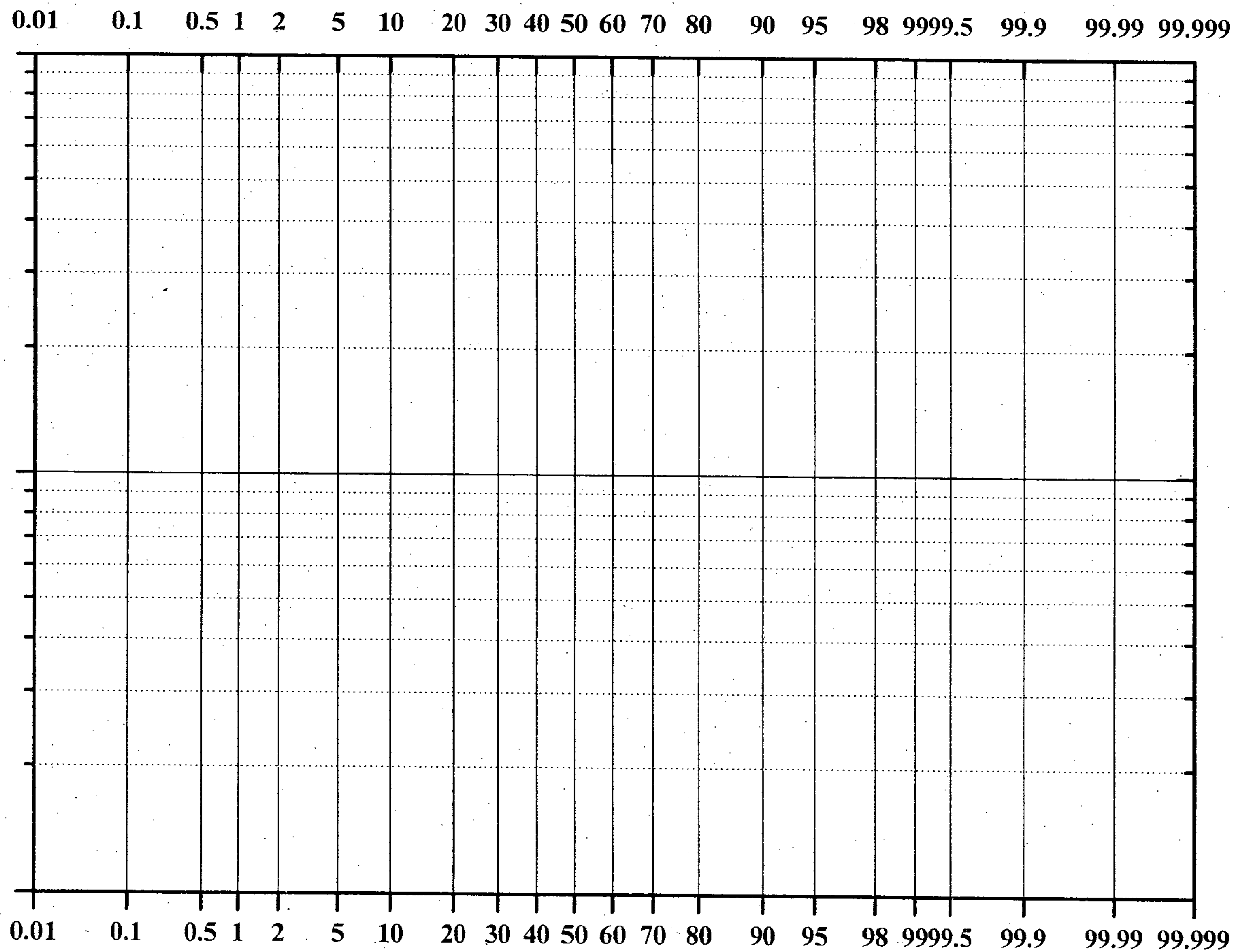
(c) In a 6 storied building all the fixtures are flush tank operated. The fixture operating pressure varies from 6 psi to 12 psi. The water supply is intermittent. Floor to floor height is 10 ft. Calculate the permissible pressure loss in the riser pipe to supply water in the top-most floor. Assume reasonable values of the missing data (if required). **(16⅔)**

8. (a) What are the principal systems of plumbing drainage? Which system do you prefer and why? Briefly explain. Also, state the principles of design of plumbing drainage. **(15)**

(b) (i) List the merits of community participation in water supply or sanitation program.
(ii) How can one identify the "environmental impact" of an activity? What do you understand by the term "mitigation"? **(15)**

(c) (i) Briefly discuss the elements of solid waste management? **(16⅔)**

(ii) List the basic steps of full EIA study.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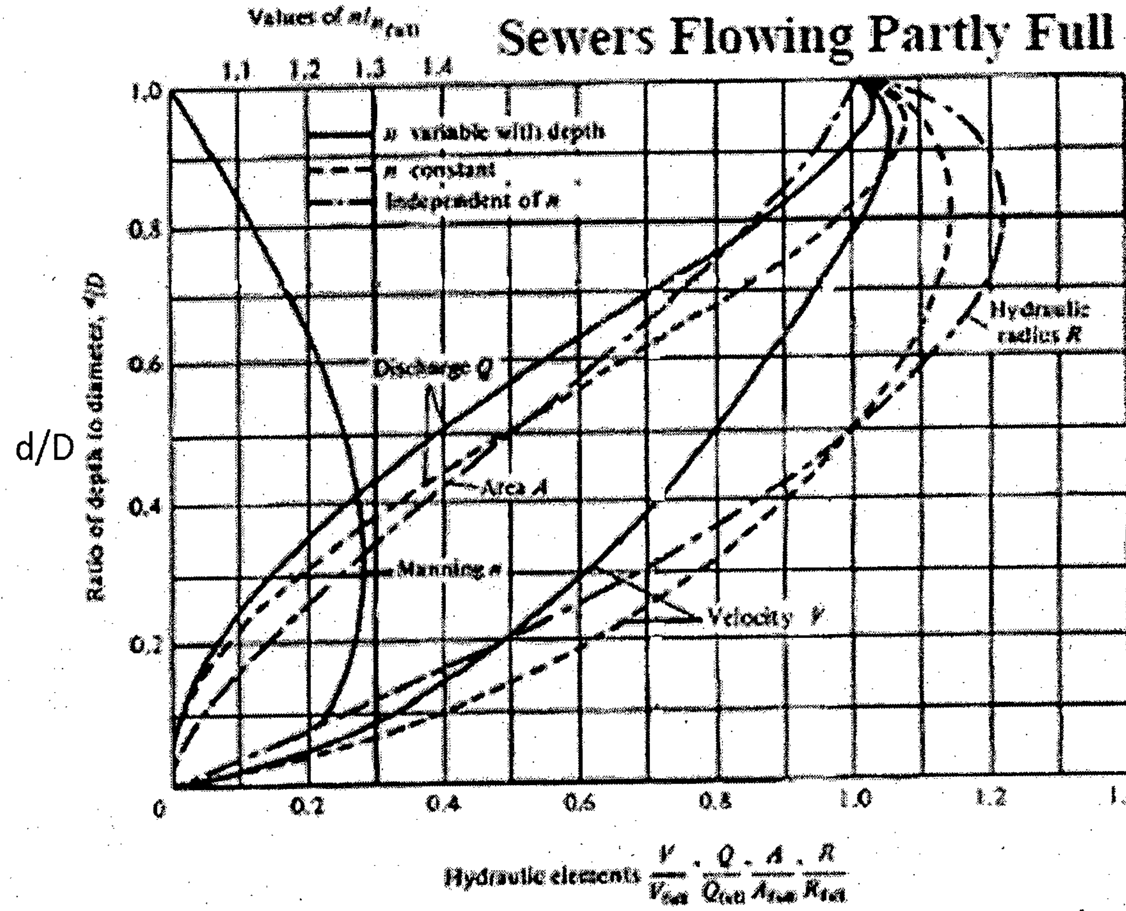
0.01 0.1 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 9999.5 99.9 99.99 99.999

Sewers Flowing Partly Full



L-3/T-2/CE **Date : 24/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

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** questions.
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 12 X 25 inch column is reinforced with six No. 9 bars as shown Fig. 1. Construct the nominal strength interaction diagram for the column with five points corresponding to pure axial load, pure bending, balance condition, ε_s = 0 (zero) and ε_s = 0.005 (tensile). Also find corresponding ϕ for the above points. Assume bending about Y-Y axis. **(28)**

Given: f_c' = 4.0 ksi and f_y = 60 ksi.

2. (a) A ground floor column of a building is to be designed for the following load combinations (axial force and uniaxial bending about strong axis)- **(18)**

Gravity load combination P_u = 500 kip, M_u = 200 kip-ft

Lateral load combination P_u = 300 kip, M_u = 300 kip-ft

A 12 X 25 inch column is designed with reinforcement of No. 9 bars as shown Fig. 1. Material strengths are f_c' = 4.0 ksi and f_y = 60 ksi.

Check the adequacy of the column. Use supplied column strength interaction design chart and γ = 0.8.

(b) Design a spirally reinforced column with about 2.5% reinforcement to support working unfactored loads: P_{DL} = 2000 kip and P_{LL} = 1200 kip. Given f_c' = 5.0 ksi and f_y = 72.5 ksi. Also, design the ACI spirals required. **(13)**

(c) What are the purposes of providing ties and spiral in a column? **(4)**

3. (a) Describe different failure modes of shear wall. **(9)**

(b) A shear wall of a 18-storey building is subjected to following factored loads: **(20)**

P_u = 650 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' = 4.0 ksi and f_y = 60 ksi. Ignore axial force as it is less than balanced load of the section.

(c) What is a slender column? Write the ACI kl_u/r limits below which the effects of slenderness may be neglected for both sway and non-sway structures. **(6)**

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)**

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(c) 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 $f_c' = 4.0$ ksi and $f_y = 60$ ksi. Check adequacy of the short column using Load Contour Method for: **(18)**

$P_u = 5000$ kip, $M_{ux} = 3000$ kip-ft, $M_{uy} = 2000$ kip-ft

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

SECTION-B

There are **FOUR** questions in this section. Answer any **THREE** questions.
Assume reasonable value for any missing data

5. (a) Explain (with appropriate graphical representation) the variation of steel stress in a prestressed concrete beam with the increase of load. **(15)**

   (b) Calculate the stresses in concrete at midspan section of prestressed concrete beam shown in Fig. 2. Given: tendon area Aps = 1560 mm^2; prestress at transfer f_0 = 1200 Mpa and n = 6. Use any method for your calculation and consider self weight of the member. **(20)**

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

   (b) Compute the loss of the prestress in steel at sec 1-1 of the cantilever beam shown in Fig. 3 due to elastic shortening of concrete. The prestress in bonded tendons at transfer is 1100 Mpa. Given: Tendon area Aps = 1960 mm^2; $E_s = 2.1 \times 10^5$ MPa; $E_{ci} = 3 \times 10^4$ MPa and $f'_{ci} = 30$ MPa. The symbols have their usual meanings. **(20)**

7. (a) A residential building is to be designed using a flat plate floor system. The interior columns are 24″ × 24″ and they are spaced 22 ft c/c in one direction and 24 ft c/c in other direction. Design the interior panel (22′ × 24′) and show the reinforcements in long direction only with neat sketches. Assume slab thickness = 9″. Specified live load = 40 psf; Floor finish and partition wall load = 60 psf in addition to the self weight of floor slab. Use $f'_c = 3.5$ ksi and $f_y = 60$ ksi for your design. **(25)**

   (b) Name different types of reinforced concrete floor slabs commonly used in Bangladesh with proper sketches. **(10)**

8. (a) The plan of a pile cap with 12 nos. 20 inch diameter cast-in-situ piles with the column (30″ × 30″) is shown in Fig. 4. The column carries a DL = 1000 kip and a LL = 600 kip (working). The individual pile capacity is adequate. Design the pile cap and show the reinforcements with neat sketches. Given: $f'_c = 3.5$ ksi and $f_y = 60$ ksi. **(18)**

   (b) An interior column of a residential building carries total service loads: **(17)**
   DL = 400 kip and LL = 200 kip. The column is 20″ × 20″ in cross section. The column is supported on a rectangular footing with the bottom at 5 ft below grade. The width of the footing is 10 ft. Design rectangular footing and show the reinforcements (in plan and sections) with neat sketches. The allowable soil bearing pressure is 4.0 ksf. Use $f_c' = 3.5$ ksi and $f_y = 72.5$ ksi for footing design.

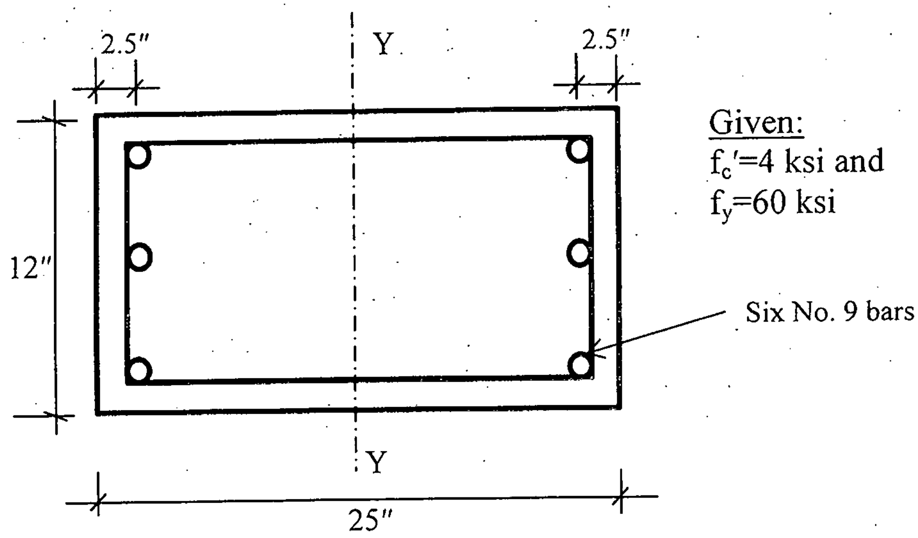
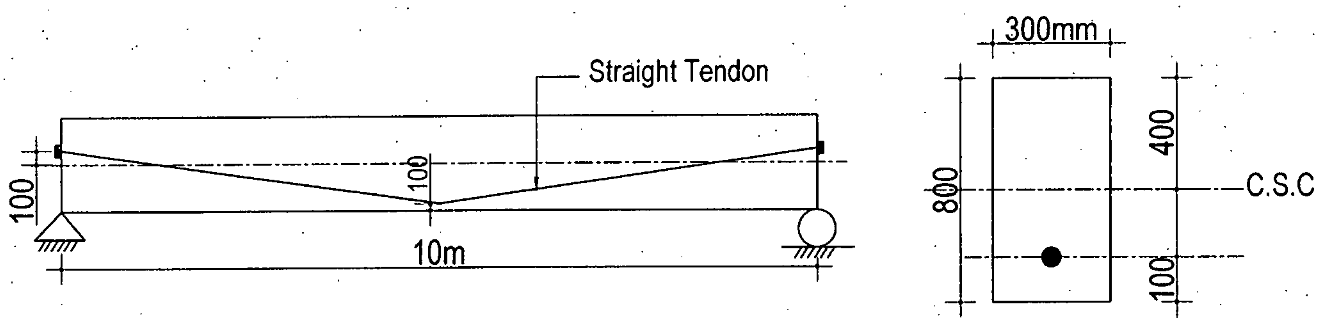


Fig. 1



Mid span Section

Fig-2

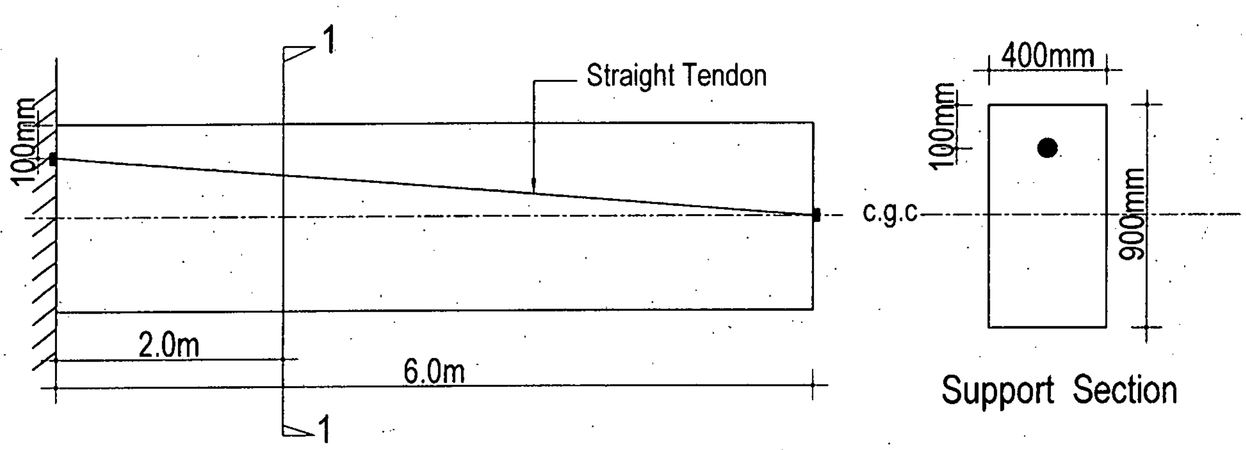


Fig-3

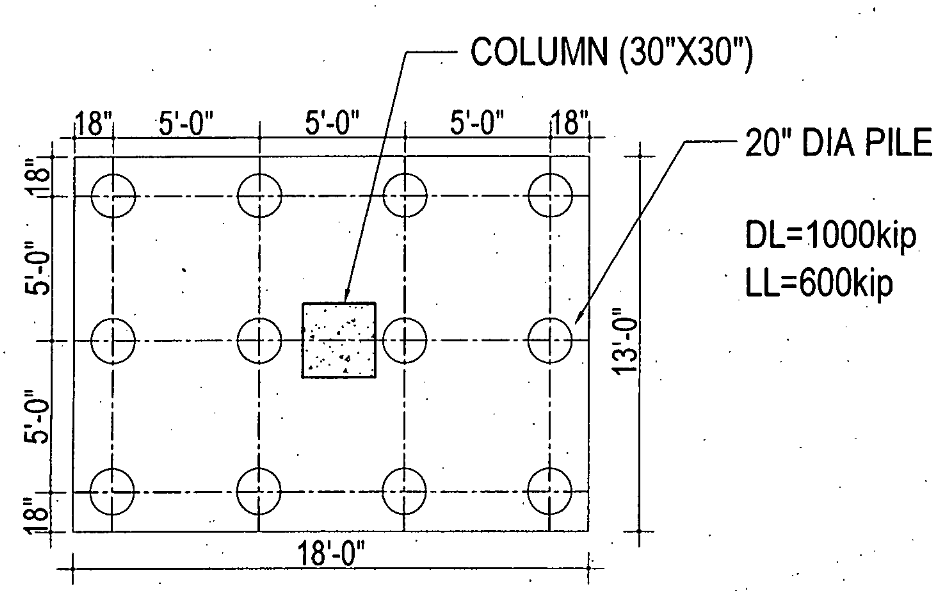
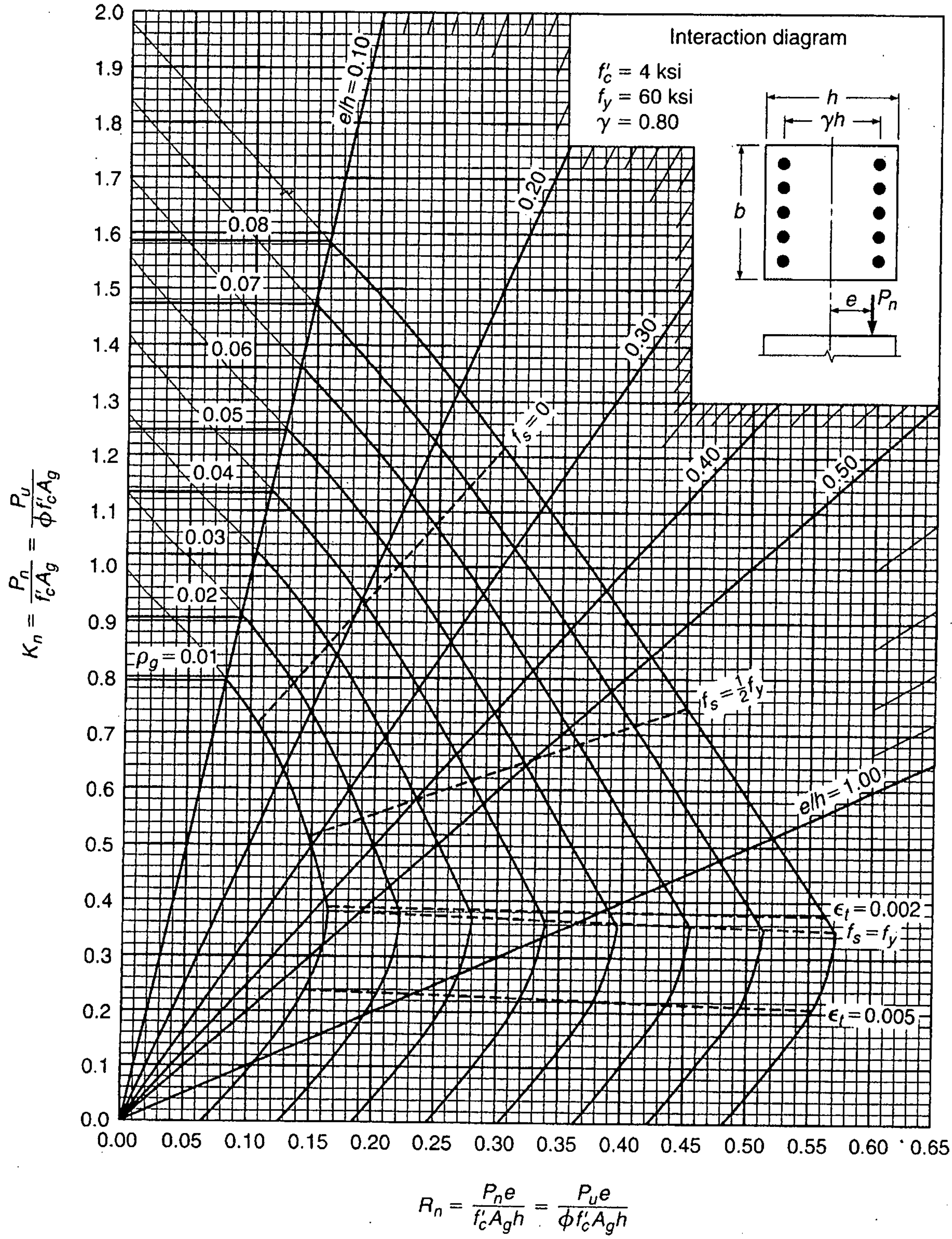


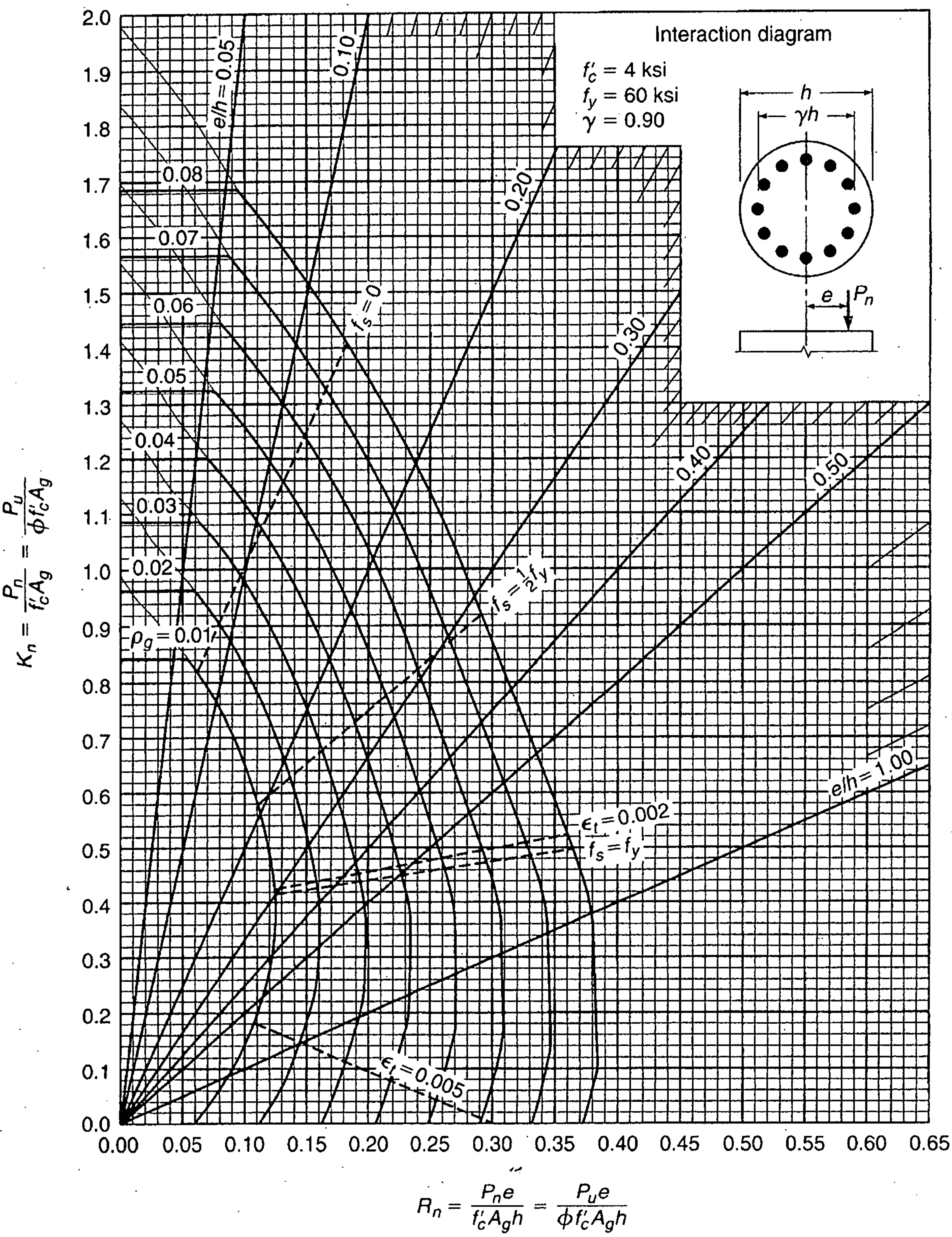
Fig-4



GRAPH A.11

Column strength interaction diagram for rectangular section with bars on end faces and $\gamma = 0.80$.

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



GRAPH A.16

Column strength interaction diagram for circular section with γ = 0.90.

L-3/T-2/CE **Date : 28/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

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

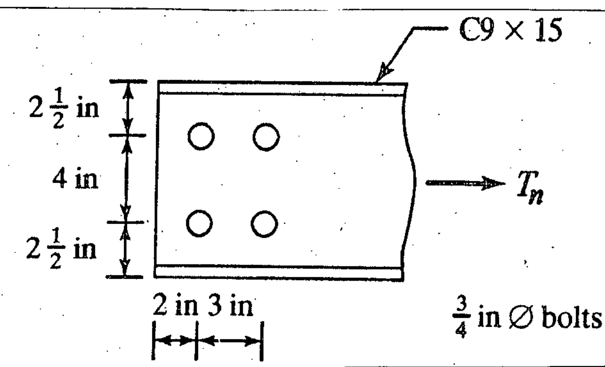
There are **FOUR** questions in this section. Answer any **THREE** questions.

Symbols and notations have their usual meanings.

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

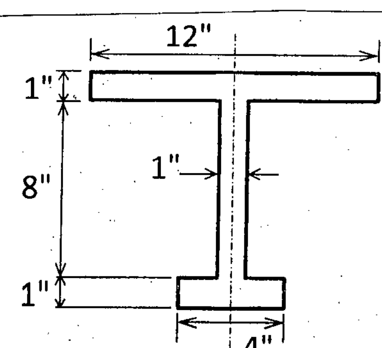
1. (a) Determine the nominal tension capacity, T_n, of the C9x15 channel section shown in Fig.1 based on tension limit states of the channel section. The channel material is A572 Grade 50 (F_y = 50 ksi, F_u = 65 ksi). Follow LRFD principle. **(17)**

Fig.1



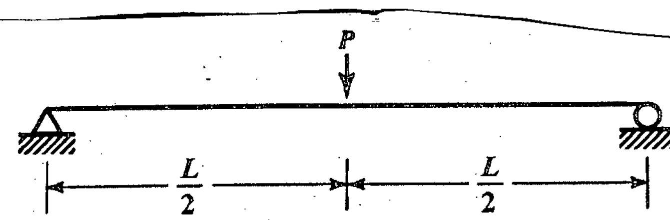
(b) Determine the shape factor for the beam section shown in Fig. 2 **(18)**

Fig.2



2. (a) A simply supported beam of span L = 20 ft shown in Fig.3 is acted upon by a point load, P, at mid-span. The magnitudes of P are 15 kip for dead load and 30 kip for live load. Beam material is A36 (F_y = 36 ksi, F_u = 58 ksi). Maximum deflection due to live load shall be limited to $\frac{1}{360}-th$ of the span. Design an economic and compact W section considering that the beam is laterally supported all along the span. Follow LRFD principle. **(17)**

Fig.3



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(b) Determine the design tensile strength, $\phi\ P_n$, for the bolted connection shown in Fig.4 based on bolt limit states only. The bolts are $\frac{7}{8}$-*in* dia A490 (F_y = 120 ksi, F_u = 150 ksi) type and the plates are of A36 (F_y = 36 ksi, F_u = 58 ksi). **(18)**

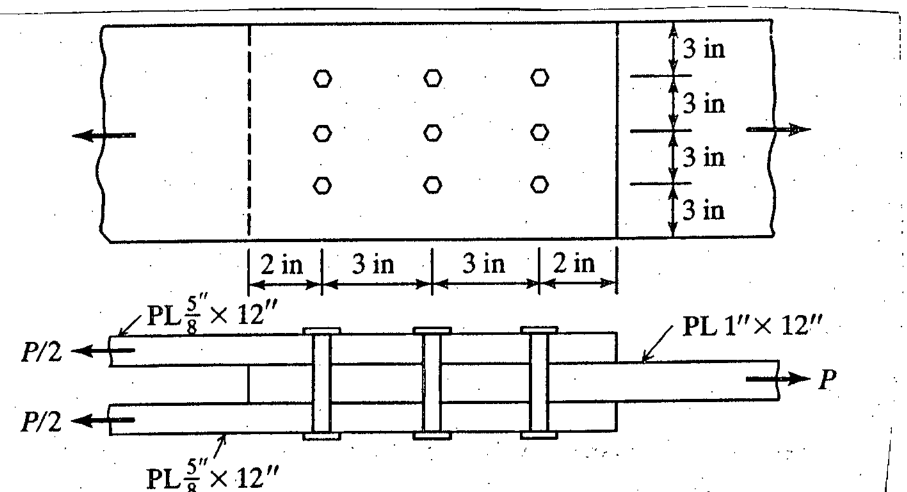

Fig.4

3. (a) For the eccentrically loaded bolted connection shown in Fig.5, determine the shear force in the most highly stressed bolt based on elastic analysis. **(17)**

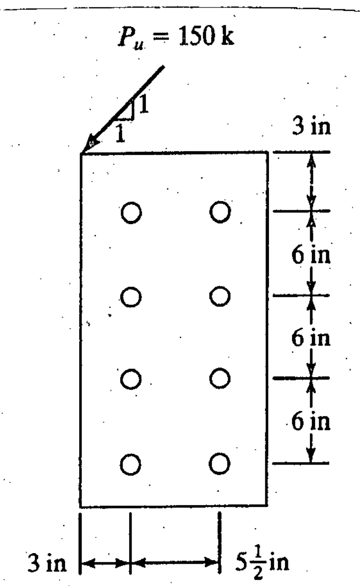

Fig.5

(b) A W14x132 beam section has to carry a shear force of 120 kip. Determine (i) maximum shear stress in the section, (ii) portion of shear force carried by the web. **(18)**

4. A W18x71 beam (A572 Gr. 50, F_y = 50 ksi, F_u = 65 ksi) has to transfer 85 k-ft dead load and 160 k-ft live load moment on to a W 21x201 (A572 Gr. 50) column on its strong axis through an extended end plate type connection. Suitably dimension the end plate and determine the bolt diameter and thickness of end plate (A572 Gr. 50). Use ASTM A325 bolts (F_y = 90 ksi, F_u = 120 ksi). Maximum diameter of bolts shall be limited to 1 inch. Show the detailed endplate dimensions and bolt hole locations on neat sketches. **(35)**

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SECTION-B

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

5. (a) Draw a column strength curve and indicate regions of short, intermediate and long column. How does failure of short column differ from that of long column? **(6)**
(b) Determine effective length factors, K for the columns of the frame shown in Fig.6 column Alignment charts are included in Annexure –1. **(9)**
(c) Find the allowable load of the column having cross-section and support conditions shown in Fig.7. Use A992 steel. **(20)**

6. (a) What is local bucking? Differentiate between stiffened and unstiffened element. Write down AISC limits for width to thickness ratio to prevent local bucking in I – shape column. **(15)**
(b) Select lightest section for a column of 24 ft long shown in Fig.8 to carry an axial deal load of 300 kip and live load of 150 kip. Assume Fixed-Pinned ends for both axes. The column is braced at mid point in weak direction. Use AISC LRFD method and A992 steel. Sectional properties are given in Annexure – 2. **(20)**

7. (a) Define lateral torsional building with sketch. How this is prevented? **(5)**
(b) What are C_b and L_p? **(5)**
(c) Compute value of C_b for the continuous beam shown in Fig.9. Lateral supports are provided at the supports only. **(5)**
(d) A 24 ft simply supported beam of W21 × 93 section carries two concentrated load of "P" kip at a distance of 8 ft from each support. The beam is laterally supported at ends and at locations of concentrated load. What would be the value of concentrated load "P"? Use AISC/ASD method and A36 steel. **(20)**

8. (a) Investigate the adequacy of the beam-column section as shown in Fig.10. The beam is pinned at both ends. Consider bending about strong axis. Use A992 steel and AISC LRFD Method. The member is braced at the ends only. **(20)**
(b) A W14 × 132 column on a concrete base transmits an axial dead load of 400 kip and live load of 700 kip. The concrete base has a top surface area of 40 inch by 70 inch. Design the base plate (size and thickness). use A36 steel f'_c = 4 ksi concrete. Consider LRFD method. Sectional properties of A W14 × 132 is included in Annexure -2. **(15)**
Given: Nominal bearing stress,

$$f_{p(\max)} = (0.85 f'_c)\sqrt{\frac{A_2}{A_1}} \le 1.7 f'_c$$

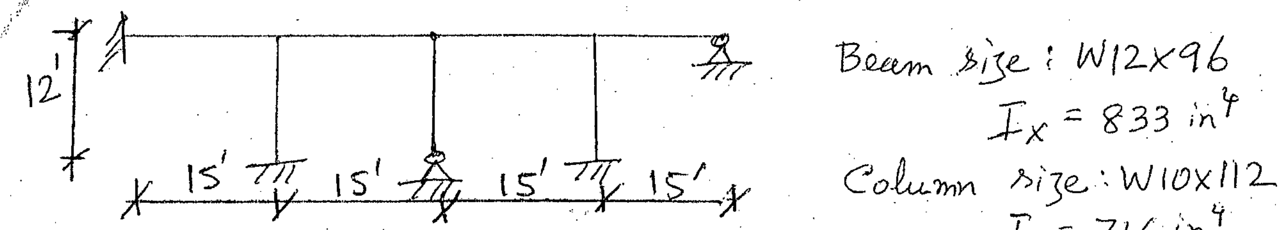


Fig. 6

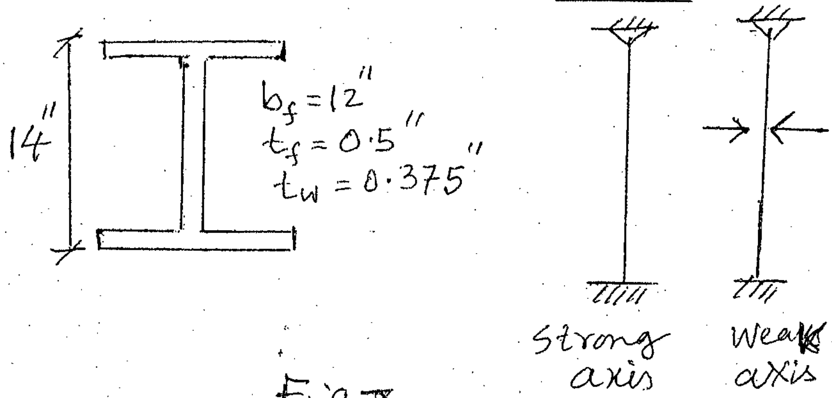


Fig 7

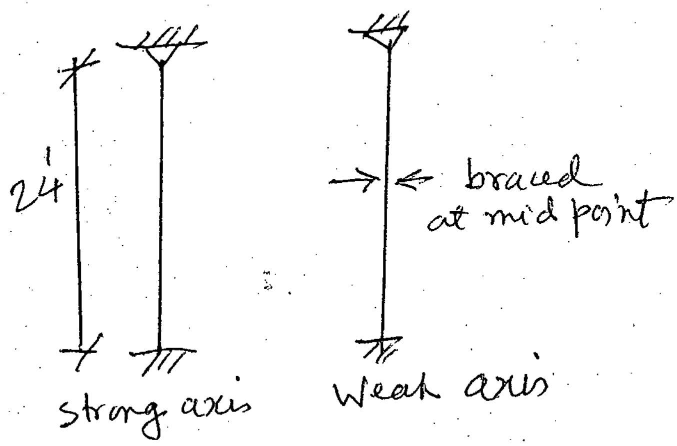


Fig 8

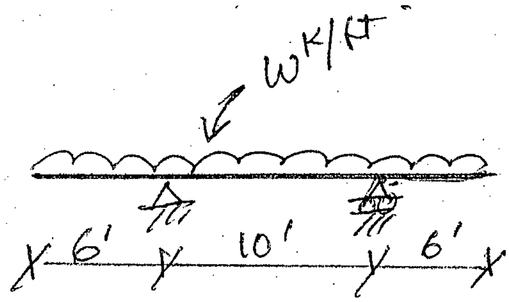


Fig 9

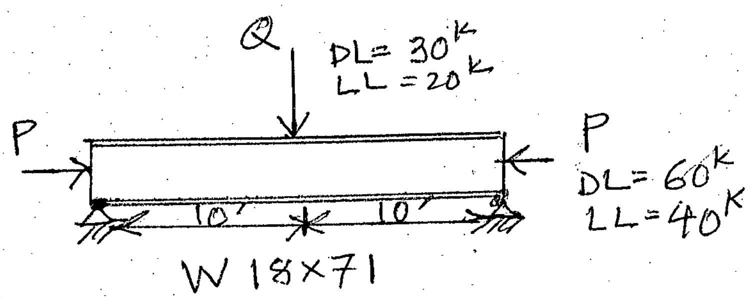


Fig. 10

Properties of channel sections

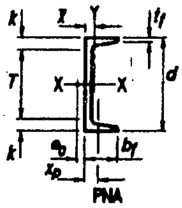


Table 1–5
C Shapes
Dimensions

Table 1–5 (continued)
C Shapes
Properties

C SHAPES

Shape	Area, A	Depth, d		Web Thickness, t_w	Flange Width, b_f	Flange Thickness, t_f	r_{ts}	h_o	Nominal Wt.
	in.²	in.		in.	in.	in.	in.	in.	lb/ft
C9×20	5.87	9.00	9	0.448	2.65	0.413	0.848	8.59	20
×15	4.41	9.00	9	0.285	2.49	0.413	0.824	8.59	15
×13.4	3.94	9.00	9	0.233	2.43	0.413	0.813	8.59	13.4
C8×18.7	5.51	8.00	8	0.487	2.53	0.390	0.800	7.61	18.7
×13.7	4.04	8.00	8	0.303	2.34	0.390	0.774	7.61	13.7
×11.5	3.37	8.00	8	0.220	2.26	0.390	0.756	7.61	11.5
C7×14.7	4.33	7.00	7	0.419	2.30	0.366	0.738	6.63	14.7
×12.2	3.60	7.00	7	0.314	2.19	0.366	0.721	6.63	12.2
×9.8	2.87	7.00	7	0.210	2.09	0.366	0.698	6.63	9.8

Shape	Shear Ctr, e_o	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 $\bar{x}$	Axis Y-Y Z	Axis Y-Y x_p	Torsional Properties J	Torsional Properties C_w	Torsional Properties $\bar{r}_o$	Torsional Properties H
	in.	in.⁴	in.³	in.	in.³	in.⁴	in.³	in.	in.	in.³	in.	in.⁴	in.⁶	in.	
C9×20	0.515	60.9	13.5	3.22	16.9	2.41	1.17	0.640	0.583	2.46	0.326	0.427	39.4	3.46	0.899
×15	0.681	51.0	11.3	3.40	13.6	1.91	1.01	0.659	0.586	2.04	0.245	0.208	31.0	3.69	0.882
×13.4	0.742	47.8	10.6	3.49	12.6	1.75	0.954	0.666	0.601	1.94	0.219	0.168	28.2	3.79	0.875
C8×18.7	0.431	43.9	11.0	2.82	13.9	1.97	1.01	0.598	0.565	2.17	0.344	0.434	25.1	3.05	0.894
×13.7	0.604	36.1	9.02	2.99	11.0	1.52	0.848	0.613	0.554	1.73	0.252	0.186	19.2	3.26	0.874
×11.5	0.697	32.5	8.14	3.11	9.63	1.31	0.775	0.623	0.572	1.57	0.211	0.130	16.5	3.41	0.862
C7×14.7	0.441	27.2	7.78	2.51	9.75	1.37	0.772	0.561	0.532	1.63	0.309	0.267	13.1	2.75	0.875
×12.2	0.538	24.2	6.92	2.60	8.46	1.16	0.696	0.568	0.525	1.42	0.257	0.161	11.2	2.86	0.862
×9.8	0.647	21.2	6.07	2.72	7.19	0.957	0.617	0.578	0.541	1.26	0.205	0.0996	9.15	3.03	0.846

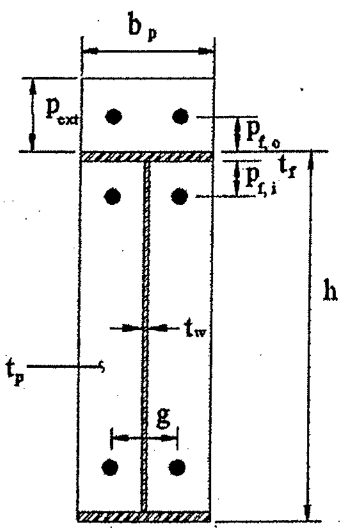
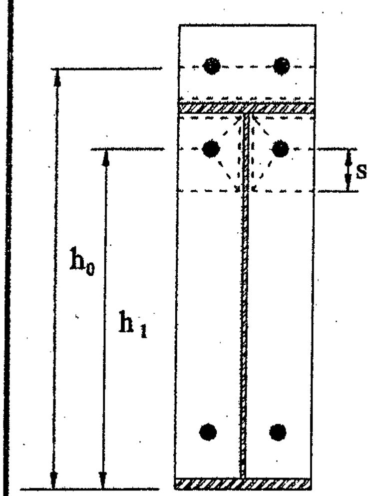
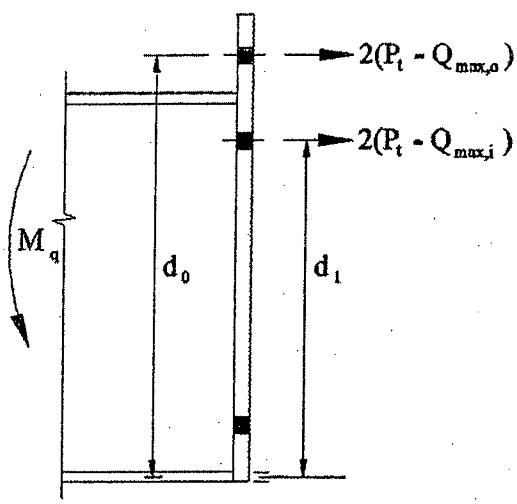
End plate design equations and tables

Bolt diameter $d_b = \sqrt{\dfrac{2M_u}{\pi\phi F_t \sum d_n}}$, End plate thickness, $t_p = \sqrt{\dfrac{1.11\gamma_r \phi M_{np}}{\phi_b F_{py} Y}}$

$\phi M_{np} = \phi\,[2P_t \Sigma d_n]$, where $P_t = \frac{\pi}{4} d_b^2 F_t$ and $\phi = 0.75$, $F_t = 90$ ksi for A325 bolts

Where, $\phi_b = 0.9$, $\gamma_r = 1.0$ for extended end plate, F_{py}= Endplate yield strength,
Y = yield line mechanism parameter,
Usable ASTM bolt diameters are: $^1/_2$, $^5/_8$, $^3/_4$, $^7/_8$ and 1 inch.

Table for yield line mechanism parameter for 1/1 rows of bolts (2+2-bolts)

Geometry	Yield-Line Mechanism	Bolt Force Model
		

End-Plate Yield

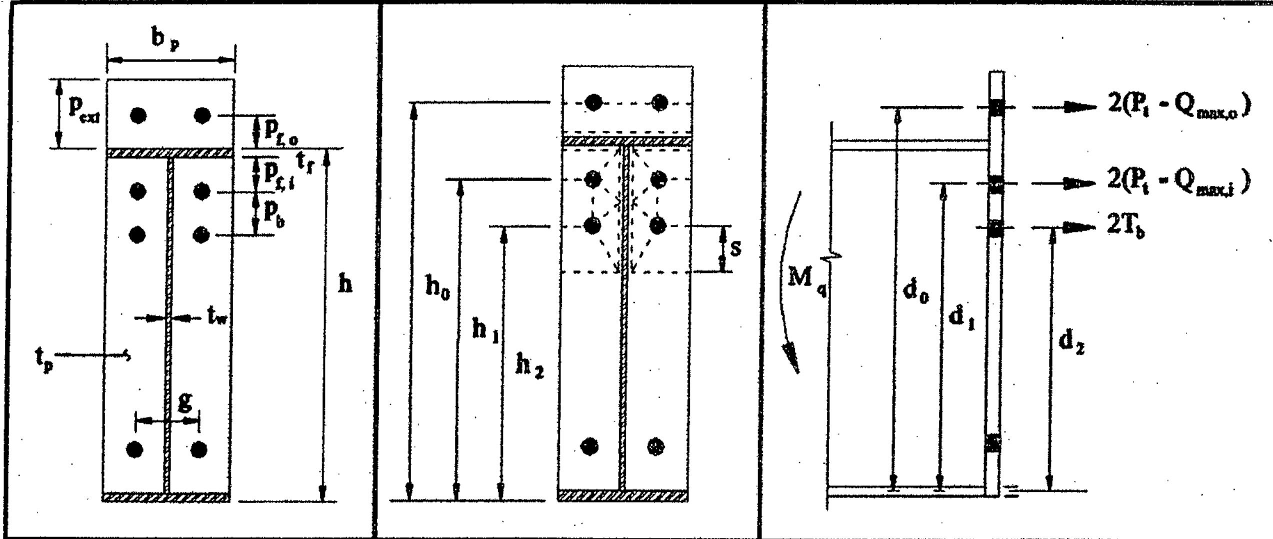
$$\phi M_n = \phi_b M_{pl} = \phi_b F_{py} t_p^2 Y$$

$$Y = \frac{b_p}{2}\left[h_1\left(\frac{1}{p_{f,i}} + \frac{1}{s}\right) + h_0\left(\frac{1}{p_{f,o}}\right) - \frac{1}{2}\right] + \frac{2}{g}\left[h_1\left(p_{f,i} + s\right)\right]$$

Note: Use $p_{f,i} = s$, if $p_{f,i} > s$

$$s = \frac{1}{2}\sqrt{b_p g} \qquad \phi_b = 0.90$$

Table for yield line mechanism parameter for 1/2 rows of bolts (2+4-bolts)



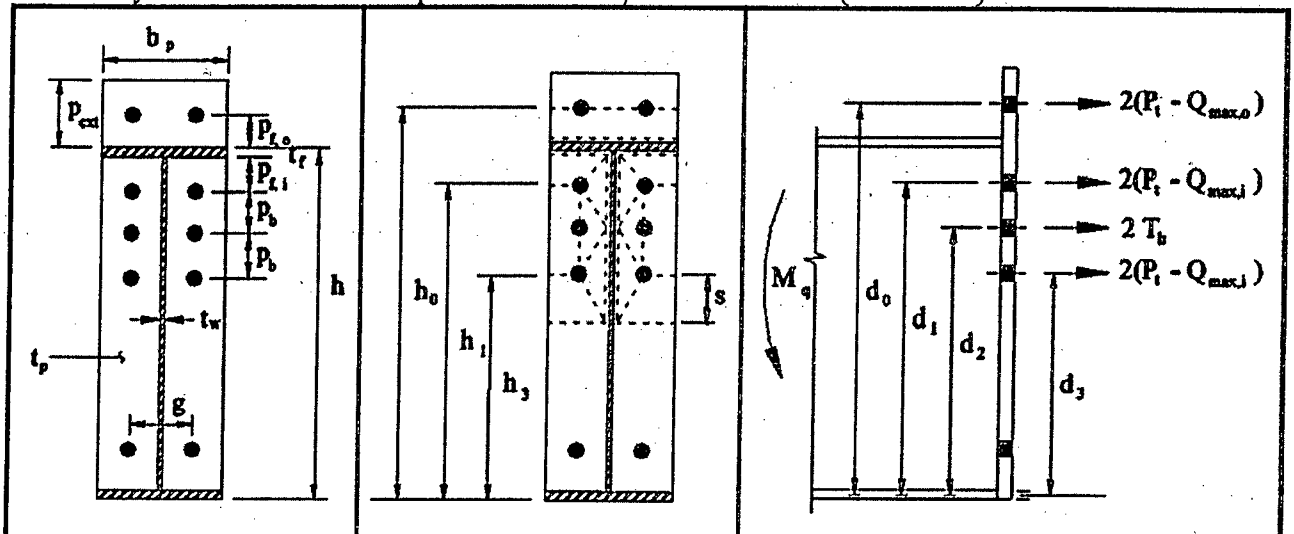
End-Plate Yield

$$\phi M_n = \phi_b M_{pl} = \phi_b F_{py} t_p^2 Y$$

$$Y = \frac{b_p}{2}\left[h_1\left(\frac{1}{p_{f,i}}\right)+h_2\left(\frac{1}{s}\right)+h_0\left(\frac{1}{p_{f,o}}\right)-\frac{1}{2}\right]+\frac{2}{g}\left[h_1\left(p_{f,i}+0.75p_b\right)+h_2\left(s+0.25p_b\right)\right]+\frac{g}{2}$$

$s = \frac{1}{2}\sqrt{b_p g}$ $\quad\phi_b = 0.90\quad$ Note: Use $p_{f,i} = s$, if $p_{f,i} > s$

Table for yield line mechanism parameter for 1/3 rows of bolts (2+6-bolts)



End-Plate Yield

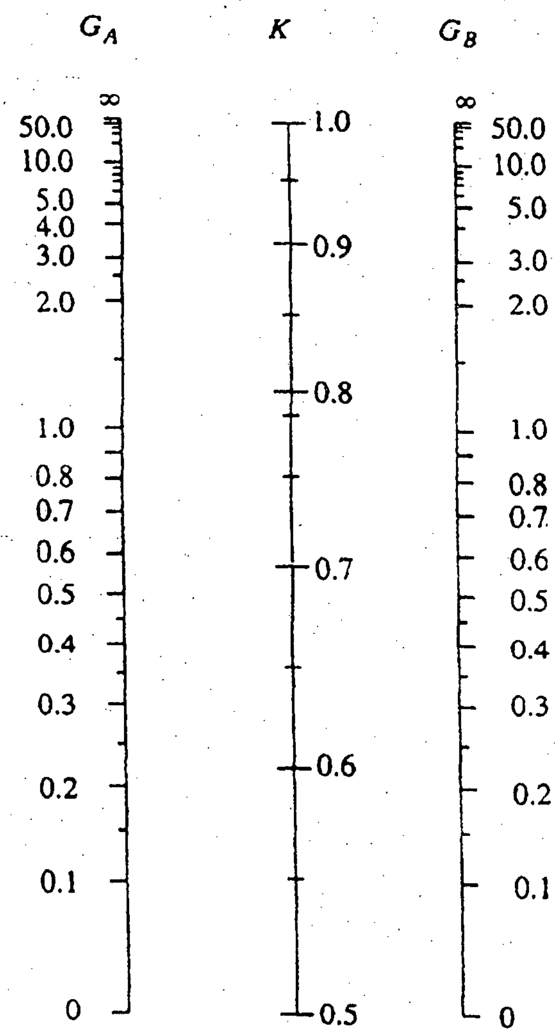
$$\phi M_n = \phi_b M_{pl} = \phi_b F_{py} t_p^2 Y$$

$$Y = \frac{b_p}{2}\left[h_1\left(\frac{1}{p_{f,i}}\right)+h_3\left(\frac{1}{s}\right)+h_0\left(\frac{1}{p_{f,o}}\right)-\frac{1}{2}\right]+\frac{2}{g}\left[h_1\left(p_{f,i}+1.5p_b\right)+h_3\left(s+0.5p_b\right)\right]+\frac{g}{2}$$

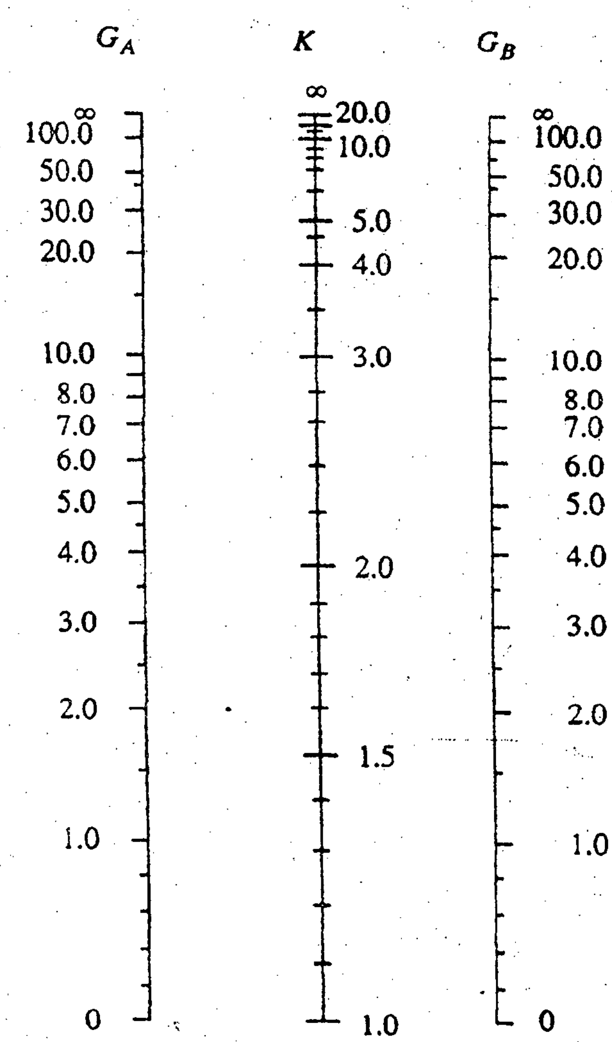
$s = \frac{1}{2}\sqrt{b_p g}$ $\quad\phi_b = 0.90\quad$ Note: Use $p_{f,i} = s$, if $p_{f,i} > s$

Annexure-1

Column alignment charts



Sidesway prevented
(Braced frame)



Sidesway not prevented
(Unbraced frame)

Column Formulae

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

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

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

Beam Formulae

$$M_n = C_b\left[M_p - (M_p - 0.7F_yS_x)\left(\frac{L_b - L_p}{L_r - L_p}\right)\right] \leq M_p$$

$$M_n = M_p - (M_p - 0.7F_yS_x)\left(\frac{\lambda - \lambda_{pf}}{\lambda_{rf} - \lambda_{pf}}\right)$$

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

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

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

AISC LRFD beam-column interaction formula

$$\frac{P_u}{\phi_c P_n} + \frac{8}{9}\left[\frac{M_{ux}}{\phi_b M_{nx}} + \frac{M_{uy}}{\phi_b M_{ny}}\right] \leq 1.0 \quad \text{For} \quad \frac{P_u}{\phi_c P_n} \geq 0.2$$

$$B = \frac{1}{1 - \frac{P_u}{P_e}}$$

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

Annexure - 2

W section properties chart

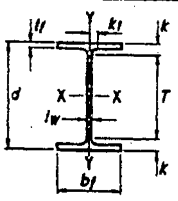


Table 1-1 (continued) W Shapes Dimensions

Shape	Area, A	Depth, d	Web Thickness, t_w	Flange Width, b_f	Flange Thickness, t_f	Distance k: k_{des}	Distance k: k_{det}	k_1	T	Workable Gage
	in.²	in.	in.	in.	in.	in.	in.	in.	in.	in.
W21×201	59.2	23.0	0.910	12.6	1.63	2.13	2 1/2	1 5/16	18	5 1/2
×182	53.6	22.7	0.830	12.5	1.48	1.98	2 3/8	1 1/4		
×166	48.8	22.5	0.750	12.4	1.36	1.86	2 1/4	1 3/16		
×147	43.2	22.1	0.720	12.5	1.15	1.65	2	1 3/16		
×132	38.8	21.8	0.650	12.4	1.04	1.54	1 15/16	1 1/8		
×122	35.9	21.7	0.600	12.4	0.960	1.46	1 13/16	1 1/8		
×111	32.7	21.5	0.550	12.3	0.875	1.38	1 3/4	1 1/8		
×101[c]	29.8	21.4	0.500	12.3	0.800	1.30	1 11/16	1 1/16		
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
×83[c]	24.3	21.4	0.515	8.36	0.835	1.34	1 1/2	7/8		
×73[c]	21.5	21.2	0.455	8.30	0.740	1.24	1 7/16	7/8		
×68[c]	20.0	21.1	0.430	8.27	0.685	1.19	1 3/8	7/8		
×62[c]	18.3	21.0	0.400	8.24	0.615	1.12	1 5/16	13/16		
×55[c]	16.2	20.8	0.375	8.22	0.522	1.02	1 3/16	13/16		
×48[c,f]	14.1	20.6	0.350	8.14	0.430	0.930	1 1/8	13/16		
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]
×65	19.1	18.4	0.450	7.59	0.750	1.15	1 7/16	7/8		
×60[c]	17.6	18.2	0.415	7.56	0.695	1.10	1 3/8	13/16		
×55[c]	16.2	18.1	0.390	7.53	0.630	1.03	1 5/16	13/16		
×50[c]	14.7	18.0	0.355	7.50	0.570	0.972	1 1/4	13/16		
W14×132	38.8	14.7	0.645	14.7	1.03	1.63	2 5/16	1 9/16	10	5 1/2
×120	35.3	14.5	0.590	14.7	0.940	1.54	2 1/4	1 1/2		
×109	32.0	14.3	0.525	14.6	0.860	1.46	2 3/16	1 1/2		
×99[f]	29.1	14.2	0.485	14.6	0.780	1.38	2 1/16	1 7/16		
×90[f]	26.5	14.0	0.440	14.5	0.710	1.31	2	1 7/16		
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
×74	21.8	14.2	0.450	10.1	0.785	1.38	1 5/8	1 1/16		
×68	20.0	14.0	0.415	10.0	0.720	1.31	1 9/16	1 1/16		
×61	17.9	13.9	0.375	10.0	0.645	1.24	1 1/2	1		
W14×53	15.6	13.9	0.370	8.06	0.660	1.25	1 1/2	1	10 7/8	5 1/2
×48	14.1	13.8	0.340	8.03	0.595	1.19	1 7/16	1		
×43[c]	12.6	13.7	0.305	8.00	0.530	1.12	1 3/8	1		
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
×53	15.6	12.1	0.345	10.0	0.575	1.18	1 3/8	15/16	9 1/4	5 1/2
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
×45	13.1	12.1	0.335	8.05	0.575	1.08	1 3/8	15/16		
×40	11.7	11.9	0.295	8.01	0.515	1.02	1 3/8	7/8		
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
×30[c]	8.79	12.3	0.260	6.52	0.440	0.740	1 1/8	3/4		
×26[c]	7.65	12.2	0.230	6.49	0.380	0.680	1 1/16	3/4		
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]
×19[c]	5.57	12.2	0.235	4.01	0.350	0.650	7/8	9/16		
×16[c]	4.71	12.0	0.220	3.99	0.265	0.565	13/16	9/16		
×14[c,v]	4.16	11.9	0.200	3.97	0.225	0.525	3/4	9/16		
W10×112	32.9	11.4	0.755	10.4	1.25	1.75	1 15/16	1	7 1/2	5 1/2
×100	29.4	11.1	0.680	10.3	1.12	1.62	1 13/16	1		
×88	25.9	10.8	0.605	10.3	0.990	1.49	1 11/16	15/16		
×77	22.6	10.6	0.530	10.2	0.870	1.37	1 9/16	7/8		
×68	20.0	10.4	0.470	10.1	0.770	1.27	1 7/16	7/8		
×60	17.6	10.2	0.420	10.1	0.680	1.18	1 3/8	13/16		
×54	15.8	10.1	0.370	10.0	0.615	1.12	1 5/16	13/16		
×49	14.4	10.0	0.340	10.0	0.560	1.06	1 1/4	13/16		

Table 1-1 (continued) W Shapes Properties

Shape	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.⁴	in.³	in.	in.³	in.⁴	in.³	in.	in.³	in.	in.	in.⁴	in.⁶
W21×201	5310	461	9.47	530	542	86.1	3.02	133	3.55	21.4	40.9	62000
×182	4730	417	9.40	476	483	77.2	3.00	119	3.51	21.2	30.7	54400
×166	4280	380	9.36	432	435	70.0	2.99	108	3.48	21.1	23.6	48500
×147	3630	329	9.17	373	376	60.1	2.95	92.6	3.45	20.9	15.4	41100
×132	3220	295	9.12	333	333	53.5	2.93	82.3	3.42	20.8	11.3	36000
×122	2960	273	9.09	307	305	49.2	2.92	75.6	3.40	20.7	8.98	32700
×111	2670	249	9.05	279	274	44.5	2.90	68.2	3.37	20.6	6.83	29200
×101[c]	2420	227	9.02	253	248	40.3	2.89	61.7	3.35	20.6	5.21	26200
W21×93	2070	192	8.70	221	92.9	22.1	1.84	34.7	2.24	20.7	6.03	9940
×83[c]	1830	171	8.67	196	81.4	19.5	1.83	30.5	2.21	20.6	4.34	8630
×73[c]	1600	151	8.64	172	70.6	17.0	1.81	26.6	2.19	20.5	3.02	7410
×68[c]	1480	140	8.60	160	64.7	15.7	1.80	24.4	2.17	20.4	2.45	6760
×62[c]	1330	127	8.54	144	57.5	14.0	1.77	21.7	2.15	20.4	1.83	5960
×55[c]	1140	110	8.40	126	48.4	11.8	1.73	18.4	2.11	20.3	1.24	4980
×48[c,f]	959	93.0	8.24	107	38.7	9.52	1.66	14.9	2.05	20.2	0.803	3950
W18×71	1170	127	7.50	146	60.3	15.8	1.70	24.7	2.05	17.7	3.49	4700
×65	1070	117	7.49	133	54.8	14.4	1.69	22.5	2.03	17.6	2.73	4240
×60[c]	984	108	7.47	123	50.1	13.3	1.68	20.6	2.02	17.5	2.17	3850
×55[c]	890	98.3	7.41	112	44.9	11.9	1.67	18.5	2.00	17.5	1.66	3430
×50[c]	800	88.9	7.38	101	40.1	10.7	1.65	16.6	1.98	17.4	1.24	3040
W14×132	1530	209	6.28	234	548	74.5	3.76	113	4.23	13.6	12.3	25500
×120	1380	190	6.24	212	495	67.5	3.74	102	4.20	13.5	9.37	22700
×109	1240	173	6.22	192	447	61.2	3.73	92.7	4.17	13.5	7.12	20200
×99[f]	1110	157	6.17	173	402	55.2	3.71	83.6	4.14	13.4	5.37	18000
×90[f]	999	143	6.14	157	362	49.9	3.70	75.6	4.11	13.3	4.06	16000
W14×82	881	123	6.05	139	148	29.3	2.48	44.8	2.85	13.5	5.07	6710
×74	795	112	6.04	126	134	26.6	2.48	40.5	2.82	13.4	3.87	5990
×68	722	103	6.01	115	121	24.2	2.46	36.9	2.80	13.3	3.01	5380
×61	640	92.1	5.98	102	107	21.5	2.45	32.8	2.78	13.2	2.19	4710
W14×53	541	77.8	5.89	87.1	57.7	14.3	1.92	22.0	2.22	13.3	1.94	2540
×48	484	70.2	5.85	78.4	51.4	12.8	1.91	19.6	2.20	13.2	1.45	2240
×43[c]	428	62.6	5.82	69.6	45.2	11.3	1.89	17.3	2.18	13.1	1.05	1950
W12×58	475	78.0	5.28	86.4	107	21.4	2.51	32.5	2.82	11.6	2.10	3570
×53	425	70.6	5.23	77.9	95.8	19.2	2.48	29.1	2.79	11.5	1.58	3160
W12×50	391	64.2	5.18	71.9	56.3	13.9	1.96	21.3	2.25	11.6	1.71	1880
×45	348	57.7	5.15	64.2	50.0	12.4	1.95	19.0	2.23	11.5	1.26	1650
×40	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]	285	45.6	5.25	51.2	24.5	7.47	1.54	11.5	1.79	12.0	0.741	879
×30[c]	238	38.6	5.21	43.1	20.3	6.24	1.52	9.56	1.77	11.9	0.457	720
×26[c]	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]	156	25.4	4.91	29.3	4.66	2.31	0.848	3.66	1.04	11.9	0.293	164
×19[c]	130	21.3	4.82	24.7	3.76	1.88	0.822	2.98	1.02	11.8	0.180	131
×16[c]	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]	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	716	126	4.66	147	236	45.3	2.68	69.2	3.07	10.1	15.1	6020
×100	623	112	4.60	130	207	40.0	2.65	61.0	3.03	10.0	10.9	5150
×88	534	98.5	4.54	113	179	34.8	2.63	53.1	2.99	9.85	7.53	4330
×77	455	85.9	4.49	97.6	154	30.1	2.60	45.9	2.95	9.73	5.11	3630
×68	394	75.7	4.44	85.3	134	26.4	2.59	40.1	2.91	9.63	3.58	3100
×60	341	66.7	4.39	74.6	116	23.0	2.57	35.0	2.88	9.54	2.48	2640
×54	303	60.0	4.37	66.6	103	20.6	2.56	31.3	2.86	9.48	1.82	2320
×49	272	54.6	4.35	60.4	93.4	18.7	2.54	28.3	2.84	9.42	1.39	2070

L-3/T-2/CE **Date : 06/03/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

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

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** questions.

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

(b) Explain with a neat sketch the interaction between land use and transportation. Explain the tasks involved in the evaluation phase for a transportation network. **(12)**

(c) Explain the factors that influence mode choice of a trip maker. **(12)**

A calibration study resulted in the following utility equation for different modes in Dhaka: $U_k = a_k - 0.25X_1 - 0.032\,X_2 - 0.015\,X_3 - 0.002\,X_4$, where

	Automobile	Bus
a_k = mode specific constant	-0.12	-0.22
X_1 = access plan egress time in minutes	5	10
X_2 = waiting time in minutes	0	15
X_3 = line-haul time in minutes	20	40
X_4 = out-of-pocket-costs in Taka	100	50

From the above data find the share of two modes for a forecasted trips of 5000 using a log it model.

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

(i) Design speed (ii) Design Vehicle (iii) Transition Runoff (iv) Widening of curve.

(b) Determine the minimum passing sight distance for a two-lane, two-way highway for the following conditions: **(12)**

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

(c) Explain recognized bicycle facilities in a roadway for safe bicycle movement. **(11)**

3. (a) State the purposes of traffic islands in an intersection. Explain with diagrams the general classification of road traffic islands. **(12)**

Contd P/2

CE 351

Contd... Q. No. 3

(b) State the general warrants for grade separations and interchanges at an intersection. Show with a neat sketch the flow directions for a "T" interchange. **(12)**

(c) Explain the factors involved in transportation crashes. **(11)**

4. (a) List the common problems associated with uncontrolled on-street parking. Compare parallel parking with angular parking. Briefly explain the importance of the street lighting. State the problems associated with the larger sized vehicle and mention important requirements of a truck terminal. **(3+3+3+6)**

(b) Differentiate between roadway signs and markings. List different types of signal controller. At what circumstances all-red period is considered in traffic signal design? **(3+3+4)**

(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 =	6 sec	5 sec
Initial and final lost time =	4 sec	3 sec

	North	South	East	West
Flow (pcu/hr) =	570	670	710	650
Saturation flow (pcu/hr) =	1850	2030	2150	2040

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

SECTION-B

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

5. (a) Discuss the steps in transportation system analysis with particular reference to urban public transportation system. Based on the discussion develop a system model for urban public transportation system using the standard transport system model format. **(18)**

(b) State the objectives and methods of collecting data for the following surveys: **(17)**

(i) Volume (ii) Delay (iii) Speed (iv) Origin-Destination.

6. (a) Explain three basic evaluation parameters of a transportation system. Also, discuss accessibility vs. mobility criteria of various urban road types. How these affect the urban road network design? **(16)**

Contd P/3

CE 351

Contd... Q. No. 6

(b) Write short notes on the following key points of transportation system. **(12+7=19)**

(i) Queing and storage (ii) Cost-level of service trade-off (iii) Demand consolidation (iv) Demand and supply equilibrium.

Also, define the following.

(i) Flow rate (ii) Contra flow (iii) PCE/PCU (iv) Desired speed (v) Pace (vi) Spot speed. (vii) DHV.

7. (a) Explain the factors influencing urban transport system. Also, discuss three ideal city types with respect to transportation system. Develop a match / mismatch chart for 4 parts of Dhaka city comparing with ideal city types. **(18)**

(b) Discuss 8 emerging transport technologies of recent time. Explain features of Advanced Public Transport System (APTS), Commercial Vehicle Operation (CVO), and Traffic Management Center (TMC). **(17)**

8. (a) What are the issues of urban public transport system. Discuss the items of urban public transport service design. Also, draw network structure for Radial, Grid, Trunk-feeder and Hub-spoke type of network. **(18)**

(b) Illustrate an overview description of Bangladesh Railway and Bangladesh Inland Water Transport network and facilities. Explain the comment with valid reasons, "Bangladesh multi-modal transport system is heading towards an unsustainable trend". **(17)**

L-3/T-2/CE Date : 12/03/2018

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

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** questions.

1. (a) Derive Euler's equation of motion for steady flow. **(10)**

(b) The critical depth for triangular channel is $y_c = \sqrt[5]{\dfrac{2\alpha Q^2}{gz^2}}$ **($6\frac{2}{3}$)**

(c) Water is flowing at a velocity of 1.9 m/s and a depth of 1.3 m in a long rectangular channel 2.5m wide. Compute (i) the height of a smooth upward step in the channel bed that will produce critical flow in the channel, and (ii) the depth and change in water level produced by (a) a smooth upward step of 0.35m, (b) a smooth upward step of 0.70m. In all cases, neglect energy losses and take $\alpha = 1.10$. **(18)**

(d) A trapezoidal channel is given with b = 3.0m, z = 2 and Q = 10m^3/s. **(12)**
Calculate the critical depth and velocity by Newton Raphson method.

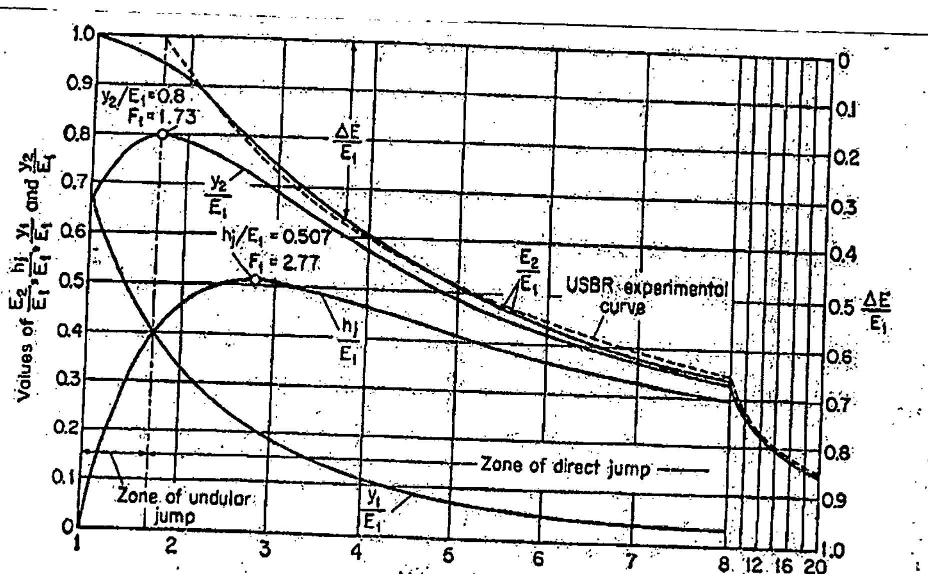
2. (a) The values of initial and sequent depth in connection with a hydraulic jump in a horizontal rectangular channel are 0.18m and 3.78m respectively. Compute the values of V_1 (m/s), V_2 (m/s), q (m^2/s), Fr_1, Fr_2, h_L. **(12)**

(b) Derive the relationship for efficiency of a hydraulic jump. **(10)**

$$\frac{E_2}{E_1} = \frac{\left(1+8Fr_1^2\right)^{\frac{3}{2}} - 4Fr_1^2 + 1}{8Fr_1^2\left(2+Fr_1^2\right)}$$

(c) A rectangular channel is 1.5m wide and inclined at an angle of 3^0 with the horizontal. Determine the type of jump when the discharge is 1.0 m^3/s, the initial depth of flow section (d_1) is 0.04m and the tail water depth is 0.9m. Determine d_2 and y_2 *. **(12)**

(d) Characteristic curve of hydraulic jump in horizontal rectangular channel is shown below. **($12\frac{2}{3}$)**



Contd P/2

WRE 311

Contd... Q. No. 2(d)

Discuss the character of the parameters shown in y-axis with the increase in Froude No. and justify your answer mathematically.

3. (a) The velocity distribution along a given vertical is given in the following table. Calculate the mean velocity of flow when the depth of flow is 3.00m. **(10)**

z (m)	0.0	0.40	0.70	1.30	1.60	2.10	2.70	3.00
u(m/s)	0.0	0.79	1.48	2.77	3.29	3.52	2.06	1.10

(b) Compute the geometric properties of the given circular channel whose diameter is 1.50m. The depth of flow through the channel is 0.90m. **(8)**

(c) Compute the values of the distribution coefficients α and β for the velocity distribution $u = 4 + 2\frac{z}{y}$ along a vertical in a wide channel when the depth of flow in the channel is 2.30m. **($12\frac{2}{3}$)**

(d) Why the velocity distribution is not uniform in an open channel? **(6)**

(e) Define: (i) Artificial channel, (ii) Depth of flow section, and (iii) Stage. **(10)**

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

(b) A lined channel with n = 0.023 is to be laid on a slope of 1 in 1000. The side slope of the channel is to be maintained at 2.0H: 1.0V. Determine the section dimensions of a practical trapezoidal section with rounded corners to carry a discharge of 80.0 m^3/s when the maximum permissible velocity is 2.5m/s. **(12)**

(c) Using the Lacey method, design a stable alluvial channel when d = 6.0mm and Q = 14 m^3/s. **(10)**

(d) The shear stress ratio K can be expressed by side angle of the channel and angle of repose of the soil-prove. **($8\frac{2}{3}$)**

(e) What are the advantages of using Lacey's method over Kennedy's method in designing a stable channel and what are the assumptions for designing a channel by 'Tractive Force Method'? **(8)**

SECTION-B

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

5. (a) Briefly explain different types of non-uniform flow with relevant examples. **(8)**

(b) Define: (i) Viscous sub-layer (ii) Hydraulically rough boundary. **(8)**

Contd P/3

WRE 311

Contd... Q. No. 5

(c) Briefly explain the factors affecting Manning roughness coefficient. **(10)**

(d) A channel consists of a main section and two side sections with respective roughness, energy and momentum coefficients as shown in Figure 1. Compute the total discharge and the mean velocity of flow for the entire section if the bed slope is 0.0002. Also compute the numerical values of n, α and β for the entire section. **($20\frac{2}{3}$)**

6. (a) Under what circumstances the slope-area method can be used to compute flood discharge. Mention the salient features to be considered during selection of a suitable channel reach to apply this method. **(10)**

(b) A rectangular channel is 6 m wide and laid on a slope of 0.25%. The channel is made of concrete (k_s = 1 mm) and carries water at a depth of 0.50 m. Determine the mean velocity, discharge and the state of flow. Also compute the velocity along a vertical at a depth of 0.20 m from the water surface. Given that the von Karman constant is 0.40. **(16)**

(c) A parabolic channel with a discharge of 20 m^3/s and n = 0.025; is laid on a bottom slope of 0.0025. The profile of the channel is given by $y^2 = 4z$. Compute the normal depth and velocity by applying trial-and-error method. **($20\frac{2}{3}$)**

7. (a) Derive the equation: **(12)**

$$\frac{dh}{dx} = \frac{1-\left(\frac{h_n}{h}\right)^N}{1-\left(\frac{h_c}{h}\right)^M}$$

where the notations have their usual meanings.

(b) Deduce the expression for the length of the flow profile between two sections in a wide channel by Bresse method. consider that the conveyance is expressed in terms of the Chezy formula. **(10)**

(c) A trapezoidal channel with bottom width of 5 m, side slope = 1V:2H, Manning roughness coefficient = 0.020 and bottom slope = 0.002 carries a discharge of 48.67 m^3/s. A dam constructed across the channel raises the water level to a depth of 5 m just upstream of it. Show the resulting flow profile if h_c = 1.69 m and h_n = 2.02 m. The elevation of the channel bottom at the dam site is 100m. Determine the stage at a distance 50 m upstream of the dam. Apply the standard step method. Assume uniform velocity distribution and neglect eddy loss. **($24\frac{2}{3}$)**

Contd P/4

WRE 311

8. (a) Draw the possible flow profile(s) in the following serial arrangements of channels: **(24)**

   (i) Steep-Mild-Milder

   (ii) Critical-Horizontal-Steep

   (iii) Steep- Critical-Mild

   (iv) Critical-Adverse-Horizontal

   (b) Explain why A1 and H1 profiles are not possible. **(10)**

   (c) A rectangular channel with 10 m width, n = 0.025 and α = 1.15 has three reaches arranged serially. The bottom slopes of these reaches are 0.0050, 0.0080 and 0.0090, respectively. For a discharge of 35 m^3/s in this channel, sketch the resulting flow profiles. **($12\frac{2}{3}$)**

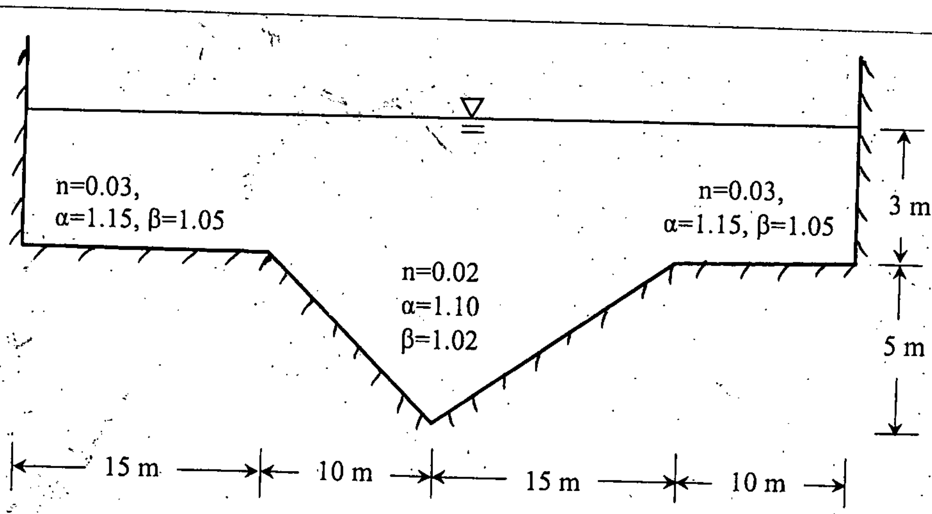


Figure 1 for Question 5(d)
