L-4/T-1/CE **Date: 26/10/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2020-2021

Sub: **CE 401** (Project Planning and Construction Management)

Full Marks: 280 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) The network of a Civil Engineering project is shown in Figure-1 along with the duration of each activity. Compute activity time and total float of each activity and also locate the critical path on the network. **(26⅔)**

   (b) Manifest the safety measures that should be taken for Hot Bitumen Works. Illustrate "Activity oriented network diagram" and "Event oriented network diagram". **(5+5)**

   (c) Show a milestone chart. How does it differ from a bar chart? Explain Project Management Cycle with a diagram. **(5+5)**

2. (a) Explain the basic steps of formulating a linear programming model. Compile the advantages and limitations of linear programming. **(5+5)**

   (b) Civil Engineering Department of BUET is preparing a trip for 400 students. The company who is providing the transportation has 10 Buses of 50 seats and 8 Buses of 40 seats, but only has 9 drivers available. The rent cost for a large bus is Tk. 8000 and Tk. 6000 for a small bus. Formulate the problem by linear programming model and calculate how many buses of each type should be used for the trip to minimize the rent cost. (Use graphical method) **(14⅔)**

   (c) A construction company has an opportunity to submit a bid for the construction of a new factory building. From the specifications provided by the client, the PERT network along with three time estimate (in week) for each activity are shown in Figure-2. Compute Critical path and its Standard Deviation and probability of the project completion within 38 weeks. **(22)**

3. (a) Briefly state the basic processes of project planning. Why determination of market opportunities is considered as a key component of the feasibility study of a project? **(13+7)**

   (b) Describe the concept of "The time value of money". What is the present equivalent value of Tk. 6 Lac, 5 years from now at 11% interest rate compounded quarterly? **(7⅔+7)**

   (c) An alternative A, requires an initial investment of Tk. 10 Lac and annual expense of Tk. 3 Lac for the next 8 years. Alternative B, on the other hand, requires an initial investment of Tk. 15 Lac and annual expense of Tk. 2 Lac for the next 8 years. Which alternative will you prefer if the interest rate is 9%? **(12)**

Contd P/2

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4. (a) What do you understand by "cost of capital"? Prove that **(5+10)**

$$A = p\left[\frac{i(i+1)^n}{(1+i)^n - 1}\right]$$

Where the symbols have their usual meanings.

(b) What is MARR? List the causes of variation of MARR value. What is the basic difference between private projects and public projects? **(3+6+4⅔)**

(c) A contractor is considering the purchase of a new tractor that has an expected useful life of 4 years. It costs Tk. 50 Lac and should generate a net annual income of Tk. 20 Lac. Its likely salvage value is Tk. 10 Lac. Another option is to purchase a used tractor having an estimated service life of 2 years for Tk. 25 Lac. It would have no salvage value after the service life. The estimated net annual income from it is Tk. 12 Lac. Calculate the rate of return for each of the tractors? **(18)**

SECTION – B

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

5. Ahsanullah Hall is one of the oldest student dormitories at BUET. Suppose BUET authority plans to construct a new dormitory building on the existing ground of Ahsanullah Hall. This project involves relocating existing students, demolishing existing dormitory building, and designing and constructing a new dormitory building with modern facilities and considerations. The newly proposed dormitory will be an eight-story building with one basement. The building will be designed to provide accommodation for about 1000 students with sufficient well-designed open space, sports, and extra curriculum facilities. The funding for this project is expected to come from Bangladesh Government's development budget.

(a) Identify the major phases of the above-mentioned Ahsanullah Hall Project. List important stakeholders who could be involved in various phases of the project. **(15)**

(b) Explain briefly, using sketches, the Design-Bid-Build and Design-Build project delivery methods, clearly indicating the functional and contractual relationships within the project team. Among these two options, in your opinion, what would be the suitable contract and delivery method for the Ahsanullah Hall Project? Justify your thought. **(16⅔)**

(c) Suppose BUET authority wants to use the Open Tender contract method for the Ahsanullah Hall Project. Identify and list the essential Bid documents for this project. What are the advantages and disadvantages of open tender? **(15)**

Contd P/3

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6. (a) What is a Work Breakdown Structure (WBS) in a construction project? Sketch a WBS with three levels of details for *the Ahsanullah Hall* Project (described in Question 5). **(15)**

(b) What is a site layout plan in a construction project? What are the essential elements required to consider for preparing a site layout plan? Sketch a site layout plan for *the Ahsanullah Hall Construction* Project. **(16⅔)**

(c) Identify and list the major construction equipment that will be required for the *Ahsanullah Hall* Project. In response to this question, you should consider different phases of the construction project, including demolition, excavation, and construction of sub- and super-structures. Briefly, propose a safety plan for the operation of those construction equipment and general safety aspects at the construction site. **(15)**

7. (a) List the types of conflict that may occur in a team. Explain the conflict levels in a high performing team graphically. **(10⅔)**

(b) Consider the following scenario: A retailer exclusively sells jerseys in his shop. As the Football World Cup-2022 is fast approaching, he decides to place two different orders for jerseys- 1800 premium jerseys from Thailand and 3800 regular jerseys from Bangladesh. Each Thai and BD jersey will cost BDT 450 and BDT 250, respectively. He decides to sell Thai jersey at BDT 1000 each whereas BD jersey will cost half of this rate. After the world cup ends, all remaining jersey will have a salvage value of BDT 150 each. Assume the demand is normally distributed over time. The following table provides a history of previous orders from the same retailer: **(26)**

Product Description	Last Year's Forecast	Actual Demand	Error	Standard Deviation of A/F
THAI Jersey	2000	1900	−100	0.0962
BD Jersey	3000	3500	+500	

Find the optimum order quantity and expected profit margin for THAI jersey. Standard normal distribution chart is attached at the annexure.

(c) Differentiate between Dialectical Inquiry Process and Devil's Advocacy Process. **(10)**

8. (a) Define the following topics: (i) Shadow price (ii) Hurdle rate. **(5+5)**

(b) Find the expected return on investment using capital asset pricing model for the Bus Rapid Transit Line-3 project in Dhaka city. The term of investment is 15 years. Risk free interest rate is 3.5%. The transportation project has a volatility factor of 1.3. The investors expect the market to rise in value by 8% per year. **(10)**

Contd P/4

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Contd... for Q. No. 8

(c) A branch office of an insurance company processes 10,000 claims per year. Average processing time is 3 weeks. Assume the office works 50 weeks per year. Determine, the throughput (per week), average flow time (in year) and average number of claims being processed at any given point. **(10)**

(d) Consider the after-tax cash flows for three mutually exclusive projects: **(16⅔)**

Year	A	B	C
0	–25000	–48,000	–34,000
1	15000	25000	15000
2	20000	17000	25000
3	–7000	–10000	–5000
4		21000	5000
5		5000	5000
6			5000

All costs are in BDT. Assume a discount rate of 10% p.a. and inflation rate of 3.5%. If all the projects are repeated indefinitely which project should be accepted?

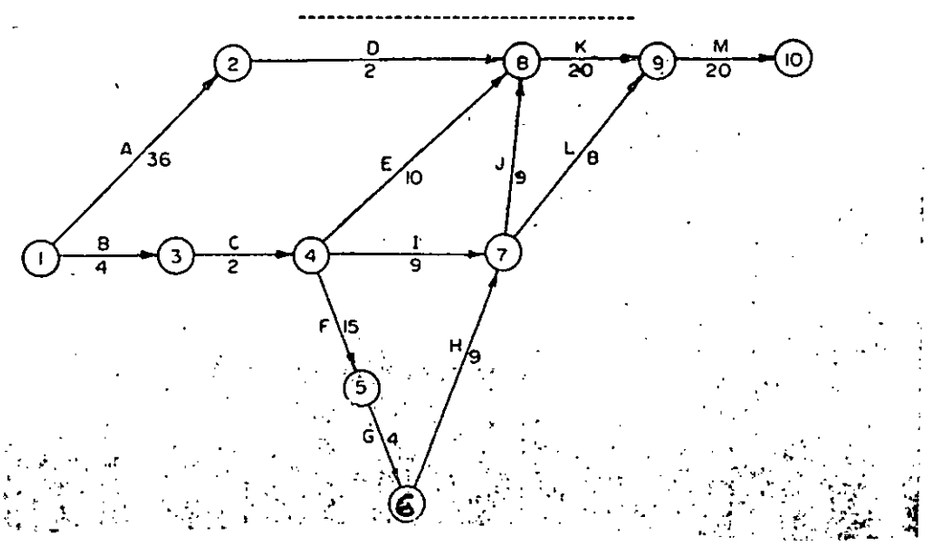


Figure – 1 for Q 1(a)

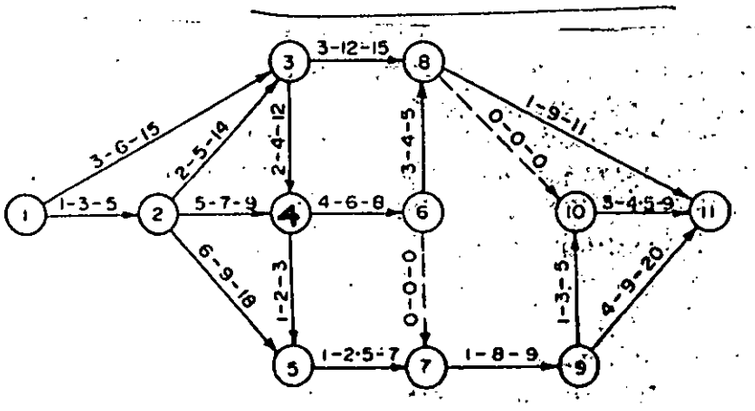


Figure – 2 for Q 2(c)

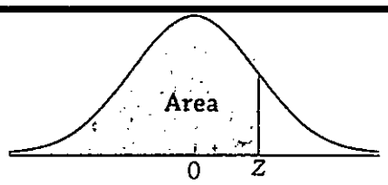
Table 1: Standard Normal Distribution Function

Z (+),	*Probability* (P_r)(%)	Z (−)	*Probability* (P_r) (%)
0	50·0	0	50·0
+0·1	53·98	−0·1	46·02
+0·2	57·93	−0·2	42·07
+0·3	61·79	−0·3	38·21
+0·4	65·54	−0·4	34·46
+0·5	69·15	−0·5	30·85
+0·6	72·57	−0·6	27·43
+0·7	75·80	−0·7	24·20
+0·8	78·81	−0·8	21·19
+0·9	81·59	−0·9	18·41
+1·0	84·13	−1·0	15·87
+1·1	86·43	−1·1	13·57
+1·2	88·49	−1·2	11·51
+1·3	90·32	−1·3	9·68
+1·4	91·92	−1·4	8·08
+1·5	93·32	−1·5	6·68
+1·6	94·52	−1·6	5·48
+1·7	95·54	−1·7	4·46
+1·8	96·41	−1·8	3·59
+1·9	97·13	−1·9	2·87
+2·0	97·72	−2·0	2·28
+2·1	98·21	−2·1	1·79
+2·2	98·61	−2·2	1·39
+2·3	98·93	−2·3	1·07
+2·4	99·18	−2·4	0·82
+2·5	99·38	−2·5	0·62
+2·6	99·53	−2·6	0·47
+2·7	99·65	−2·7	0·35
+2·8	99·74	−2·8	0·26
+2·9	99·81	−2·9	0·19
+3·0	99·87	−3·0	0·13

For 8.2(c)

Annexure

Table 1: Standard Normal Distribution Chart for Question 7 (b)



z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621

L-4/T-1/CE **Date : 16/10/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2020-2021

Sub : **CE 411** (Analysis of Indeterminate Structures)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols carry their usual meaning. Assume reasonable values for any missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. **Answer all questions.**

1. (a) Write down a typical flexibility equation in matrix form and identify the matrices for (i) Displacement , (ii) Flexibility, (iii) Redundant **(6)**

   (b) "Diagonal elements lead the fate of solution while zero elements in other non-diagonal members simplifies the solution"-Explain the statement in terms of achievable advantages by using internal release system over the external release system. **(4)**

   (c) Find support moments on the beam shown in Figure 1 using flexibility method. **(16.25)**

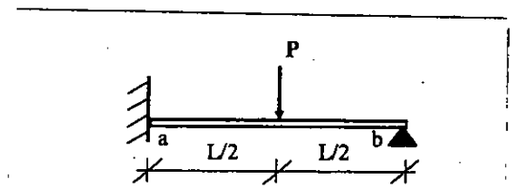


Figure 1

2. (a) Define influence line. **(4)**

   (b) "Degree of statical indeterminancy dictates the shape of influence line" – State the underlying principles that relates the fore(moment) with the displacement(rotation) in qualitatively constructing the influence lines. **(6)**

   (c) Draw qualitative influence line for mid-span bending moment of any beam of the multi-storied frame shown in Figure 2. What will be the loading spans to activate the critical condition for that moment? **(10+6.25)**

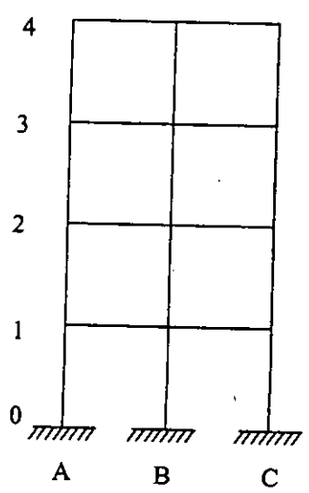


Figure 2

Contd P/2

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3. Answer either (a) or (b) **(3+18+5.25)**

(a) Figure 3 shows a portal frame having constant EI for all members. (i) State the degree of statical indeterminancy of the system; (ii) In order to solve the frame, derive and compose the flexibility equations in matrix form; (iii) If support 'D' settles vertically to a small but finite quantity, what will be the changes in the flexibility equations of (ii) in taking care of calculating the induced sway?

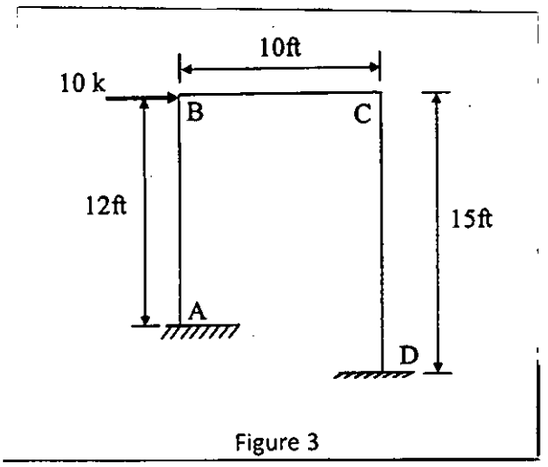


Figure 3

OR

(b) Analyze the truss shown in Figure 4. Figures in (4) indicate the areas of cross section in sq.in. E = 30,000 ksi. Use flexibility method. **(26.25)**

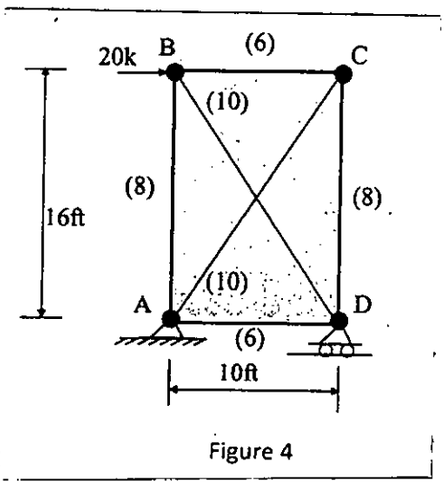


Figure 4

4. Answer either (a) or (b)

(a) Determine the support reactions of the beam shown in Figure 5. Take E = 29 $\times 10^3$ ksi and I = 510 in^4. Use stiffness method. **(26.25)**

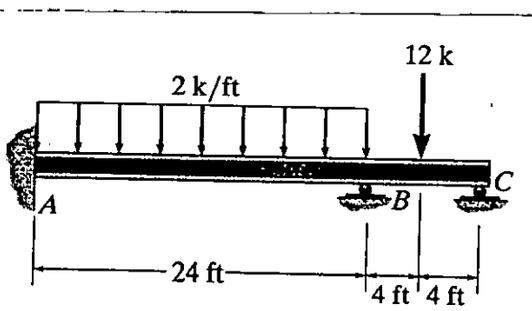


Figure 5

Contd P/3

CE 411 **OR**

(b) Determine the deflection at Node 1 and reactions on the beam shown in Figure 6. Node 1 slides smoothly along the surface and Node 2 is fixed. EI is constant. Given, P = 100 kN. Use stiffness method. **(26.25)**

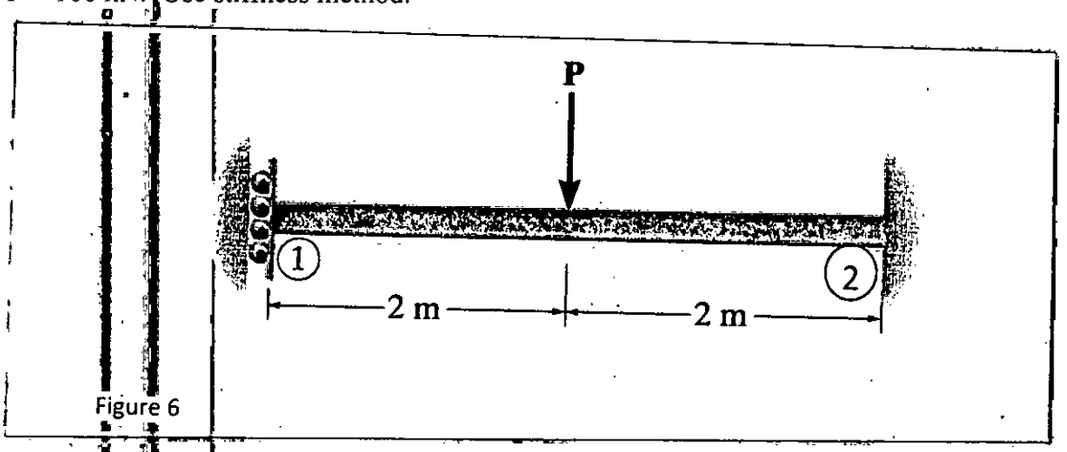


Figure 6

SECTION – B

There are **FOUR** questions in this section. Answer all the questions.

Assume any reasonable value of missing data, if any.

5. (a) Analyze the beam in Fig. 7(a) by moment distribution and draw the shear force and bending moment diagrams. Given E = 30,000 ksi. **(25)**

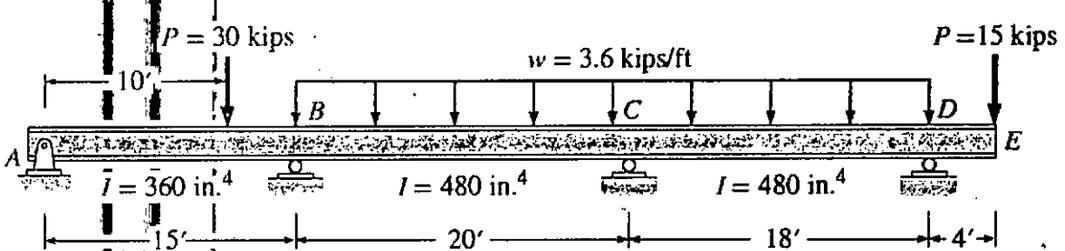


Fig. 7 (a)

(b) If support B in Fig. 7(b) settles ½ inch under the 16-kip load, determine the reactions and draw the shear and moment diagrams for the beam. Given: E = 30,000 ksi, I = 600 in^4. Use moment-distribution method. End A is fixed supported and B is roller supported. **(10)**

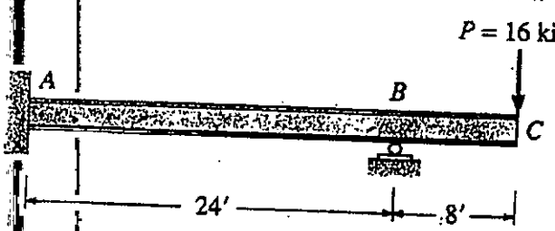


Fig. 7 (b)

Contd P/3

CE 411

6. **Answer either (a) or (b)**

(a) Analyze the frame by moment-distribution method and draw the bending moment diagram for the frame loaded as shown in Fig. 8(a). **(22)**

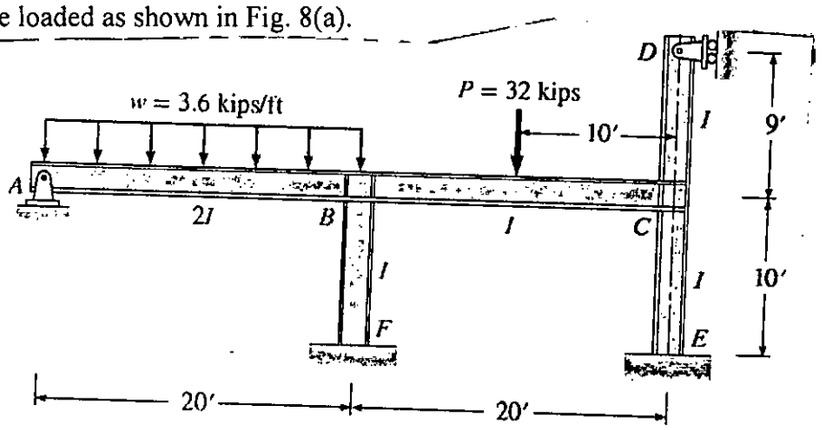


Fig. 8(a)

OR

(b) Analyze the frame in Fig. 8(b) by moment-distribution method. Draw the shear force and bending moment diagrams for the frame. Given: E = 30,000 ksi and I = 300 in^4 for all members. **(22)**

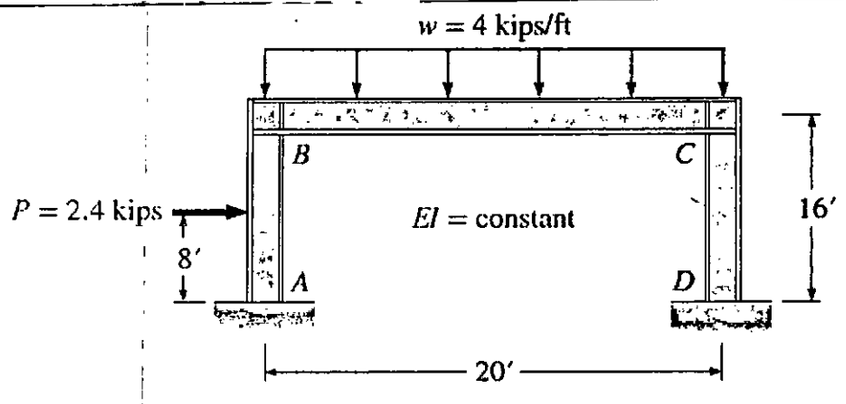


Fig. 8(b)

7. Determine the joint displacements and bar forces of the truss shown in Fig. 9 by the direct stiffness method. Member properties: $A_1 = 2$ in.^{2}, $A_2 = 2.5$ in.^{2}, and E = 30,000 ksi. **(26)**

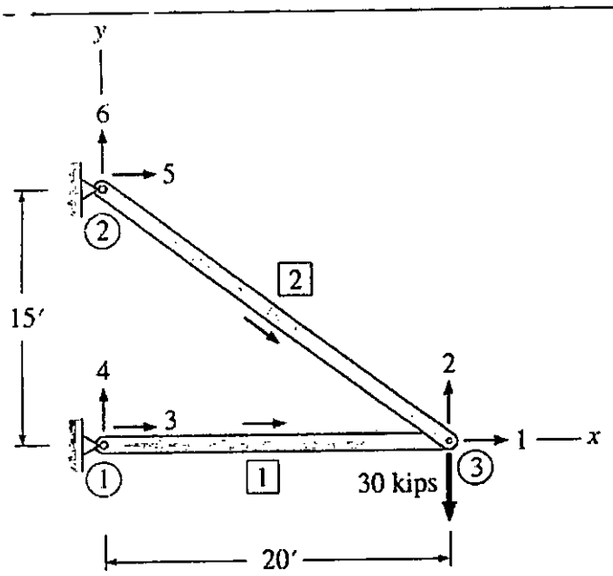


Fig. 9

Contd P/4

CE 411

8. **Answer either (a) or (b)**

(a) Determine the structure stiffness matrix K for the frame shown in Fig. 10(a). The support at node 3 is fixed. Take E = 29000 ksi, I = 650 in^4, A = 20 in^2 for each member. **(22)**

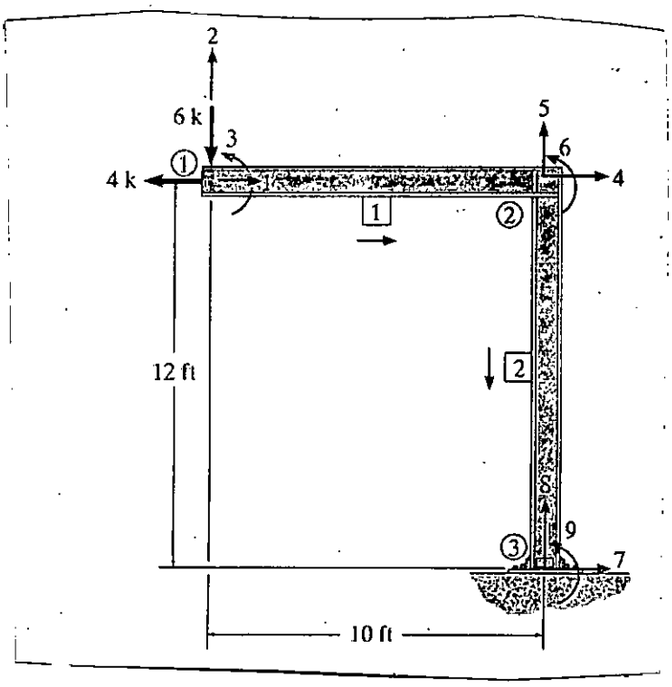


Fig 10(a).

OR

(b) Determine the structure stiffness matrix K for the frame shown in Fig. 10(b). Take, E = 29000 ksi, I = 700 in^4, and A = 20 in^2 for each member. **(22)**

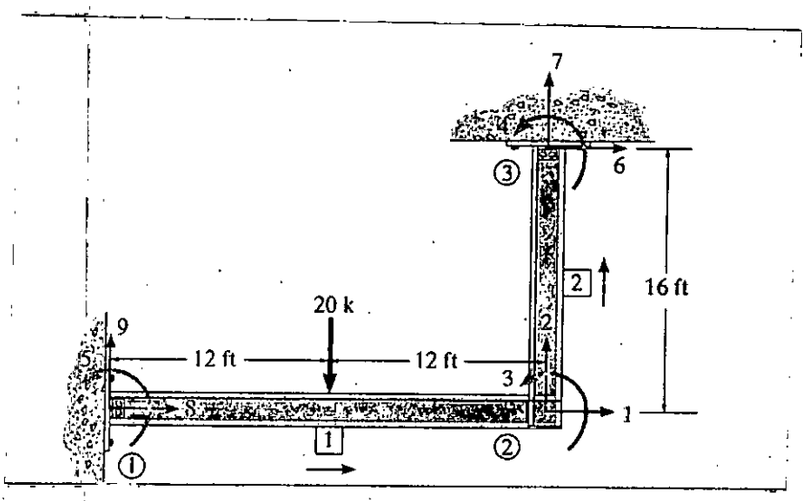
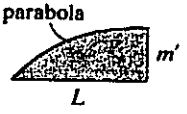
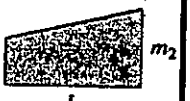
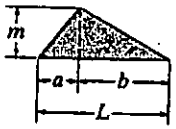
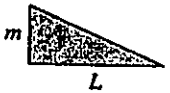


Fig. 10(b)

APPENDIX

Table of Product Integral

$\int_0^L m\,m'\,dx$				
	$mm'L$	$\frac{1}{2}mm'L$	$\frac{1}{2}m(m'_1 + m'_2)L$	$\frac{2}{3}mm'L$
	$\frac{1}{2}mm'L$	$\frac{1}{3}mm'L$	$\frac{1}{6}m(m'_1 + 2m'_2)L$	$\frac{5}{12}mm'L$
	$\frac{1}{2}m'(m_1 + m_2)L$	$\frac{1}{6}m'(m_1 + 2m_2)L$	$\frac{1}{6}[m'_1(2m_1 + m_2) + m'_2(m_1 + 2m_2)]L$	$\frac{1}{12}[m'(3m_1 + 5m_2)]L$
	$\frac{1}{2}mm'L$	$\frac{1}{6}mm'(L + a)$	$\frac{1}{6}m[m'_1(L + b) + m_2(L + a)]$	$\frac{1}{12}mm'\left(3 + \frac{3a}{L} - \frac{a^2}{L^2}\right)L$
	$\frac{1}{2}mm'L$	$\frac{1}{6}mm'L$	$\frac{1}{6}m(2m'_1 + m'_2)L$	$\frac{1}{4}mm'L$

L-4/T-1/CE **Date : 01/10/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2020-2021

Sub : **CE 441** (Foundation Engineering)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

Assume any reasonable value of missing data.

1. (a) A pile group consisting of 12 piles (dimensions are in mm) is subjected to a total vertical load of 4 MN, with eccentricity e_x =0.3 m and e_y=0.4 m. Determine the maximum load on an individual pile. **(15)**

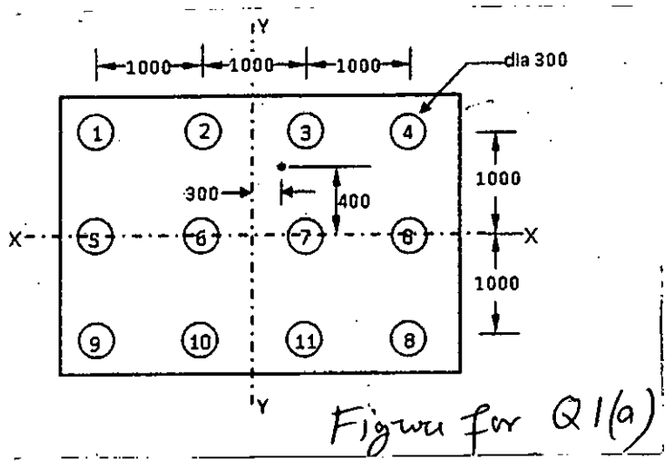


Figure for Q 1(a)

(b) A rectangular raft of size 10 m × 16 m is founded at a depth of 4 m below the ground surface in loose to medium dense sand with q_n = 120 kN/m^2. Standard penetration tests conducted at the site gave the following corrected N_{60} values. The water table is at the base of the foundation. Above the water table γ = 18.0 kN/m^3, and submerged γ_b = 9.5 kN/m^3. Estimate the elastic settlement of footing at the center. Given: the influence factor for overburden pressure due to soil surcharge =

$$= 0.66\left(D_f/B\right)^{-0.19} + 0.025\left(L/B + 12\mu - 4.6\right)$$ **(20)**

Depth below GL, m	2	4	6	8	10	12	14	16	18
SPT, N_{60}	8	8	12	12	11	16	18	17	20

Table 1: Range for μ (Bowel's 1996)

Type of soil	μ
Clay, saturated	0.4 - 0.5
Clay, unsaturated	0.1 - 0.3
Sandy clay	0.2 - 0.3
Silt	0.3 - 0.35
Sand, dense	0.2 - 0.4
Coarse sand (e= 0.4~0.7)	0.15
Fine grained (e= 0.4~0.7)	0.25
Rock	0.1 - 0.4

Table 2: E_s for clay (Murthy: pg 203)

$E_s = Ac_u$

c_u: Undrained cohesion obtained from field test

Clay type	A
Clay, stiff, inorganic	500 ~ 1500
Clay, soft, organic	100 ~ 500
Inorganic clay:	
High plastic	low value of A
Low plastic	high value of A

Tables and Figures for Question No 1(b)

Contd P/2

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Contd...Q. No. 1(b)

Table 3: E_s (in kPa) by making use of SPT and CPT

Soil Type	Using SPT	Using CPT
Sand (normally consolidated)	$500(N_{cor}+15)$	$2\sim4\ q_c$
Sand, saturated	$250(N_{cor}+15)$	--
Sand (over consolidated)	--	$6\sim30\ q_c$
Gravelly sand, gravel	$1{,}200(N_{cor}+6)$	--
Clayey sand	$320(N_{cor}+15)$	$3\sim6\ q_c$
Silty sand	$300(N_{cor}+6)$	$1\sim2\ q_c$
Soft clay	--	$3\sim8\ q_c$

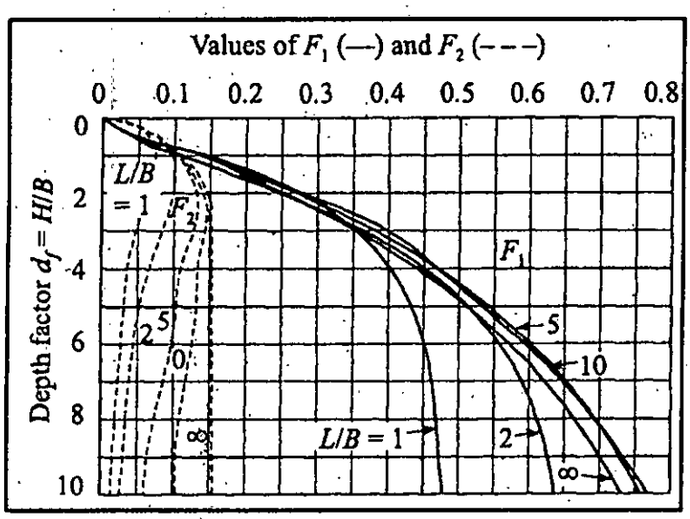

Figure 1: Settlement due to load on surface of elastic layer: (a) F_1 and F_2 versus depth factor $d_f = H/B$ for various L/B (after Steinbrenner, 1934).

Tables and Figures for Question No 1(b)

2. (a) Estimate the allowable load capacity of a 1.2-m-diameter concrete closed-ended pipe pile embedded 16 m in the soil profile shown. The factor of safety required is 2. The N values are blows/ft. Assume: γ_{sat} = 18.0 kN/m^3 for the soil deposit at 0~4 m and 18.5 kN/m^3 for the rest; γ_w = 9.8 kN/m^3, and γ_{con}= 24 kN/m^3. Compute the load capacity of a single pile as (i) a drilled shaft and (ii) driven pile. Give reasonable justification of the results being different. **(15)**

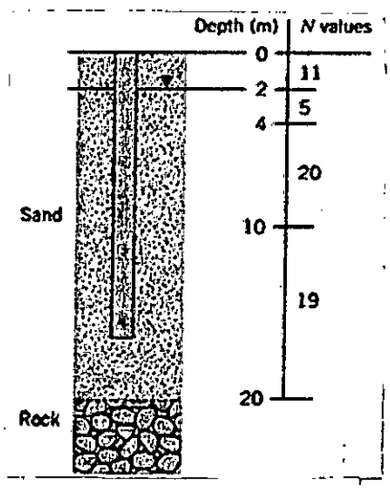

Fig. For Ques. No. 2a

Contd P/3

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Contd...Q. No. 2

(b) A square footing of 3 m side is founded at a depth of 1.5 m below the ground surface in a cohesionless soil having angle of shearing resistance $\phi = 33°$. The water table (WT) is at 3.5 m below ground level. The moist weight of soil above the water table is 17.5 kN/m^3. Determine **(A)** the ultimate bearing capacity of the soil, **(B)** the net allowable bearing pressure, and **(C)** the load/meter for a factor of safety of 3. Due to seasonal variation, the water table (WT) rise to the ground level at the vicinity of the foundation. The saturated unit weight of soil is 20.0 kN/m^3. Determine the changed **(D)** net allowable bearing pressure and **(E)** the load/meter for the same factor of safety as above. Use the general shear failure with the bearing capacity factors proposed by Hansen. **(20)**

Hansen's factors are:

$$N_q = e^{\pi \tan\phi} \tan^2(45 + \phi/2), N_c = (N_q - 1)\cot\phi, N_\gamma = 1.5(N_q - 1)\tan\phi$$

$$S_c = 1 + \left(N_q / N_c\right)(B/L); s_q = 1 + (B/L)\tan\phi; s_\gamma = 1 - 0.4(B/L)$$

$$d_c = 1 + 0.4\frac{D_f}{B}, d_q = 1 + 2\tan\phi(1 - \sin\phi)^2 \frac{D_f}{B}, \text{ and } d_\gamma = 1 \text{ for all } \phi$$

3. (a) Write down the qualitative expressions for Q_a of a single pile for the following load cases (refer to the soil profile of **Fig. for Ques. No. 3a**) in which a pile is installed through Layer 1, Layer 2 and finally Layer 3, when:

- Design / working load is vertical and compressional
- Design / working load is vertical but tensile (i.e., uplift)

Note: use (in the expression of Q_a) the term q_{base} (end bearing), $q_{f.sand}$, $q_{f.clay}$ (for usual friction in sand and clay layer, respectively) and $q_{nf.clay}$ (negative skin friction in clay), etc. **(15)**

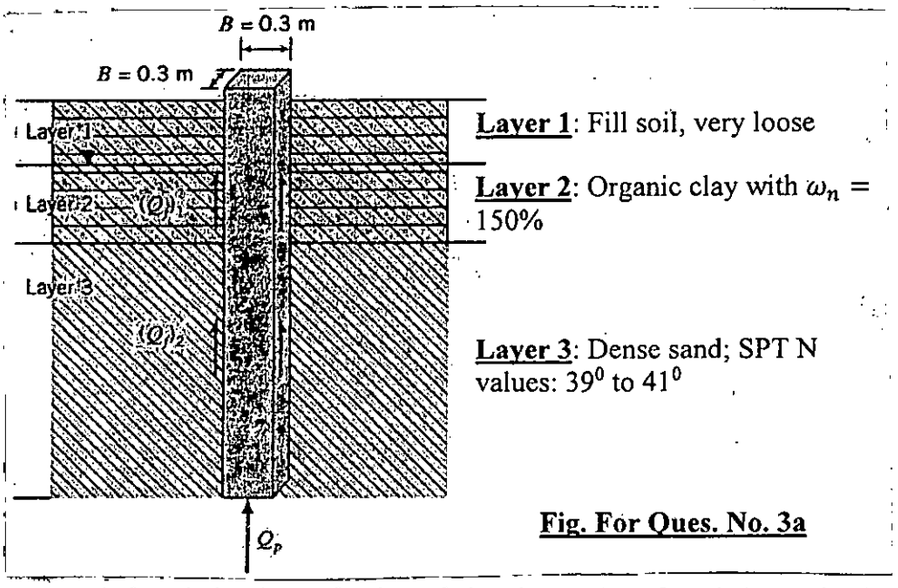

Fig. For Ques. No. 3a

(b) A water tank foundation has a footing of size 6 m × 6 m, founded at a depth of 3 m below ground level in a medium dense sand stratum of great depth. The corrected average SPT value obtained from the site investigation is 20 and average density of soil, γ= 18.5 kN/m^3. The foundation is subjected to a vertical load at an eccentricity of B/10 along one of the axes. Estimate the ultimate load Q_{ult} by Meyerhof's method. Given (symbols have their usual meanings):

Contd P/4

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

ϕ (deg):	28	30	32	34	36	38	40
N_q:	14.7	18.4	23.2	29.4	37.7	48.9	64.1
$N\gamma$:	11.2	15.7	22.0	31.1	44.4	64.0	93.6

$s_q = 1 + 0.1\, N_\varphi \left(B/L\right)$; $s_\gamma = s_q$, for $\phi > 10°$, and $d_q = 1 + 0.1\sqrt{N_\varphi}\left(D_f/L\right)$

Also, write a short-note on the minimum depth for shallow foundation. Why does bearing capacity of shallow footing increase with the depth of foundation? **(20)**

4. (a) In which type of soil do you need TSA and ESA analyses to estimate Qu of a single pile. Explain the background reasoning for both type of analysis. Show that a cylinder of soil of annular thickness greater than 40% of the pile radius is disturbed, and hence, explain the rationality of using ϕ'_{cs} instead of ϕ'_p in the formulation of 'pile capacity estimation' in ESA analysis. **(15)**

   (b) Static pile load test was carried out on a 400 mm-by-400 mm solid concrete pile (with γ_{con} = 4 ksi) installed 20 m into a loose-to-medium sandy soil. The pile was driven into the soil. Selected load-displacement data are shown in the table below. (i) determine the allowable load if the serviceability limit is 12 mm. (ii) Is the maximum load the ultimate load? Justify your answer. (iii) State the various Codes to define Q_a. (iv) Quote the major limitation of the 'Static Load test', and (v) Explain the necessity of using O-cell in such a test. **(20)**

Load (kN)	0	800	1100	2250	2800	3200	3500	3600	3620
Displacement (mm)	0	2.5	3.8	7.5	10	12.5	15	20	26

SECTION – B

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

5. (a) Briefly describe the steps involved in soil investigation. Difference between wash boring and percussion drilling. **(10)**

   (b) Write down the assumptions and limitations of 'Ordinary Method of Slices' and 'Bishop's Simplified Method of Slices' for slope stability analyses. **(10)**

   (c) Write three main causes involved in the instability of a slope. Derive the expression of factor of safety for an infinite slope that makes an angle β with the horizontal considering the occurrence of seepage in the soil mass. Also, compare the factor of safety equation with the case of no seepage. **(15)**

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6. (a) What are the laboratory tests for which distributed and undisturbed samples are required? What is the current practice in selecting design SPT N values? **(10)**

(b) Define friction ratio (F_r) in CPT test. Draw a typical graph showing the general range of friction ratio for various types of soil. **(10)**

(c) Briefly describe the methods of determining water table for high and low permeable soil.

Observation of the water table was intended in a borehole made in silty sub-soil (i.e., soils with moderate permeability) by Hvorslev's method. Accordingly, water was bailed out of the borehole and depths of the water levels in the borehole were recorded at 24 hour intervals (data given in the table below).

Time elapsed, (hr)	Depth of water level from the ground surface (m)
0	9.5
24	8.4
48	7.6
72	7.0

Determine, the depth of the water table and locate it in a neat sketch. Relevant formulae for the method are: **(15)**

$$h_0 = \frac{\Delta h_1^2}{\Delta h_1 - \Delta h_2}, \; h_2 = \frac{\Delta h_2^2}{\Delta h_1 - \Delta h_2}, \; h_3 = \frac{\Delta h_3^2}{\Delta h_2 - \Delta h_3}$$

The notations represent their usual meanings.

7. (a) What are the reasons behind the SPT N value variation? State the basic principles of 'cross-hole seismic survey' method used for sub-soil exploration. How shear modulus (G) can be determined using this survey? **(10)**

(b) State the difference between 'altered soil' and 'disturbed soil'. Show the variation of pre-consolidation pressure with field vane shear strength in a neat sketch. **(10)**

(c) Figure shows the cross-section of an earth slope in homogenous clay soil. The figure also shows an arbitrary failure surface, its center and five slices. Calculate the factor of safety using **Ordinary Method of Slices.** Given, γ = 17.5 kN/m^3 and unconfined compressive strength = 60 kPa. For homogenous soil and ordinary method of slices, factor of safety is given by: **(15)**

$$Fs = \frac{\sum_{n=1}^{n=p} \left(c\Delta L_n + w_n \cos\alpha_n \tan\phi\right)}{\sum_{n=1}^{n=p} w_n \sin\alpha_n}$$

Symbols have their usual meaning.

Contd P/6

L-4/T-1/CE **Date : 25/09/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2020-2021

Sub : **CE 451** (Transportation Engineering II-Pavement Design and Railway Engineering)

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Describe the materials requirement, construction steps and Bangladesh condition suitability of following low cost road surfaces: Cement Treated layer, Herringbone Brick layer, Single bituminous surface Treatment (SBST) and Dense bituminous carpet seal. **(4×6=24)**

   (b) Discuss bituminous pavement recycling process with relevant advantages and disadvantages. Explain a rational highway maintenance management system with schematic flow chart type diagram; and compare the crack repairing schemes of flexible and rigid pavements. **(11+11⅔)**

2. (a) Explain the earth embankment construction process highlighting equipment required, erosion control, traffic control and construction quality control issues. Compare between cement treated base (CTB) and graded aggregate base. Describe the steps of compacting hot bituminous surface layer. **(12+6+6)**

   (b) Explain the steps of rigid cement concrete pavement construction highlighting joints temperature reinforcement, texturing and curing issues. Discuss the precautions required to construct rigid cement concrete pavement in hot weather conditions. Explain the problems resulting from poor drainage of layer underneath the rigid pavement. **(11+6+5⅔)**

3. (a) Differentiate between Bitumen and Tar. Briefly describe and mention the uses of slow-curing cutback asphalts. Mention the types and grades of emulsified asphalt. **(6+4+6⅔)**

   (b) Write the objectives of asphaltic concrete mix design. Briefly state the main differences between Marshall and HVEEM method of mix design with regard to (i) compaction of specimens (ii) design criteria, and (iii) tests of specimens. **(5+10)**

   (c) Calculate the Approximate Bitumen Ratio (ABR) i.e. the starting asphalt content in the test series of HVEEM mix design procedure for Medium Curing cutback asphalt [MC-3000]. The necessary data are provided below: **(15)**

Surface area of aggregates	34.8 ft^2/lb
Specific gravity of fine aggregates	2.62
Specific gravity of coarse aggregates	2.72
Weighted average Specific gravity of fine and coarse aggregates	2.66
% of fine aggregate	55
% of coarse aggregate	45
C.K.E of 2 fine aggregate specimens	7.4, 7.2
% Oil retained of 2 coarse aggregate specimens	2.8, 2.8

Contd P/2

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4. (a) Mention the stages and sources of aggregates used for highway construction. Differentiate between hydrophilic and hydrophobic aggregates along with examples, "It is recommended that bitumen contents on the right-hand increasing side of the voids in mineral aggregate (VMA) curve be avoided"-Explain. **(5+5+5)**

   (b) "Aggregates used in HMA mixes should be cubicle rather than disproportionate in their dimensions"-explain. Write the implications of low sand equivalent value and excessive amount of mineral filler in bituminous mixtures. Also, mention the RHD specifications for mineral filler for bituminous mix suitable for roads in Bangladesh. **(3+4+4⅔)**

   (c) In a Marshall sample, the bulk specific gravity of mix and aggregates are 2.324 and 2.546 respectively. The sample includes 5% of bitumen (by total weight of mix) of specific gravity 1.10. The theoretical maximum specific gravity of mix is 2.441. Find the void filled with bitumen (VFB) in the Marshall sample (in percentage). **(20)**

SECTION – B

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

5. (a) Show with a neat sketch different components of Permanent Way and how the gauge is measured. **(12)**

   (b) State the requirements of an ideal rail sleeper. What are meant by "sleeper density" and "spacing of sleepers"? **(16)**

   (c) Compute the steepest gradient that a train of 20 wagons with a locomotive can travel with the following data: **(18⅔)**

i	Weight of each wagon	...	20 tonnes
ii	Weight of Locomotive	...	150 tonnes
iii	Tractive effort of Locomotive	...	15 tonnes
iv	Rolling resistance of Locomotive	...	3 kg/tonne
v	Rolling resistance of wagon	...	2.5 kg/tonne
vi	Speed of the train	...	60 kmph.

6. (a) Explain with neat sketches the function of a semaphore signal. **(12)**

   (b) Explain with neat sketches the classification of railway signals according to location. **(16)**

   (c) What is a 'turnout'? Draw a complete labelled diagram for a left-hand turnout. **(18⅔)**

7. (a) Broadly classify pavements. Draw typical cross sections for flexible, rigid, semi-rigid pavements. Differentiate between flexible and rigid pavements w.r.t. Load Distribution Mechanism, Aggregate Type & Modulus of Elasticity. Write short note on 'Perpetual pavement' and 'Polymer Modified Binder (PMB)'. Briefly state the significance of PMB use in Bangladesh. **(4+6+6+4+2=22)**

Contd P/3

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Contd...Q. No. 7

(b) Mention four important places where rigid pavement is recommended. Joint-wise classify rigid pavement. Write down two important benefits of continuously reinforced rigid pavement (CRCP)? What special considerations are needed for odd-shaped panel? Schematically show the reinforcement details of rigid pavement also show construction and contraction joints. **(2+3+2+3+5=15)**

(c) An existing 4-lane regional highway constructed on embankment requires full reconstruction. A number of trial pits were undertaken and the CBR of the subgrade beneath the existing road was found to be 3%. A 24 hour classified traffic count was carried out on a typical weekday and shown only heavy vehicles as follows. Determine the pavement layer thicknesses by using RHD flexible pavement design guide method. Consider annual traffic growth rate 10% and design period 20 years. Use Base type II. Necessary Tables are given at the end of the question paper. **(9⅔)**

Vehicle Categories	Base year Two-way Flow / day
Heavy truck	100
Medium truck	400
Light truck	200
Large bus	300

8. (a) Write down four common modes of distresses of flexible and rigid pavements. State the problems associated with pavement 'Fatigue Cracking' and main causes of this distress? How to remove 'Bleeding of bituminous pavement'? Write down the sequences of pavement failure under submerged condition in Bangladesh. Why joints are used in rigid pavement? **(4+4+2+6+2=18)**

(b) What were the purposes and outcomes of AASHO road test? What is standard axle load? A truck in an intercity road applies 24Kip and 16Kip loads by the rear and front axles. Using the 4^{th} power approximation, determine the total equivalent damage caused by one pass movement of this truck in terms of ESALs. **(4+2+4=10)**

(c) Design a concrete pavement by using PCA method for the conditions given below. Give one trial and put your comments on the trial thickness. Solution should be given in the worksheet provided at the end of question paper. **(18⅔)**

Contd P/4

CE 451

Contd...Q. No. 8(c)

Truck Axle Load Distributions

Axle Load Groups (kip)	Number of Axles, N	Axle Load Groups (kip)	Number of Axles, N
Single Axles		**Tandem Axle**	
22	6,500	32	1,25,000
24	14,000	36	2,50,000

Modulus of Subgrade Reaction, k:		100	pci
Modulus of Rupture, MR	:	550	psi
Load Safety Factor	:	1.2	
Doweled joints	:	Yes	
Concrete Shoulder	:	No	
Untreated Subbase	:	6 in	

Effect of Untreated Subbase on k Values,

Subgrade value (pci),	Subbase k value, pci			
	4 in.	6 in.	9 in.	12in.
50	65	75	85	110
100	130	140	160	190
200	220	230	270	320
300	320	330	370	430

HVEEM Design Charts: For Q. No. 3(c)

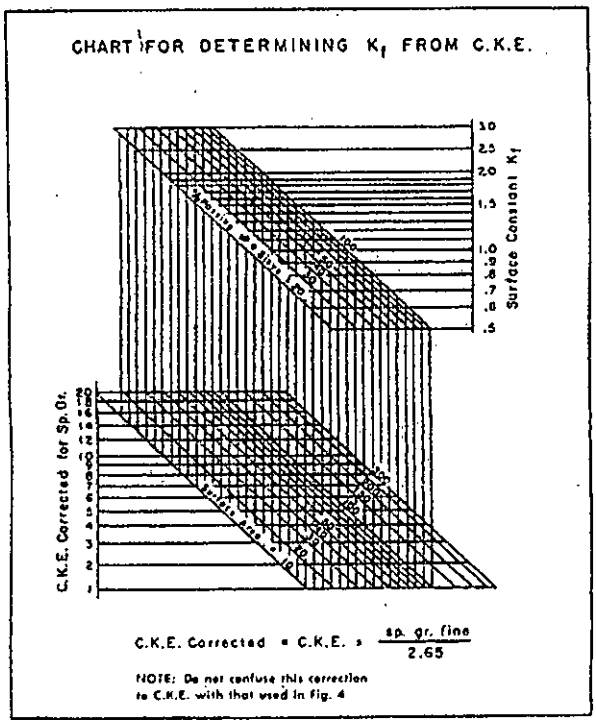

Chart No.1 - Estimating the Optimum Asphalt Content.
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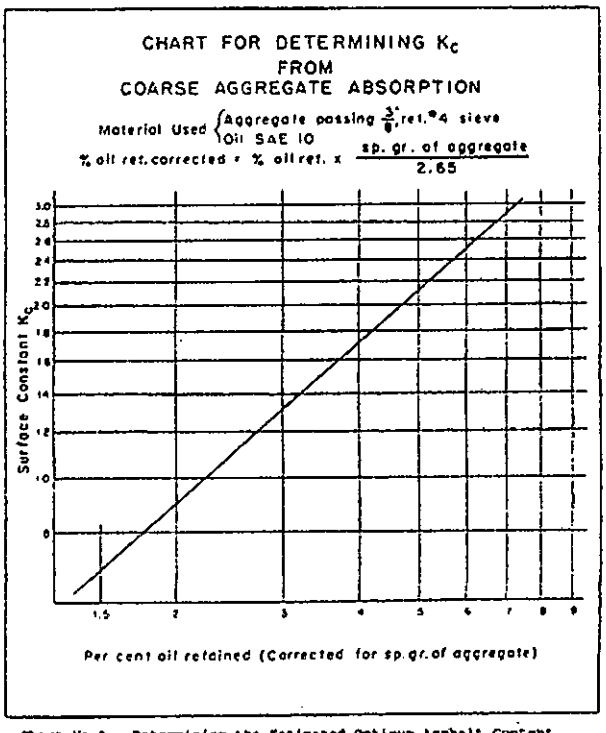

Chart No.2 - Determining the Estimated Optimum Asphalt Content.
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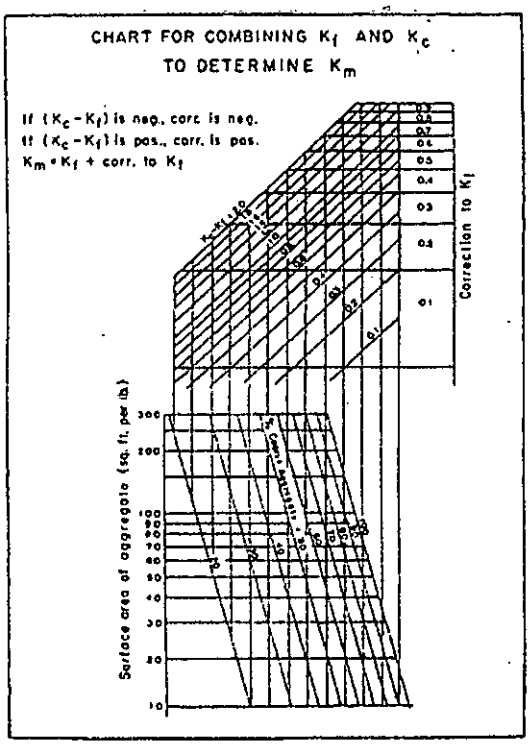

Chart No.3 - Determining the Estimated Optimum Asphalt Content.
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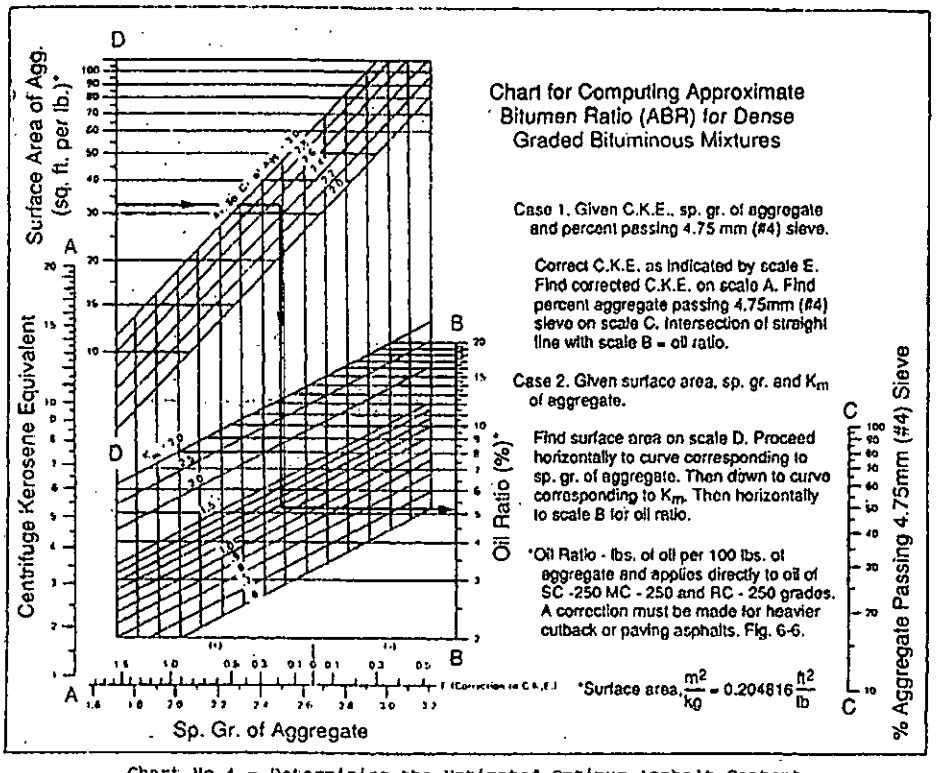

Chart No.4 - Determining the Estimated Optimum Asphalt Content.
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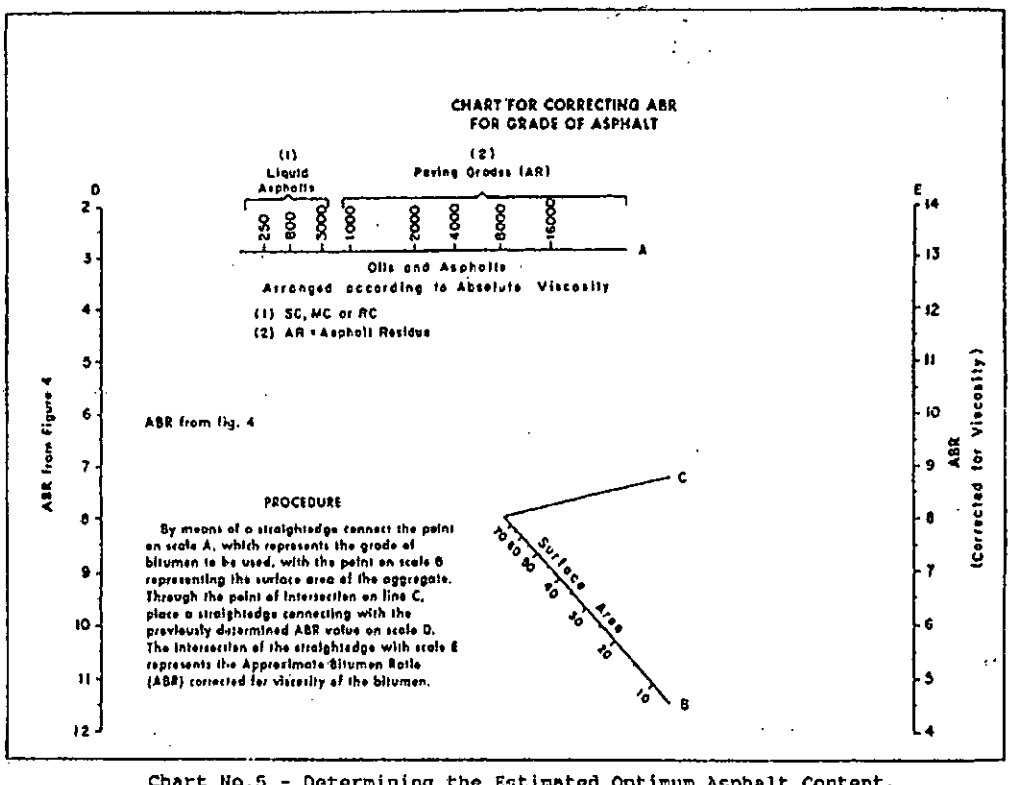

Chart No.5 - Determining the Estimated Optimum Asphalt Content.
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For Q 7(c)

Table 1: Improved Sub-grade Requirements

CBR Required	Compacted thickness of additional layer to provide required CBR				
	CBR of underlying layer				
	<2%	2%	3%	4%	5%
5%	Sub-grade material should be removed	450mm	300mm	250mm	200mm

Table 2: Thickness Design Table for Flexible Pavements (RHD design guide method)

mm	Surfacing (mm)		Roadbases (mm)* (Select one type)			Sub-bases (mm)** *Subgrade CBR %*		
Traffic ESA (mill)	Asphalt Wearing Course	Asphalt Base-Course	Cement-bound Granular	Granular Base Type I	Granular Base Type II	5	8 - 25	> 25
60 - 80	40	155	Refer to BRRL for design advice	N/A	N/A	300	150	0
40 - 60		140						
30 - 40		125						
25 - 30		110		250	300	250		
17 - 25		105						
15 - 17		95				200		
11 - 15		90						
9 - 11		80		200	250			
7 - 9		70						
6 - 7		65						
5 - 6		60						
4 - 5		55						
3 - 4		45		175	200	175		
< 3		35		150	175	150		

* CBR of granular base type I is min. 80%
* CBR of granular base type II is min. 50%
** CBR of sub-base material is 25%

N/A. = not applicable

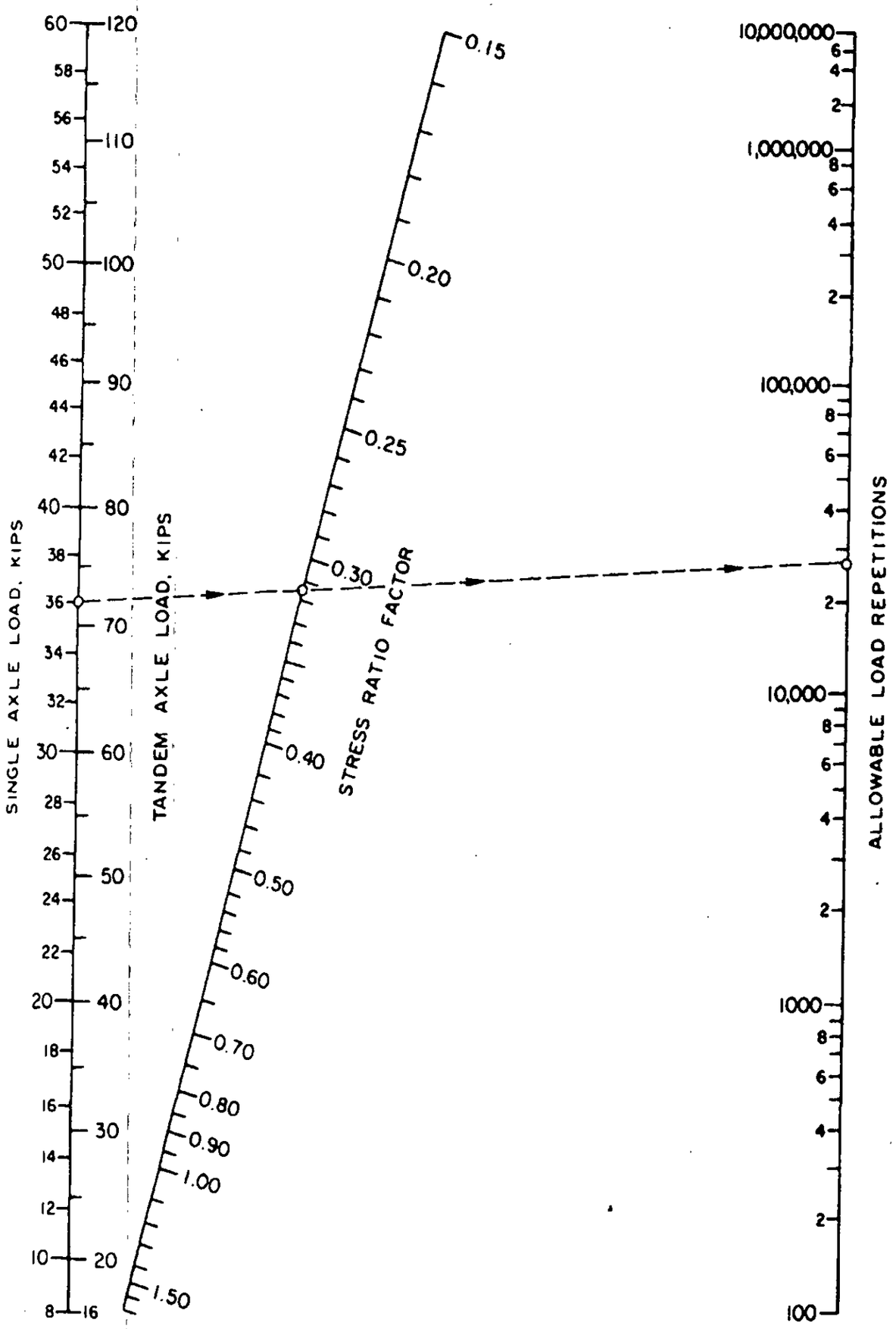
For Q 8(c)

Equivalent Stress — No Concrete Shoulder (Single Axle/Tandem Axle)

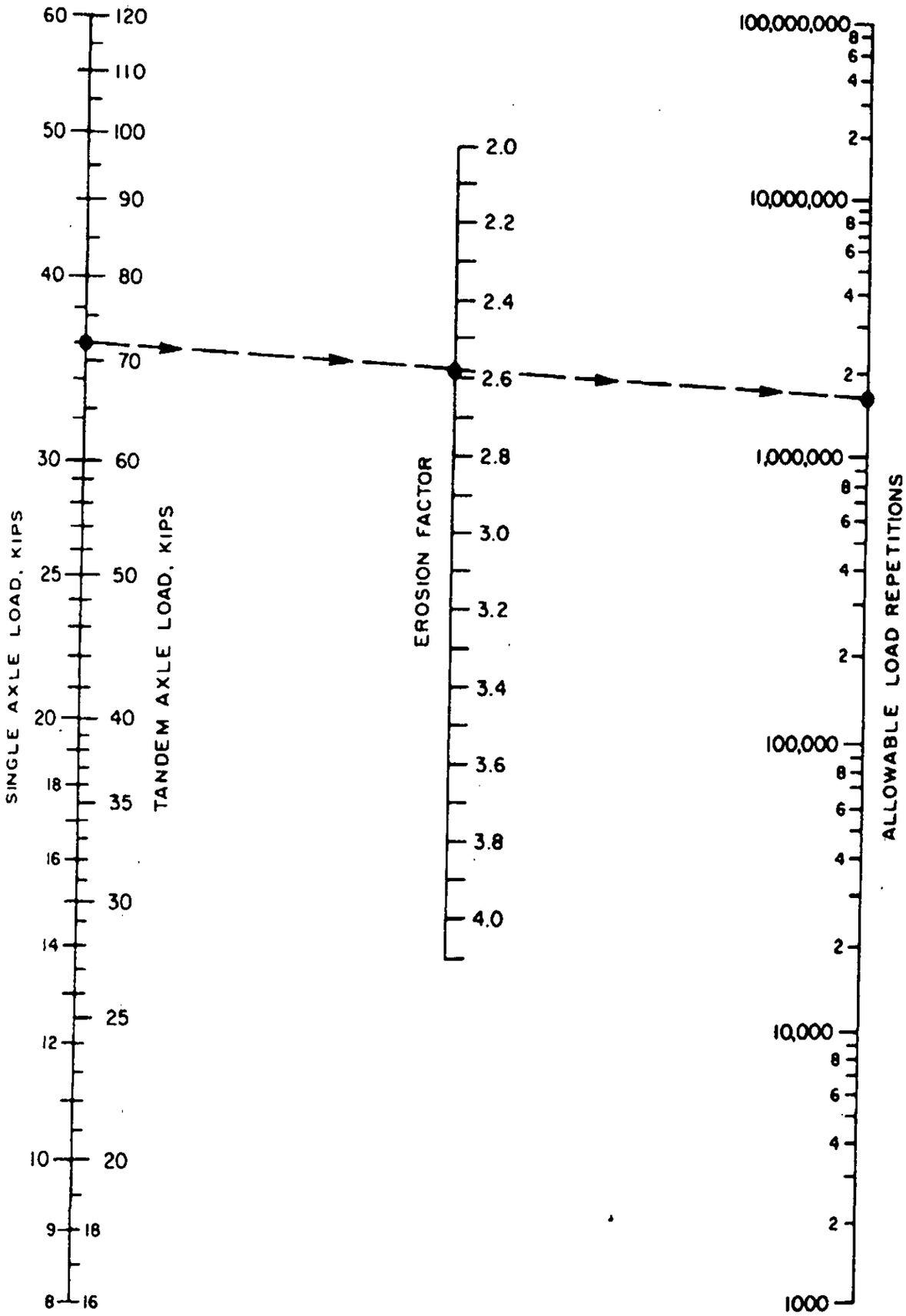
Slab thickness, in.	*k* of subgrade-subbase, pci						
	50	100	150	200	300	500	700
4	825/679	726/585	671/542	634/516	584/486	523/457	484/443
4.5	699/586	616/500	571/460	540/435	498/406	448/378	417/363
5	602/516	531/436	493/399	467/376	432/349	390/321	363/307
5.5	526/461	464/387	431/353	409/331	379/305	343/278	320/264
6	465/416	411/348	382/316	362/296	336/271	304/246	285/232
6.5	417/380	367/317	341/286	324/267	300/244	273/220	256/207
7	375/349	331/290	307/262	292/244	271/222	246/199	231/186
7.5	340/323	300/268	279/241	265/224	246/203	224/181	210/169
8	311/300	274/249	255/223	242/208	225/188	205/167	192/155
8.5	285/281	252/232	234/208	222/193	206/174	188/154	177/143
9	264/264	232/218	216/195	205/181	190/163	174/144	163/133
9.5	245/248	215/205	200/183	190/170	176/153	161/134	151/124
10	228/235	200/193	186/173	177/160	164/144	150/126	141/117
10.5	213/222	187/183	174/164	165/151	153/136	140/119	132/110
11	200/211	175/174	163/155	154/143	144/129	131/113	123/104
11.5	188/201	165/165	153/148	145/136	135/122	123/107	116/98
12	177/192	155/158	144/141	137/130	127/116	116/102	109/93
12.5	168/183	147/151	136/135	129/124	120/111	109/97	103/89
13	159/176	139/144	129/129	122/119	113/106	103/93	97/85
13.5	152/168	132/138	122/123	116/114	107/102	98/89	92/81
14	144/162	125/133	116/118	110/109	102/98	93/85	88/78

Erosion Factors — Doweled Joints, No Concrete Shoulder (Single /Tandem Axle)

Slab thickness, in	*k* of subgrade-subbase, pci					
	50	100	200	300	500	700
4	3.74/3.83	3.73/3.79	3.72/3.75	3.71/3.73	3.70/3.70	3.68/3.67
4.5	3.59/3.70	3.57/3.65	3.56/3.61	3.55/3.58	3.54/3.55	3.52/3.53
5	3.45/3.58	3.43/3.52	3.42/3.48	3.41/3.45	3.40/3.42	3.38/3.40
5.5	3.33/3.47	3.31/3.41	3.29/3.36	3.28/3.33	3.27/3.30	3.26/3.28
6	3.22/3.38	3.19/3.31	3.18/3.26	3.17/3.23	3.15/320	3.14/3.17
6.5	3.11/3.29	3.09/3.22	3.07/3.16	3.06/3.13	3.05/3.10	3.03/3.07
7	3.02/3.21	2.99/3.14	2.97/3.08	2.96/3.05	2.95/3.01	2.94/2.98
7.5	2.93/3.14	2.91/3.06	2.88/3.00	2.87/2.97	2.86/2.93	2.84/2.90
8	2.85/3.07	282/299	2.80/2.93	2.79/2.89	2.77/2.85	2.76/2.82
8.5	2.77/3.01	2.74/2.93	2.72/2.86	2.71/2.82	2.69/2.78	2.68/275
9	2.70/2.96	2.67/287	2.65/2.80	2.63/2.76	2.62/2 71	2.61/2.68
9.5	2.63/2.90	2.60/2.81	2.58/2.74	2.56/2.70	2.55/2.65	2.54/2.62
10	2.56/2.85	2.54/2.76	2.51/2.68	2.50/2.64	2.48/2.59	2.47/256
10.5	2.50/2.81	2.47/2.71	2.45/2.63	2.44/2.59	2.42/2.54	2.41/2.51
11	2.44/2.76	2.42/2.67	2.39/2.58	2.38/2.54	2.36/2.49	2.35/2.45
11.5	2.38/2 72	2.36/2.62	2.33/2.54	2.32/2.49	2.30/2.44	2.29/2.40
12	233/2.68	2.30/2 58	2.28/2.49	2.26/2.44	2.25/2.39	2.23/2.36
12.5	2.28/2.64	2.25/2.54	2.23/2.45	2.21/2.40	2.19/2.35	2.18/2.31
13	2.23/2.61	2.20/2.50	2.18/2.41	2.16/2.36	2.14/230	2.13/2 27
13.5	2.18/2.57	2.15/2.47	2.13/2.37	2.11/2.32	2.09/2.26	2.08/2 23
14	2.13/2.54	2.11/2.43	2.08/2.34	2.07/2.29	2.05/2.23	2.03/2.19



Fatigue analysis—allowable load repetitions based on stress ratio factor (with and without concrete shoulder).



Erosion analysis—allowable load repetitions based on erosion factor (without concrete shoulder).

Worksheet for Q 8(c)

Calculation of Pavement Thickness

Project _____

Trial thickness _____ in
Subbase-subgrade, k _____ pci
Modulus of Rupture, MR _____ psi
Load safety factor, LSF _____

Doweled joints yes ____ no ____
Concrete shoulder yes ____ no ____
Design Period _____ years

Axle Load, kips	Multiplied by LSF	Expected repetitions	Fatigue analysis		Erosion Analysis	
			Allowable repetitions	Fatigue Percent	Allowable repetitions	Damage Percent
1	2	3	4	5	6	7

8. Equivalent stress _____ 10. Erosion factor _____
9. Stress ratio factor _____

Single Axles

11. Equivalent stress _____ 13. Erosion factor _____
12. Stress ratio factor _____

Tandem Axles

			Total		Total	

L-4/T-1/CE **Date : 20/10/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2020-2021

Sub : **WRE 451** (Hydrology, Irrigation and Flood Management)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Give a qualitative comparison between atmospheric water and groundwater in terms of residence time. **(5)**

(b) Four rain gages are located within a rectangular area with four corners at (0, 0), (0, 15), (14, 15) and (14, 0) having the following coordinates of rain gage locations and recorded rainfalls: **(15)**

Rain gage location	Rain fall (mm)
(3, 9)	18
(7, 12)	25
(10, 10)	42
(6, 2)	35

All coordinates are expressed in kilometers. Compute the average rainfall in the area by Thiessen Polygon Method. Use plain graph paper.

(c) The coordinates of a 6-h unit hydrograph (UH) is given below. Compute the ordinates of a 3-h unit hydrograph. **(15)**

Time (hr)	0	3	6	9	12	15	18	21	24	27	30
Ordinates of 6-h UH (m^3/s)	0	30	70	130	80	60	50	30	18	10	0

2. (a) 'Isohyetal method is more flexible than Thiessen polygon method' – explain. **(5)**

(b) At a climatic station, air pressure, air temperature and relative humidity are 101.3 kPa, 20°C and 60%, respectively. Calculate the corresponding vapor pressure, specific humidity, air density and dew-point temperature. **(15)**

(c) The ordinates of a storm hydrograph of a river draining a catchment are of 165 km^2 due to a 4-hr rainfall are given below. Derive the ordinates of a 4-hr unit hydrograph. Further compute the 8-hr unit hydrograph using the method of superposition. **(15)**

Time (hr)	0	4	8	12	16	20	24	28	32	36
Discharge (m^3/s)	20	100	400	600	300	200	90	50	40	40

3. (a) Explain how the volume of effective rainfall is taken equal to the volume of direct runoff in hydroglogic calculations. **(5)**

(b) The average rainfall values over a catchment in three successive 6-h intervals are known to be 5.5, 1.5 and 3.5 cm. The φ-index for the catchment is estimated to be 0.25 cm/hr. At the beginning the base flow is 10 m^3/s and it increases by 1 m^3/s every 12-hr till the end of direct runoff. Estimate the ordinates of the resulting flood hydrograph. Use the 6-hr hydrograph (UH) ordinates from the table below. **(15)**

Contd P/2

WRE 451

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

Time (hr)	0	6	12	18	24	30	36	42	48	54	60	66
Ordinates of 6-h UH (m^3/s)	0	20	80	130	150	130	90	52	27	15	5	0

(c) The time distribution of a storm event is given below: **(15)**

Time from start (min)	30	60	90	120	150	180	210	240
Cumulative rainfall (cm)	0.5	1.9	4.9	7.3	9.2	9.9	11.1	12

(i) The φ-index is computed to be 1.3 cm/hr. Find out the volume of direct runoff if the catchment area is 0.9 km^2.

(ii) Compute the volume of total infiltration.

(iii) Find out the runoff coefficient for the catchment.

4. (a) Briefly explain the Area-Velocity method in calculating discharge in a river. **(5)**

(b) Route the following hydrograph through a river reach for which K = 10 hr and x = 0.15. The outflow discharge is 5 m^3/s in the beginning. **(15)**

Time (hr)	0	4	8	12	16	20	24	28	32	36
In flow (m^3/s)	5	10	10	50	45	35	20	15	10	8

(c) The design precipitation intensity is 3.8 in/hr for a storm with a T-year return period with slope of 0.005 and maximum length of travel of water of 1000 m. Estimate the design return period (T). Also estimate the design precipitation volume (m^3). Find out the design peak discharge (m^3/s) using rational method for the catchment. The area of the catchment is 2 km^2 and runoff coefficient is 0.5. Use the IDF curves (Fig. 1) and Kirpich formula for your estimation. **(15)**

SECTION – B

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

5. (a) What is duty and delta? How delta can be influenced by the efficiency of irrigation method for agricultural field. Consider other external factors remain unchanged. **(8)**

(b) Suppose you have a tomato garden on your roof which is grown on soilless media with drip irrigation. On an emergency you had to leave your place for few days and you asked your neighbour to take care of your garden for those days. Your neighbour forgets to take care of the plants for two days. What to do you think will happen to your garden? Justify your answer. **(7)**

(c) Design a border irrigation system for a 12 ha field having a field length 120m and a field slope of 0.003. The required depth of infiltration and roughness coefficients (n) are found to be 3 inch and 0.015, respectively. The values of empirical parameter of the Kostiakov infiltration equation k and a are 0.033m/ha and 0.63 respectively. **(10)**

(d) Furrows of 120m length and 0.70 m width and a having a sloe of 0.3% are initially irrigated for 40 min with a stream size of 0.005 m^3/s. The stream size is then reduced to half and continued for 30 min. The furrow end is closed (no outflow from the furrow). Determine the average depth of infiltrated water. **(10)**

Contd P/3

WRE 451

6. (a) How sediment concentration in irrigation water influences the design and efficiency of irrigation canal system? Which type of distribution canal in a canal system will be affected the most due to the presence of sediment in irrigation water? Why? **(10)**

(b) Suppose you are producing the same crop in two different climatic zones of Bangladesh. One near the ocean and other in the north eastern part of Bangladesh. Do you expect any variation of consumptive use during the base period of the crop on those locations? Why? **(10)**

(c) A volume of 2200 m^3 water is applied to a wheat field of 1.8 ha. The root zone depth of wheat is 62 cm and soil porosity is 42%. When the moisture content in the soil falls to 35% of the available water between the field capacity (26%) and permanent wilting point (13%) of the soil, determine the water application efficiency. **(10)**

(d) A farmer is planning irrigation scheduling for a farm producing rice crop with an area of 10 ha. For efficient irrigation management he is required to monitor the moisture content in his field regularly. If the farmer uses tensiometer method for this purpose, what do you think he will find the result on July 27th where there was rainfall on 26th July for almost 24 hrs. Justify your answer. **(5)**

7. (a) In our country, how do you think the salt accumulation influence crop production? In the southern part of Bangladesh, what could be the measures to deduce the salt accumulation? **(6)**

(b) In a wheat field moisture readings are found as 25, 29, 31 and 35% by volume at a depth of 15, 30, 45 and 60 cm, respectively. Compute the total moisture up to 50 cm of soil depth using the first method of radiological method. **(6)**

(c) A canal water supply is available but will not meet the total crop water demand. The canal water is blended with a poorer quality well water to an extent of 75% canal water and 25% well water. What is the SAR of the blended water. The following data are found from water analysis. **(10)**

	ECw	Ca	Mg	Na	HCO_3	SAR
	(ds/m)	(me/l)	(me/l)	(me/l)	(me/l)	
Canal water	0.23	1.41	0.54	0.48	1.8	0.5
Well water	3.60	2.52	4.00	32.0	4.5	18.0

(d) Compute the consumptive use and other irrigation requirement for the following crop data where the values of both application and conveyance efficiency are 85%. **(13)**

Contd P/4

WRE 451

Contd...Q. No. 7(d)

Dates and growth period	Pan evaporation, Ep in cm	Consumptive use coefficient (K)	Effective precipitation (cm)
Oct 16 -31	8.49	0.44	3.42
Nov 1-30	15.57	0.54	2.19
Dec 1-31	16.59	0.94	0.54
Jan 1-31	19.1	0.99	0.15
Feb 1-2	1.54	0.73	0.02

8. (a) Urban flooding is influenced by the collective contributions of climate change, unplaced city development, and social behavior of inhabitants. Do you agree or disagree with the statement? Justify. **(8)**

(b) Suppose that your village is located near the bank of Teesta river which is prone to flooding almost every year. What flood mitigation measures would you adapt for your village and why? **(7)**

(c) A sandy loam soil holds water at 140 mm/m depth between field capacity and permanent wilting point. The root depth of the crop is 30 cm and the allowable depletion of water is 35%. The daily water use by crop is 5 mm/day. The area to be irrigated is 60 ha and water can be diverted at 28 liter/s. The irrigation application efficiency is 40%. There are no rainfall and groundwater contribution. Determine,

(i) Allowable depletion depth between irrigations **(15)**

(ii) Frequency of irrigation

(iii) Net application depth of water

(iv) The volume of water required to irrigate 60 ha

(d) Estimate the leaching requirement when the electrical conductivity of saturated extract soil is 10 mmho/cm at 25% reduction in the yield of a crop. The electrical conductivity of irrigation water is 1.2 mmho/cm. **(5)**

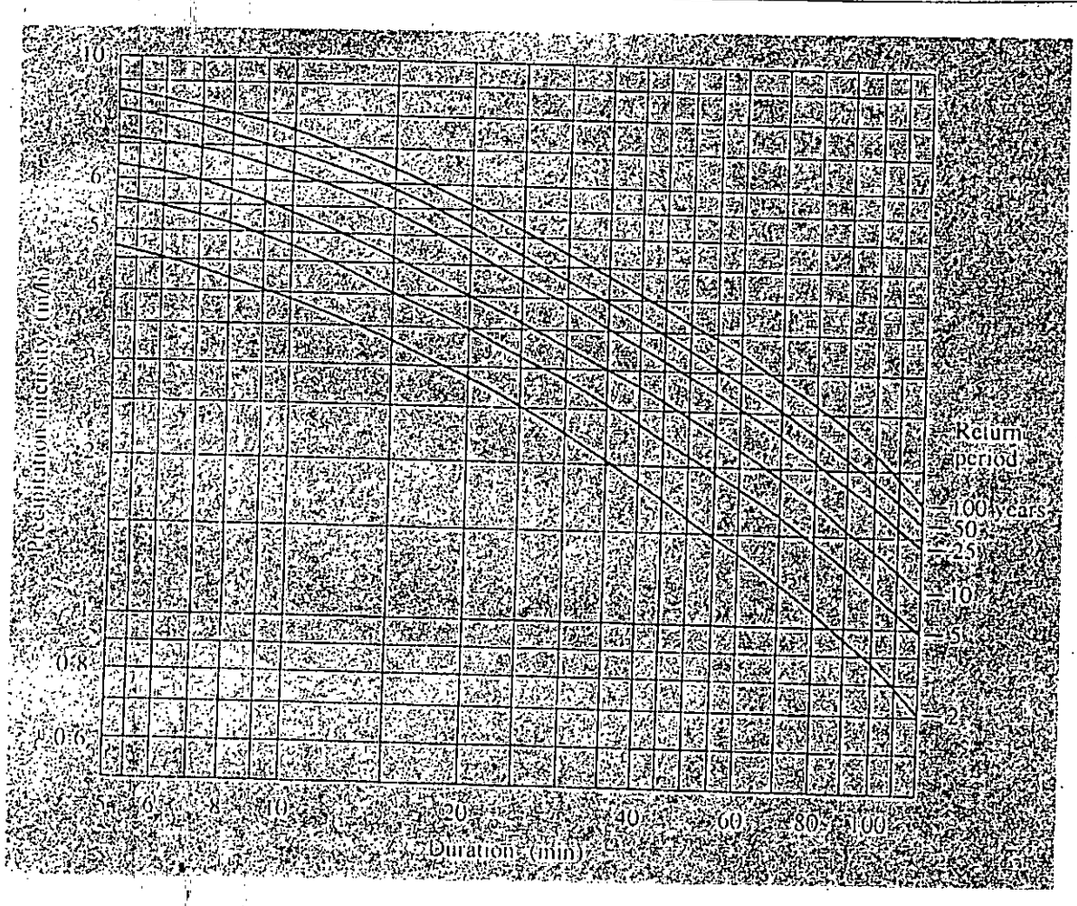


Fig. 1: Intensity-Duration-Frequency (IDF) curves for Q. 4(c)

Supplement Equations if Required

1. $\Delta = \frac{8.64\,B}{D}$
2. $\eta_d = \left(1 - \frac{d}{D}\right)$
3. $CIR = C_u - R_e$
4. $C_u = \frac{k.p}{40}[1.8t + 32]$
5. $E_p = 0.459.\ R.C_t.C_w.C_h.C_s.C_e$
6. $E_t = \frac{A.H_n + E_a\gamma}{A+\gamma}$
7. $V = \left[\frac{Qf^2}{140}\right]^{1/6}$
8. $D_{iw} = D_c + D_d$
9. $C_t = 0.393 + 0.02796\,T_c + 0.0001189T_c^2$
10. $C_w = 0.708 + 0.0034W - 0.0000038W^2$
11. $C_h = 1.250 - 0.0087H + 0.75 \times 10^4 H^2 - 0.85 \times 10^{-8}H^4$
12. $C_s = 0.542 + 0.008S - 0.78 \times 10^{-4}S^2 + 0.62 \times 10^{-6}S^3$
13. $H_n = H_c(1-r)\left(a + b\frac{n}{N}\right) - \sigma T_a^4\left(0.56 - 0.092\sqrt{e_a}\right) \times \left(0.10 + 0.90\frac{n}{N}\right)$
14. $q_{min} = (5.95 \times 10^{-6}) \times \frac{L \times S_0^{0.5}}{n}$
15. $q_{apl} = CU_q \frac{L^{1.0562} \times n^{0.1094} \times k^{1.225} \times a^{3.832}}{S^{0.09} \times D_{req}^{0.823}}$
16. $T_{apl} = CU_T \frac{L^{1.1} \times n^{0.0093} \times S_0^{0.0203} \times k^{0.387} \times D_{req}^{0.952}}{q_{apl}^{1.0885} \times a^{0.75}}$
17. $S = \frac{f^{5/3}}{3340Q^{1/6}}$
18. $SAR = \frac{Na^+}{\sqrt{\frac{Ca^{2+}+Mg^{2+}}{2}}}$
19. $SP = \frac{Na^+}{Na^+ + Ca^{++} + Mg^{++} + K^+} \times 100$
20. $LR = {}^{D_d}/_{D_{iw}} = {}^{EC_{iw}}/_{EC_d}$
21. $D_{iw} = [EC_d/(EC_d - EC_{iw})] \times D_c$
22. $C_e = 0.97 + 0.00984\,E$