University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2022
Program: B.Sc. Engineering (Civil)

Course Title: Project Planning and Management | Course Code: CE 401
Time: 3 Hours | Credit Hours: 3.00 | Full Marks: 150

Answer all the questions.

1. (i) "For better *Value for Money (VfM)* option, one should also consider the risk kept for the whole life of the asset in addition to the cost and quality."
Explain the above quoted statement with relevant example. **[07]**

(ii) What are the negotiations criteria for goods, works and consultancy services mentioned in the PPA 2006? **[08]**

2. The network of a construction project is shown in **Fig. 1**, along with the duration of each activity.

(i) Compute the followings:
(a) Earliest and Latest Event Time of each activity. **[15]**
(b) Activity Time (EST, EFT, LST, LFT) of each activity. **[15]**
(c) Total Float of each activity. **[05]**

(ii) Locate the critical path on the network. **[05]**

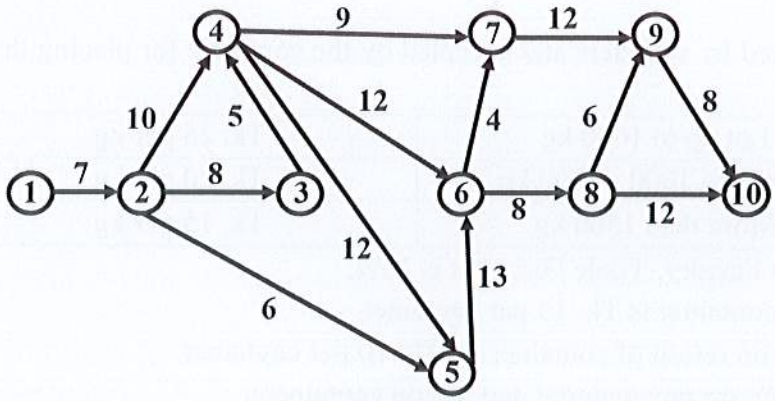

Fig. 1

3. A transport company has two types of trucks, Type A and Type B. Type A has a refrigerated capacity of 20 m^3 and a non-refrigerated capacity of 40 m^3, while type B has the same overall volume with equal sections for refrigerated and non-refrigerated stock. A grocer needs to hire trucks for the transport of 3000 m^3 of refrigerated stock and 4000 m^3 of non-refrigerated stock. The cost per km of a type A is \$30 and \$40 for type B.

(i) Formulate the objective function and constraint equations as a linear programming problem for the above-mentioned case. **[05]**

(ii) How many trucks of each type should the grocer rent to achieve the minimum total cost (**apply <u>Graphical method</u>**)? **[15]**

4. In a metropolitan area, new traffic signals were installed at 41 intersections under the project 'Signal Installation'. Accident data were analyzed for two years before and after the signal installation at each intersection. There were significant changes in accidents at those intersections with a reduction of accidents, from 7.0 accidents per intersection per year to 2.0 accidents per intersection per year.

Evaluate the project 'Signal Installation' using:

(i) Net Present Value method **[30]**
(ii) Benefit Cost Ratio method **[15]**

Use the following data:

Capital cost of Signal Installation: $ 100,000 per intersection
Operating and maintenance cost: $ 10,000 per intersection per year
Appraisal period: 5 years
Discount Rate: 10 percent
Average cost of an accident: $ 45,000
Expected Residual value: $ 15,000

5. (i) Briefly describe the objectives of Inventory Management. **[10]**

(ii) The particulars relating to 950 kg of a certain raw material purchased by a particular company during September 2022 are as below:

Lot prices quoted by suppliers and accepted by the company for placing the purchase order are:

Lot up to 1000 kg	Tk. 25 per kg
Between 1000 - 1500 kg	Tk. 20 per kg
More than 1500 kg	Tk. 15 per kg

For Supplies to Factory, Trade Discount is 15%.
Price of 25 kg container is Tk. 15 per container.
Credit allowed on return of containers is Tk. 10 per container.
Sales Tax is 10% on raw material and 5% on containers.
Transportation cost paid by the purchaser is Tk. 1500.
Insurance is 2% (on net invoice value) paid by the purchaser.
Stores Overheads applied at 5% on total purchase cost of material.
The entire quantity has been received and issued to production.
The containers are returned in due course.

Analyze the above data/information to calculate the followings:

(a) Total cost of material purchased. **[15]**
(b) Unit cost of material issued to production. **[05]**

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University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2022
Program: B. Sc. Engineering (Civil)

Course Title: Structural Engineering III | Credit Hours: 3.0 | Course Code: CE 411
Time: 3 hours | Full Marks: 100 (10× 10)

ANSWER ALL THE QUESTIONS. Any missing data can be assumed reasonably.

1. Use Stiffness Method (neglect axial deformations) to calculate rotation and deflection of joint ***f*** of the frame ***abcdefg*** loaded as shown in ***Fig.1***, if the joint ***f*** is a circular foundation of radius 4 ft on the surface of subsoil (half-space) with shear wave velocity (v_s) equal to 880 ft/sec
[Given: $EI = 44 \times 10^3$ k-ft^2, $\gamma_{soil} = 120$ pcf, Poisson's ratio of soil, $\nu = 0.25$].

2. Use Stiffness Method (neglecting axial deformations) to calculate the value of applied load ***F*** required to cause buckling of the frame ***abcd*** loaded as shown in ***Fig.2***
[Given: $EI = 44 \times 10^4$k-ft^2].

3. Use Stiffness Method considering geometric nonlinearity and flexural deformations only to calculate the unknown rotation at joint ***c*** and deflection at ***b*** and ***d*** of the frame ***abcde*** loaded as shown in ***Fig.3***
[Given: $w = 4.4$ k/ft, $EI = 44 \times 10^4$ k-ft^2].

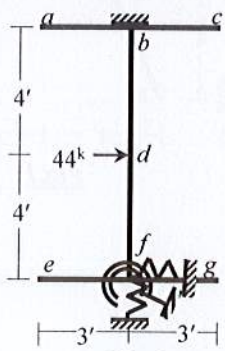


Fig.1

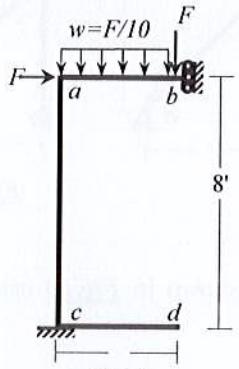


Fig.2

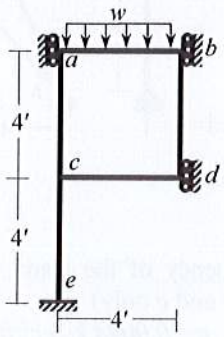


Fig.3

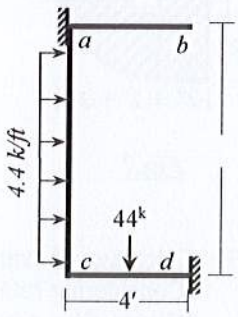


Fig.4

4. Use Stiffness Method considering flexural deformations only to calculate the unknown rotation at ***c*** of the frame ***abcd*** loaded as shown in ***Fig.4***
[Given: $EI = 44 \times 10^4$ k-ft^2]

5. Determine the degree of kinematic indeterminacy (**doki**) and show the corresponding deflections and rotations of the 2D frame (***Fig.5***) and 3D frame (***Fig.6***) for the following cases
   (i) Not considering boundary conditions
   (ii) Considering boundary conditions
   (iii) Neglecting axial deformations.

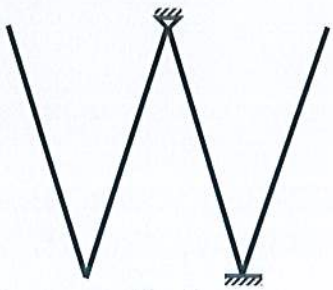


Fig.5

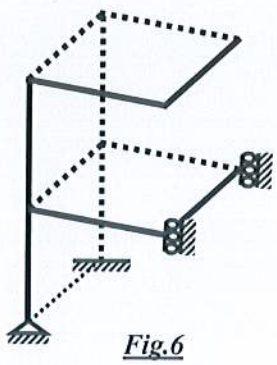


Fig.6

6. Calculate Yield Moment and Plastic Moment capacity of the section shown in ***Fig.7*** if the section is made of elastic-fully plastic material
[Given: $\sigma_y = \sigma_{yp} = 50$ *ksi*].

7. Use the Energy Method to calculate the load (i) ***Q*** needed to form beam mechanism,(ii) ***P*** needed to form the sidesway mechanism in the frame loaded as shown in ***Fig.8***
[Given: $M_{P(beam)} = 144$ *k-ft*, $M_{P(column)} = 244$ *k-ft*].

8. For the 2D truss ***abcd*** loaded as shown in ***Fig.9***,
(i) Identify zero-force members, (ii) Determine the displacements of joints ***a***,
(ii) Calculate member forces
[Given: $EA/L = 1200$ *k/ft*].

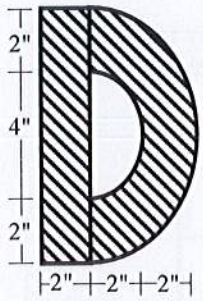


Fig.7

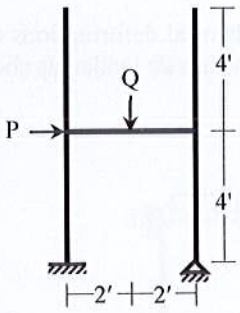


Fig.8

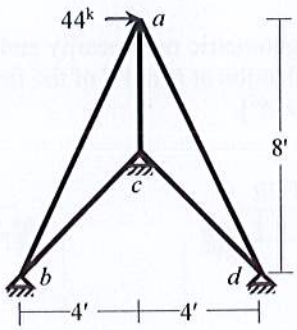


Fig.9

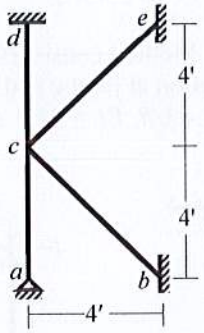


Fig.10

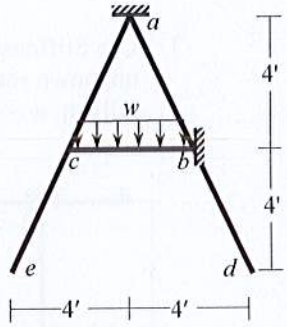


Fig.11

9. Calculate 1st natural frequency of the frame ***abcde*** shown in ***Fig.10*** using consistent mass matrices (Considering rotations at ***a*** and ***c*** only)
[Given: $EI = 44 \times 10^3$ *k-ft*^{2}, $\mu = 0.0044$ *k-sec*^{2}*/ft*^{2}].

10. Frame structure ***abcde*** shown in ***Fig.11*** is subjected to a dynamic load, $w = 4.4e^t$ (*k/ft*).
Use *Constant Average Acceleration* (*CAA*) Method to calculate the rotation of joint ***c*** at time $t = 0.10$ sec
[Given: $EI = 44 \times 10^4$ *k-ft*^{2}, $\mu = 0.0044$ *k-sec*^{2}*/ft*^{2}, *Damping ratio of the system* $= 4.4\%$].

List of Useful Formulae for CE 411

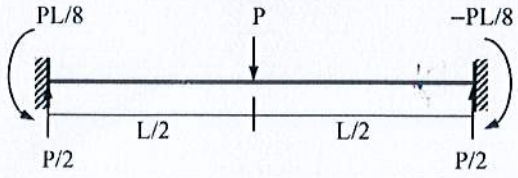
* The stiffness matrix $\mathbf{K_m}^G$ of a 2D truss member in the global axis system is given by

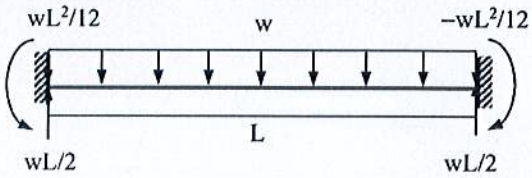
$$\mathbf{K_m}^G = S_x \begin{pmatrix} C^2 & CS & -C^2 & -CS \\ CS & S^2 & -CS & -S^2 \\ -C^2 & -CS & C^2 & CS \\ -CS & -S^2 & CS & S^2 \end{pmatrix}$$

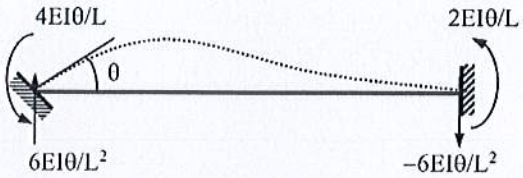
and Truss member force, $P_{AB} = S_x [(u_B - u_A) C + (v_B - v_A) S]$

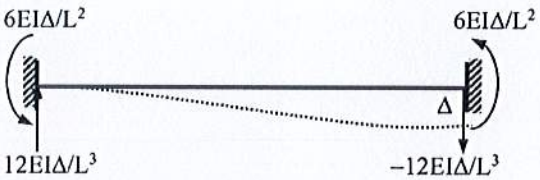
[where $C = \cos\theta$, $S = \sin\theta$]

Fixed End Reactions for One-dimensional Prismatic Members under Typical Loadings









* The stiffness matrix of a 3D truss member in the global axes system [using $C_x = \cos\alpha$, $C_y = \cos\beta$, $C_z = \cos\gamma$] is

$$\mathbf{K_m}^G = S_x \begin{pmatrix} C_x^2 & C_xC_y & C_xC_z & -C_x^2 & -C_xC_y & -C_xC_z \\ C_yC_x & C_y^2 & C_yC_z & -C_yC_x & -C_y^2 & -C_yC_z \\ C_zC_x & C_zC_y & C_z^2 & -C_zC_x & -C_zC_y & -C_z^2 \\ -C_x^2 & -C_xC_y & -C_xC_z & C_x^2 & C_xC_y & C_xC_z \\ -C_yC_x & -C_y^2 & -C_yC_z & C_yC_x & C_y^2 & C_yC_z \\ -C_zC_x & -C_zC_y & -C_z^2 & C_zC_x & C_zC_y & C_z^2 \end{pmatrix}$$

$C_x = L_x/L$, $C_y = L_y/L$, $C_z = L_z/L$
where $L = \sqrt{[L_x^2 + L_y^2 + L_z^2]}$

* Member force $P_{AB} = S_x [(u_B - u_A) C_x + (v_B - v_A) C_y + (w_B - w_A) C_z]$
* Torsional stiffness $T_1 = GJ/L$
* Ignoring axial deformations, the matrices $\mathbf{K_m}^L$ and $\mathbf{G_m}^L$ of a frame member in the local axis system are

$$\mathbf{K_m}^L = \begin{pmatrix} S_1 & S_2 & -S_1 & S_2 \\ S_2 & S_3 & -S_2 & S_4 \\ -S_1 & -S_2 & S_1 & -S_2 \\ S_2 & S_4 & -S_2 & S_3 \end{pmatrix} \qquad \mathbf{G_m}^L = (P/30L) \begin{pmatrix} 36 & 3L & -36 & 3L \\ 3L & 4L^2 & -3L & -L^2 \\ -36 & -3L & 36 & -3L \\ 3L & -L^2 & -3L & 4L^2 \end{pmatrix}$$

where $S_1 = 12EI/L^3$, $S_2 = 6EI/L^2$, $S_3 = 4EI/L$, $S_4 = 2EI/L$

* $\mathbf{K_{total}} = \mathbf{K} + \mathbf{G}$, buckling occurs (i.e., $P = P_{cr}$) when $|\mathbf{K_{total}}| = 0$

* For sections of Elastic-Fully-Plastic material, $A_t = A_c = A/2$, and $M_p = A_c\,\bar{y}_c + A_t\,\bar{y}_t$
* For RC sections, $M_p = A_s f_y (d - a/2)$, where $a = A_s f_y/(0.85 f_c' b)$
* Virtual work done by external forces (δW_E) = Virtual work done by internal forces (δW_I)
* For simply supported beams under (i) concentrated midspan load $P_u = 4 M_p/L$, and (ii) UDL $w_u = 8 M_p/L^2$
* For fixed-ended beams under (i) concentrated midspan load $P_u = 8 M_p/L$, and (ii) UDL $w_u = 16 M_p/L^2$
* For hinged-fixed ended beams under UDL $w_u = 11.66 M_p/L^2$

* Using CAA Method, $(m + c\Delta t/2 + k\Delta t^2/4)a_{i+1} = f_{i+1} - ku_i - (c + k\Delta t)v_i - (c\Delta t/2 + k\Delta t^2/4)a_i$
  [m = Total mass, c = Damping = $2\xi\sqrt{(km)}$, where ξ = Damping Ratio]
  Also $v_{i+1} = v_i + (a_i + a_{i+1})\Delta t/2$, and $u_{i+1} = u_i + v_i\,\Delta t + (a_i + a_{i+1})\Delta t^2/4$, starting with $a_0 = (f_0 - cv_0 - ku_0)/m$

* Lumped- and Consistent-Mass matrix for axial rod

$$\mathbf{M_m} = (\mu L/2)\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \qquad \mathbf{M_m} = (\mu L/3)\begin{pmatrix} 1 & 0.5 \\ 0.5 & 1 \end{pmatrix}$$

Consistent-Mass matrix for beam [μ = Mass per unit length]

$$\mathbf{M_m} = (\mu L/420)\begin{pmatrix} 156 & 22L & 54 & -13L \\ 22L & 4L^2 & 13L & -3L^2 \\ 54 & 13L & 156 & -22L \\ -13L & -3L^2 & -22L & 4L^2 \end{pmatrix}$$

* At natural frequency (i.e., $\omega = \omega_n$), $|\mathbf{K} - \omega_n^2 \mathbf{M}| = 0$
* Stiffness of Circular Surface Foundations on Half-Space

Motion	Horizontal	Vertical	Rotational	Torsional
$K_{Halfspace}$	$8G_sR/(2-\nu)$	$4G_sR/(1-\nu)$	$8G_sR^3/(3-3\nu)$	$16G_sR^3/3$

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2022
Program: B. Sc. Engineering (Civil)

Course Title: Geotechnical Engineering II — Course Code: CE 441
Time: 3 hours — Credit Hours: 3.0 — Full Marks: 120

Answer to all questions

1. (a) Is it possible to collect absolutely undisturbed sample during geotechnical sampling? Justify your answer. 7

   (b) Write down the steps of field investigation phase of a geotechnical subsurface exploration program. Write down any three general guidelines used for the selection of location of boreholes. 5

   (c) The outside and inside diameters of a split spoon sampler are 2 inches and 1-3/8 inches, respectively. The degree of disturbance (DOD) of a Shelby tube sampler is one-twelfth the DOD of the split spoon sampler. If the inside diameter of the Selby tube sampler is 73 mm, determine its outside diameter. 3

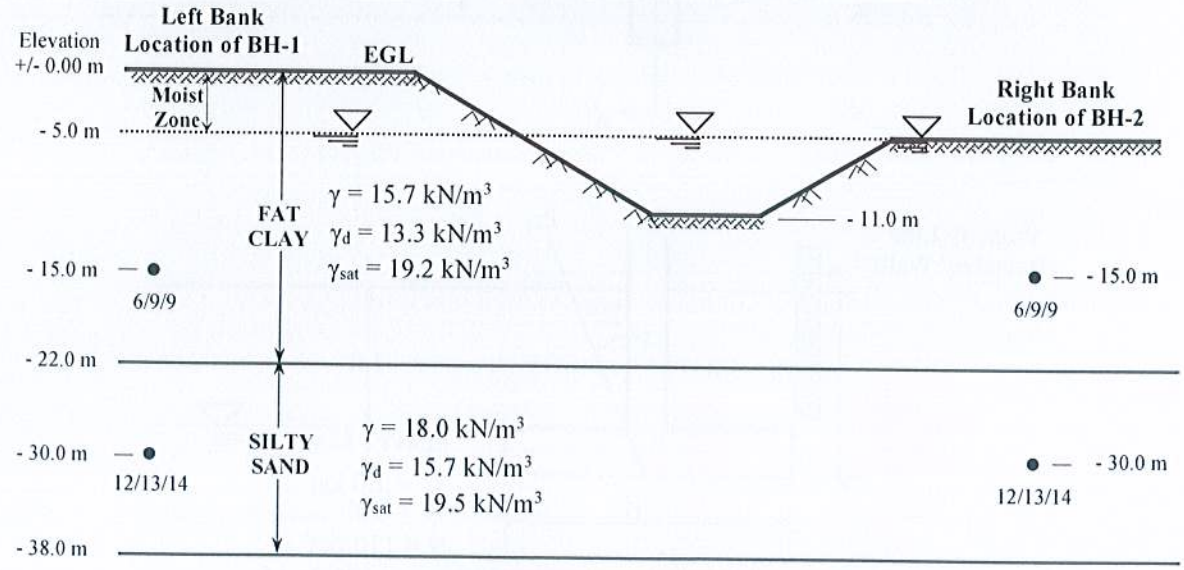
2. (a) Consider two scenarios for two very adjacent sites (having same level), site A and site B as follows: 9

   Site A: For a low-rise building project, foundation of this site was designed properly and was already constructed. A 6-ft diameter circular footing was seen to be constructed at the site for a column load of 85 kips.

   Site B: For a proposed building, at this site the exploration depth was about 20 feet blow EGL (Existing Ground Level). Assume an anticipated bearing capacity for this site to be similar to that of site A (adjacent one) and a maximum footing size of 12 feet by 16 feet. Assume the foundation bearing level to be about 10 feet below EGL.

   Check whether the depth of exploration for site B is sufficient or not. Justify your findings in comparison to the induced stress at the foundation level.

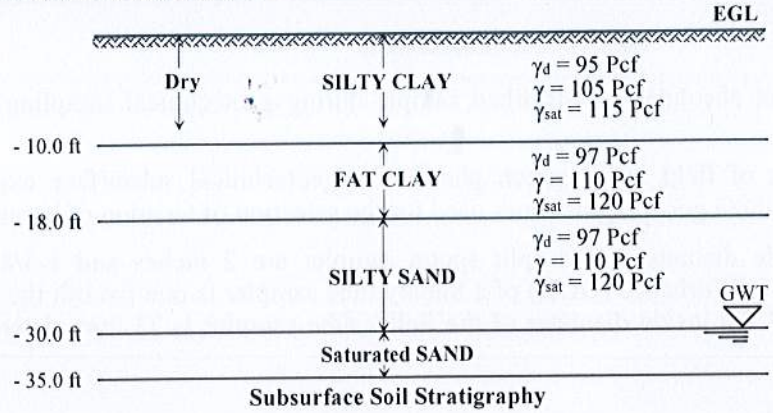
   (b) Two boreholes were advanced as a part of a preliminary geotechnical investigation for a site in Bangladesh as shown below. Determine cohesion and angle of internal friction at corresponding depths (for both boreholes) of the clay and sand deposits, respectively, based on the available data (Use empirical correlations as provided in **Appendix**). Use hammer efficiency as 55%. 11



Subsurface Soil Stratigraphy

3. (a) Discuss about shallow and deep foundations? Categorize shallow foundations. 4 + 2

(b) For fully compensated condition, if the depth of the bottom of a mat foundation is 30 ft below EGL, determine the number of stories that could be built considering uniformly distributed floor load 300 psf and soil stratigraphy as shown. 4

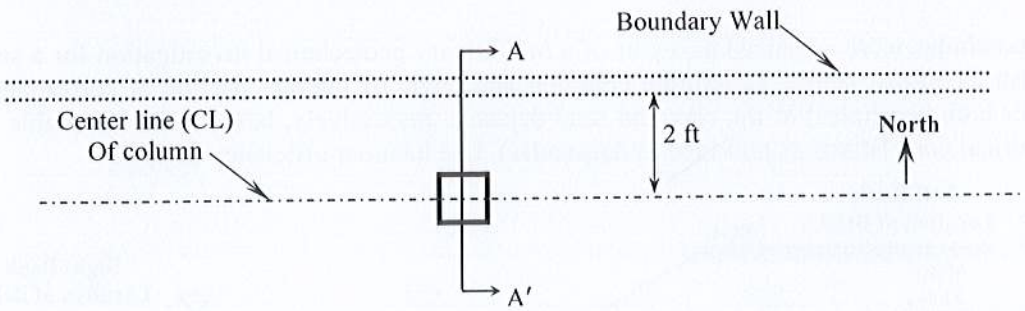


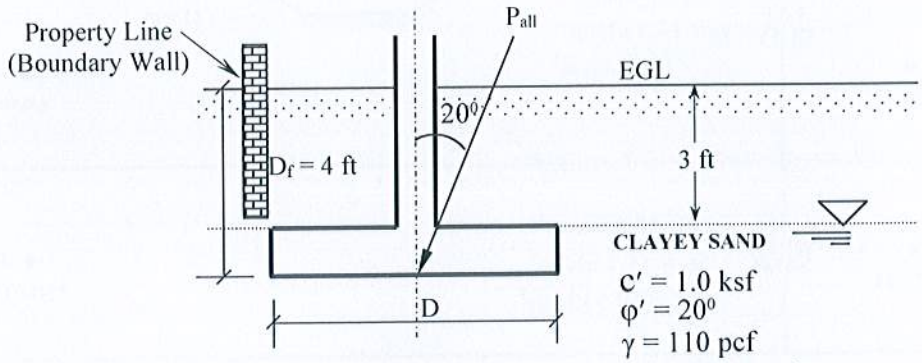
Subsurface Soil Stratigraphy

4. (a) Write down the advantages of General Bearing Capacity Equation (GBCE) over Terzaghi's Bearing Capacity Equations (TBCE). 3

(b) For the following given conditions, determine the allowable column load (P_{all}) for the following footing. 10

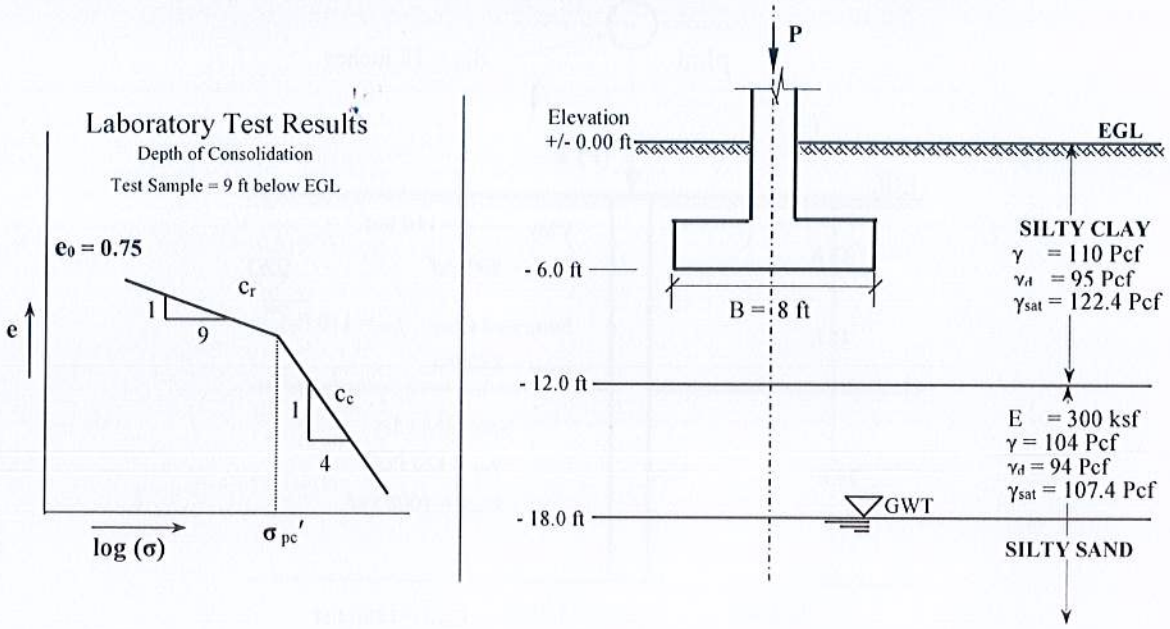
- Foundation spread cannot go beyond the interior of the boundary wall
- Centerline (CL) of the column is 2 feet south of the property line
- Circular footing
- Column location cannot be moved
- Factor of safety = 2.5
- Use general bearing capacity equation (GBCE)



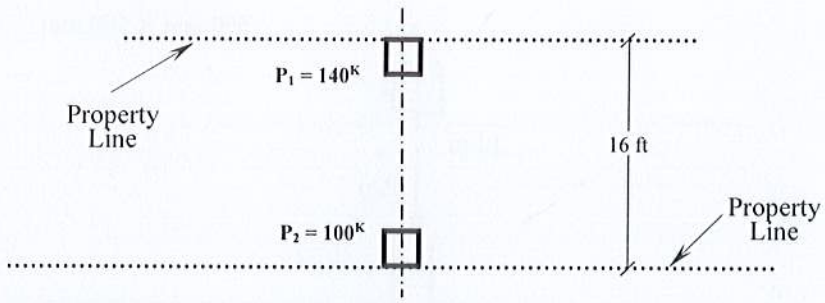


SEC A-A′

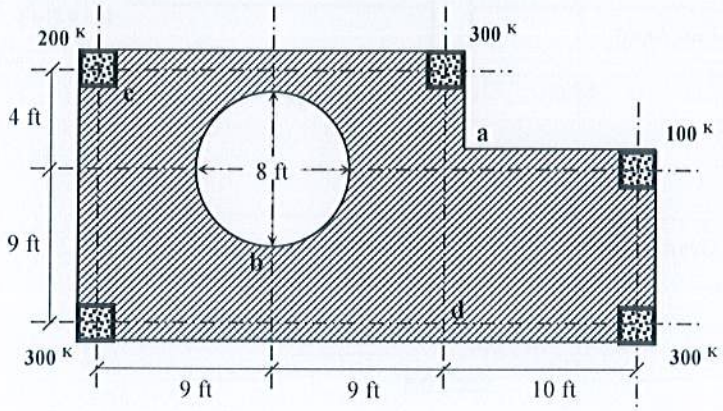
(c) A rectangular footing (8 ft X 12 ft), designed as per allowable bearing capacity based on shearing failure, is shown in the following figure. OCR of the cohesive deposit is 2.0. Estimate settlements for both sand and clay layers. Use $q_a = p = 5.0$ ksf . 12



5. (a) For the following loading, geometric and boundary conditions design the size of a combined footing. Consider allowable bearing capacity and all column dimensions 2.0 ksf and 12-inch by 12-inch, respectively. 9

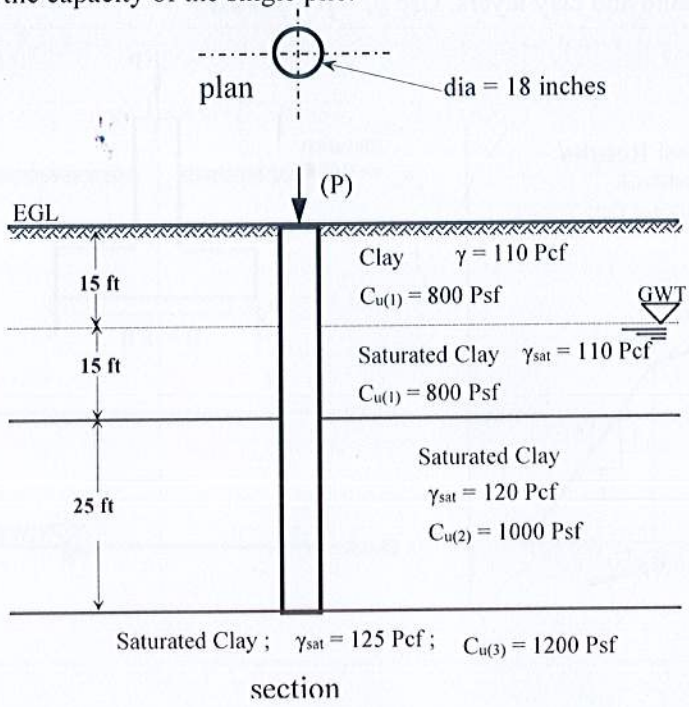


(b) The plan of a mat foundation with column loads and dimensions (24 in x 24 in each for all columns) is shown in the figure below. Calculate soil pressures at points a, b, c, d and geometric centroid. 16

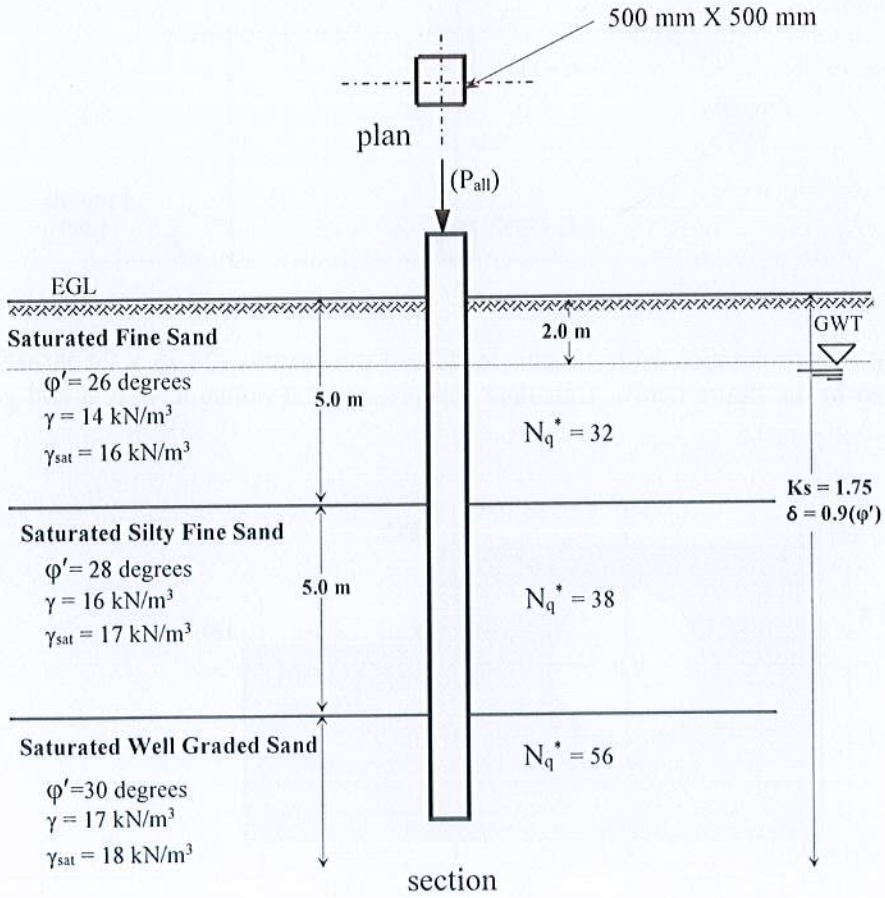


6. (a) Classify (mention names only) pile foundations according to their materials (composition), method of installation and displacement criteria. 4

(b) For the soil stratigraphy as shown below, a concrete bored pile having diameter of 18 inches was installed. Calculate the capacity of the single pile. 9



(c) The plan and X-section of a 15-meter long single pre-cast concrete pile (square) driven in different sand deposits are shown below. Estimate the allowable capacity of the single pile. 12



University of Asia Pacific
Department of Civil Engineering
Final Examination – Spring 2022
Program: B.Sc. Engineering (Civil)

Course Title: Transportation Engineering II | Course Code: CE 451
Time: 3 hours | Credit Hour: 3:00 | Full Marks: 120

1. a) What are the basic provisions for setting an ideal permanent way? (5)

   b) What kind of difficulties will you face in providing superelevation on a railway track if a branch line diverges from the main track? (7)

   c) Calculate the steepest gradient on a 4-degree curved B.G. track from the following data: (13)
   Number of wagons = 15
   Weight of one wagon = 30 tonnes
   Speed of train = 75 km/h
   Rolling resistance of wagon= 5 kg/tonne
   Weight of locomotive with tender = 270 tonnes
   The axle load of the driving wheels (shown in figure 1) = 35.7 tonnes
   Rolling resistance of locomotive = 5 kg/tonne

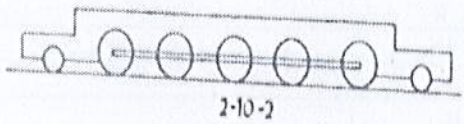


Fig: 1

   d) Compute the length of a transition curve required for an N.G. curve of six degrees. The maximum permissible speed on the curve is 135 km.p.h. This transition curve is to be used to join the ends of a 6° circular curve with the straight. Set the transition curve with the straight-taking offsets at every 63 m interval. (15)

2. Design an asphalt concrete mixture for highway pavement supporting heavy traffic. Table 1 and 2 shows data obtained from sieve analysis and the Marshall method respectively. **Determine the optimum asphalt content for this mix for the specified limits given in Table 3**. (The nominal maximum particle size in the aggregate mixture is 3/8 in.). **Also, comment on the stability and flow of the mixture.** (15+5)

Table 1: Sieve Analysis result

Retained on Sieve Designation	% By weight	Bulk specific gravity
19 mm	6-50	3.24
4.75 mm	10-65	2.66
0.180 mm	15-42	2.85
0.075 mm	5-15	3.44

Table 2: Marshall Method

Asphalt %	Weight of specimen in Air (gm)	Weight of specimen in Water (gm)	Stability (lb)	Flow (in)	Maximum Specific Gravity
4.0	1438.2	954.2	1700	15	3.10
4.5	1523.4	1055.6	1650	12	3.50
5.0	1377.8	746.2	1570	13	2.30

Table 3 Suggested Test Limit

Marshall Method Mix Criteria	Light Traffic	Medium Traffic	Heavy Traffic
Compaction (No. of blows each end of Specimen)	35	50	75
Stability N (lb)	3336(750)	5338(1200)	8006(1800)
Flow 0.25 mm (0.01 in)	8 to 18	8 to 16	8 to 14
Air Voids (%)	3 to 5	3 to 5	3 to 5
Mineral Percentage of Voids in Mineral Aggregates			
Standard Sieve Designation		%	
No. 16		23.5	
No. 4		21	
No. 8		18	
3/8 in.		16	
½ in.		15	
¾ in.		14	
1 in.		13	
1 ½ in.		12	
2 in.		11.5	
2 ½ in.		11	

3. Determine ESAL for the following data: (15)
Highway type = 8 lane rural divided highway
Assumed, SN or D = 3 and Pt = 2.5
Design year = 35
Average Daily Traffic = 8,310 (both direction)

Table 4: Traffic Information

Vehicle Types	Current AADT	Growth Rate	ESAL Factor
Passengers Cars	4425	3.0%	0.0008
Small Buses	525	2.5%	0.0081
Large Buses	347	3.1%	0.6806
Pickup Trucks	1455	2.4%	0.0122
2-axle/6-fire trucks	425	4.5%	0.6560
3 or more axle trucks	63	4.0%	0.8646
5 or more axle trailer	1070	1.9%	2.3719

4. Design a concrete pavement for a four-lane urban expressway using the AASHTO method where a 7-inch layer of untreated granular material is used as a sub-base layer. The monthly value of the resilient modulus of roadbed soil and sub-base is given in Table 5. If the rock depth is located 2 ft below the subgrade surface and the projected slab thickness is 10 in, (15+10)

i) **Estimate the effective modulus of the subgrade reaction**. And

ii) **Check whether the projected slab thickness is sufficient for such kind of pavement or not if the effective modulus of subgrade reaction, K = 700 lb/in^3.**

[Consider design ESAL as 4X10^6, the working stress of the concrete is 700 lb/in^2 and the modulus of elasticity is 6X10^6 lb/in^2. The overall standard deviation is 0.25, the load transfer coefficient is 3.0, the drainage coefficient is 0.75 and the reliability is 85%.]

Table 5: Soil Characteristics

Month	Roadbed Modulus (lb/in^2)	Sub-base Modulus (lb/in^2)
July	17,000	100,000
August	13,000	75,000
September	20,000	50,000
October	7,000	20,000
November	5,000	30,000
December	3,000	15,000

5. a) Design a suitable pavement of an asphalt mixture surface with an elastic modulus of 300,000 lb/in^2, a granular base layer with a structural coefficient of 0.15 on a subgrade having a resilient modulus of elasticity of 8500 lb/in^2. Assume all m_i values as 1. Use a reliability level of 80%, a standard deviation of 0.35, and a design serviceability loss of 3.0. Consider the value of design ESAL calculated in Q3. The CBR value of the base course is 22. The resilient modulus of the base course and sub-base course is 13,500 lb/in^2 and 5000 lb/in^2 respectively. (15)

b) Differentiate between (2.5+2.5)

i) ACV and AIV.

ii) CBR test and Plate Bearing Test

Required Formula:

$$G_{sb} = \frac{P_{ca} + P_{fa} + P_{mf}}{(P_{ca}/G_{bca}) + (P_{fa}/G_{bfa}) + (P_{mf}/G_{bmf})}$$

$$VMA = 100 - \frac{G_{mb}P_s}{G_{sb}}$$

$$P_a = 100\,\frac{G_{mm} - G_{mb}}{G_{mm}}$$

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2022
Program: B.Sc. Engineering (Civil)

Course Title: Irrigation & Flood Control | Course Code: CE 461

Time: 3 hours | Credit Hour: 3.00 | Full Marks: 100

Answer all the questions. Assume any reasonable value(s) if missing.

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1. An irrigation project in the Munshiganj district of Bangladesh diverts surface water from the Meghna River through a canal to irrigate an area of 400 hectares. Based on the data and information provided in ***Figure 1*** and ***Table 1*** below. Determine the following for the period from December to February: (14)

   - Consumptive Water Use (C_u);
   - Consumptive Irrigation Requirement (C.I.R);
   - Net Irrigation Requirement (N.I.R);
   - Field Irrigation Requirement (F.I.R);
   - Gross Irrigation Requirement (G.I.R);
   - Volume of water required to be diverted from the head works.

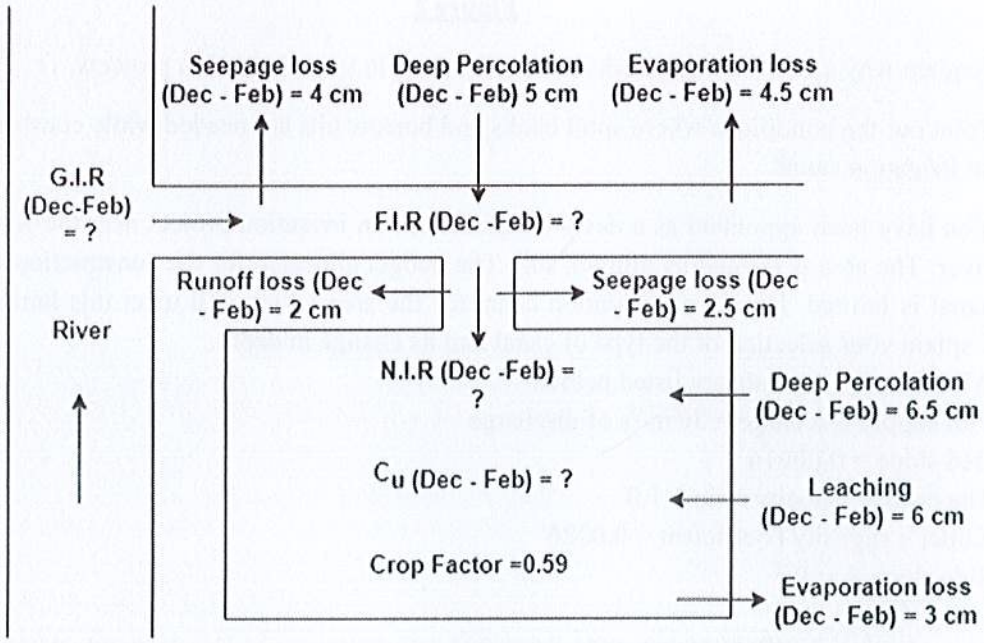

Figure 1

Table 1

Month	Monthly temperature (°C) averaged over the last 5 years	The monthly percent of daytime hours of the year computed from the Sunshine	Useful rainfall in cm averaged over the last 5 years
December	20.5	10.50	2.00
January	19.5	11.00	1.80
February	24.5	11.50	4.00

2. The gross command area of an irrigation project is 60000 ha and 75% of it is culturable. Design a reservoir needed for the project by analyzing the data and information provided in ***Figure 2***. (18)

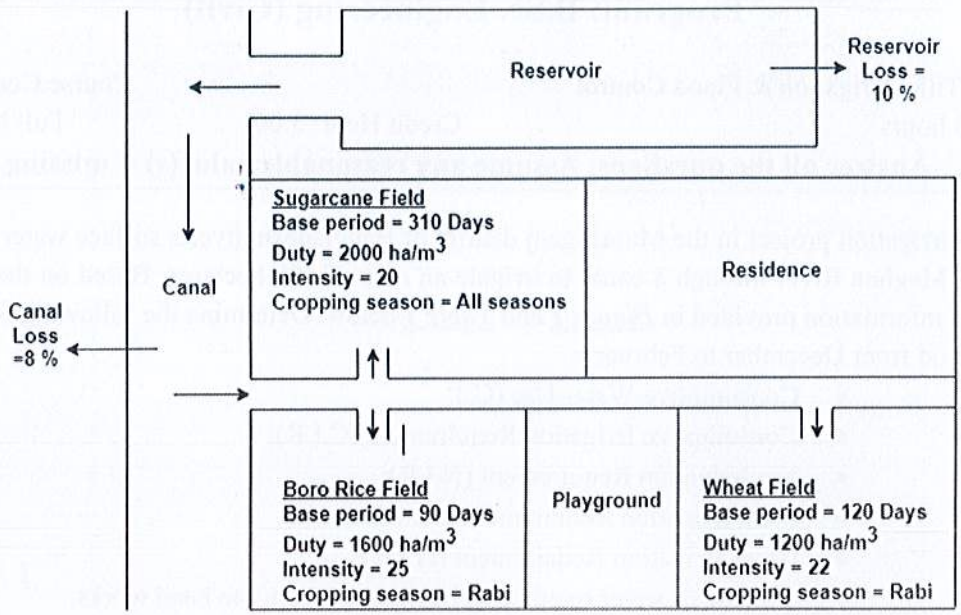

Figure 2

3. Explain why cross-drainage works need to be done in some irrigation projects. (3)

4. Point out the conditions where spoil banks and borrow pits are needed while constructing an irrigation canal. (4)

5. You have been appointed as a design engineer for an irrigation project near the Korotoa river. The area is formed by alluvial soil. The budget allocated for the construction of the canal is limited. Design an irrigation canal for the area which will meet this limitation. Explain your selection of the type of canal and its change in depth. (15)
   All the necessary data are listed below:
   Full supply discharge = 30 m^3/s of discharge
   Bed slope = 0.00016
   The critical velocity ratio = 1.0
   Kutter's rugosity coefficient = 0.0226
   Side slope = 1: 0.5
   Initial depth = 2 m
   The minimum number of trials = 2
   The final CVR must range between 0.95 and 1.0.

6. The Surma river is located in the northeast zone of Bangladesh. Every year the river gets heavily silted during the monsoon period. This often results in disastrous flooding in the surrounding area. Explain in detail how different types of channel improvement measures may reduce the risks of floods in that zone. (12)

7. Justify the usage of different storage reservoirs as flood mitigation measures. (6)

8. Evaluate the usage of the drip irrigation method for irrigating widely spaced fruit trees. (8)

9. Determine the time required to irrigate a strip of land of 0.025 hectares in the area from a tube well with a discharge of 15000 cm^3/s. The soil's infiltration capacity may be taken as 0.05 mm/h and the average depth of flow on the field as 24 cm. Also, calculate the maximum area that can be irrigated from this tube well. (6)

10. a) Classify a sample irrigation water having the following characteristics: Concentration of Na, Ca and Mg are 30, 6, and 3 milli-equivalents per liter respectively, and the electrical conductivity is 136 ppm at 25°C? Use ***Table 2*** and ***Table 3*** for references. (8)

    b) Identify the problems that might arise in using this water on fine-textured soils and their possible remedies.

11. Explain the relation between field capacity, available water, and permanent wilting point of soil with proper illustrations. (6)

Table 2

Salinity hazards	Class	EC (micromhos/cm at 25°C)	Suitability
Low	C1	< 250	Can be safely used for most crops on most soils
Moderate	C2	250 - 750	Can be used for all but extremely salt-sensitive crops
Medium	C3	750 - 2250	Can be used on soils of moderate to good permeability. Regular leaching may be needed. Crops with moderate to good salt tolerance should be grown.
High	C4	2250 - 4000	Can be used only in soils of good permeability. Special leaching is needed. Salt-tolerant crops are suitable
Very high	C5	4000 - 6000	Undesirable for irrigation and should be used only in highly permeable soils with frequent leaching and with plants of high salt tolerance
Excessive	C6	> 6000	Unsuitable for irrigation

Table 3

Sodium hazards	Class	SAR	Suitability
Low	S1	0-10	Can be used on all soil with little danger of accumulation of exchangeable sodium
Medium	S2	10 - 18	Can be used in all soils with good permeability; appreciable sodium hazards in soils of high clay and low organic matter.
High	S3	18 -26	Tends to cause harmful sodium accumulation in most soils: needs good drainage, high leaching, and organic matter addition.
Very high	S4	> 26	Generally unsatisfactory for irrigation

Useful equations

i. $A = (B+zD)\times D$

ii. $P = B + 2D\sqrt{1+z^2}$

iii. $C = \frac{87}{1+\frac{K}{\sqrt{R}}}$

iv. $V = \left[\frac{\frac{1}{n}+(23+\frac{0.00155}{S}}{1+\left(23+\frac{0.00155}{S}\right)\frac{n}{\sqrt{R}}}\right]\sqrt{RS}$

v. $V_o = 0.55\ m\ D^{0.64}$