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MES-2015
Post Name. Assistant Engineer (Civil)
Venue-MIST

১। 'পাকা' বা 'ভালো' বা 'বড়' শব্দ দিয়ে ভিন্ন অর্থসহ ৫টি বাক্য রচনা কর।

২। Make sentences with the following Idiomatic Phrases.

a) Yellow Press, b) Come across, c) come into force, d) a fish out of water, e) Last straw

৩। Translation - ক) সে তার বাবার মত দেখতে, খ) গুঁড়ি গুঁড়ি বৃষ্টি হচ্ছে,গ) পুরষ্কারটা লাভ করা কঠিন, ঘ) বারটার মধ্যে কাজ শেষ করবে, ঙ) এটা কিছু পরিমাণে সত্য

৪। পূর্ণরুপঃ a) Internet, b) ASEAN, c) BRAC, d) BIMSTEC, e) WiFi

৫। ক)বঙ্গবন্ধু স্বদেশ প্রত্যাবর্তন করেন ১৯৭২ সালের কত তারিখে?

খ) কমনওয়েলথের নির্বাহী চেয়ারম্যান কে?

গ) শিশু দিবস কবে?

ঘ) ১৭ এশিয়ান গেমস কোথায় অনুষ্ঠিত হয়?

ঙ) ২০১৮ সালের ২১তম বিশ্বকাপ ফুটবল হবে?

Ashraful
CE-120054

৬। শুদ্ধকরনঃ ক) শ্রদ্ধাঞ্জলি, খ) সম্মান, গ) সুষমা, ঘ) নিষ্পাপ, ঙ)আকস্মিক

৭। ?

৮। What are the maximum & minimum reinforcement ratio for column in ACI provision? Why maximum & minimum ratio is used in column?

Ans: ACI Code 10.9.1 specifies that a minimum reinforcement ratio of 1 % is to be used in tied or spirally reinforced columns. This minimum reinforcement is needed to safeguard against any bending, reduce the effect of shrinkage and creep and enhance ductility of columns. Maximum reinforcement ratio is limited to 8 % for columns in general to avoid honeycombing of concrete. For compression member with a cross section larger than required by consideration of loading, ACI Code 10.8.4 permits the minimum area of steel reinforcement to be based on the gross sectional area required by analysis. The reduced sectional area is not to be less than one half the actual cross sectional dimensions. In regions of high seismic risk, ACI Code 10.8.4 is not applicable

৯। Why strength reduction factor is 0.75 for shear & 0.9 for flexure? Explain.

১০। Water content 48%, LL 50%, PL 30%, SL 10%. Explain whether it is soft compressible or less compressible.

BPDB/2016
Post. Assistant Engineer (Civil)
Venue: BUET

1. Fill in the Gap?

1. The horizontal distance between two contours is called----------
2. The line of collimation must be ----------to the axis
3. Primary function of sleeper is ----------
4. Contour line is drawn through point of same----------
5. Percentage of wear aggregate is determine by----------
6. Permissible limit of iron is drinking water (1997) is ----------
7. Slump test of concrete is carry out to determined its----------
8. A #40 slot size tube well will have an opening of----------mm
9. When alum is added to water as coagulant it----------the P^H value
10. Surface runoff is the quantity of water that sealed the----------

2. True/False

1. The upper part of the ground is called sub grade
2. The ultimate stress is less than breaking stress.
3. The maximum bending moment of simply supported beam with external load lies at point of loading.
4. Contra flexure point occur only shear diagram.

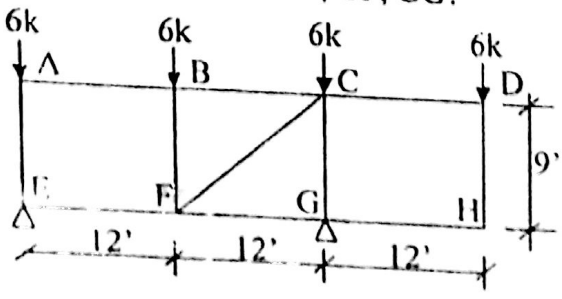
3. Calculate the stopping sight distance for highway design speed is 50mph. Assume f= 0.42 and also required dated taken assume for standardization?

4. Define fixture unit in plumbing system?

5. Why removal of turbidity is essential to effective disinfection?

6. Concrete pile of 24" dia embedded in clay unconfined compression strength of the soil is in 4ksf and the embed length of the pile is 30ft. Calculate ultimate load carrying capacity of pile if adhesive fiction between clay and pile is 0.45 , Unit weight of clay 100lb/ft^3 and water table exist at ground?

7. Find the bar forces of the member BC, CF, CG?

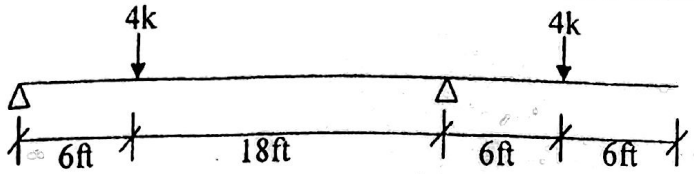


8. Percent of void is 50%. If specific gravity of soil solid is 2.70 then calculate submerged unit weight?

9. Find F.M and percentage of silt and clay?

Sieve size	#4	#8	#16	#30	#50	#100	#200	Pan
% of retain	0	1	4	12	43	2	2	4

10. Draw the Bending Moment diagram for the below structure?



11. In an unconfined compression test sample of clay 8cm long and 4cm dia fails at a load 12kg at 7% stain. Find un-drained shear strength of clay taking in account that the effect of change in cross section of sample?

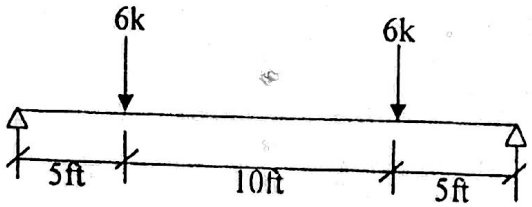
12. A municipal waste water treatment plant discharge $1.2m^3$/sec of effluent having BOD of 60mg/L that has a flow of $9.3m^3$/sec and BOD 6 mg/L. Assume complete and maxing estimate the BOD of the river just downstream of the rainfall?

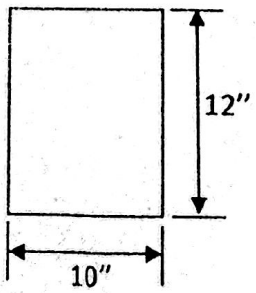
13. A wooden flume (n=0.012) with a rectangular section in 2" wide the flume discharge $3ft^3$/sec of water down 1% slop. What is depth of flow?

14. Draw the layer and coat of flexible pavement?

15. Draw the marshal quantitative curve?

16. Design the shear reinforcement below the beam f_y= 60ksi and f'_c= 3000psi?





Bangladesh Rural Electrification Board (BREB)/2016
Post. Assistant Engineer (Civil)

1. Moment of Inertia of a circular section about of its diameter (d) is

a) $\pi d^5/15$ b) $\pi d^5/32$ c) $\pi d^4/32$ d) $\pi d^4/64$

2. The slenderness ration is the ration of
a) Area of column to least radius of gyration.
b) Length of column to least radius of gyration.
c) Least radius of gyration to area of column.
d) Least radius of gyration to Length of column.

3. Factor of safety is define as the ratio of
a) Ultimate stress to working stress
b) working stress to Ultimate stress
c) Braking stress to Ultimate stress
d) Ultimate stress to Breaking stress

4. The flow in a pipe is neither laminar nor turbulent when Reynolds number is
a) Less than 200 b) Between 2000 and 3000
c) More than 3000 d) None of these

5. A staff reading taken on a point whose elevation is to be determined as on a change point is called
a) For sight reading b) Back sight reading
c) Intermediate reading d) None of these

6. Contour lines cross ridge or valley lines at

a)30^0 b)45^0 c) 60^0 d) 90^0

7. A first class brick should have a minimum crushing strength of
a) 7MN/m2 b) 10.5MN/m2
c) 12.5MN/m2 d) 14MN/m2

8. The slump test of concrete is used measure in
a) Consistency b) Tensile and Compressive strength
c) Impact value d) homogeneity

9. The Turbidity in water is caused due to
a) Silt b) Clay
c) Finely divided organic matter d) All of these

10. A water bound macadam road is an example of
a) Rigid pavement b) Semi-rigid pavement
c) Flexible pavement d) None of these

11. The property of a soil which is of great importance in finding settlement of the structure is
a) Permeability b) Shear strength
c) Consolidation d) Compressibility

12. The sensitivity of a normal clay about
a) 2 to 4 b) 4 to 8 c) 8 to 15 d) 15 to 20

13. The failure of foundation of a building is due to
a) withdrawal of subsoil moisture
b) Unequal of subsoil moisture
c) Lateral escape of the supporting material
d) All of these

14. The most commonly uses material for damp proofing is

a) Bitumen b) Paraffin wax
c) Cement solution d) cement concrete

15. Too much fineness of cement
a) Results cracks in concrete b) Generates greater heat
c) Develops early strength d) All of these

16. The factor which effects the design of concrete mix is
a) Fineness modulus b) Water-cement ratio
c) slump d) Both a & b

17. The important batching is to obtain
a) Strength b) Workability
c) Durability d) All of these

18. The process of Harding the concrete mixes by seeping its surface moist for a certain period is called
a) Floating b) Curing
c) Screening d) None of these

19. If singly reinforced beam, steel reinforcement is proceed in
a) tensile zone b) Compression zone
c) Both zone d) Neutral zone

20. If the load on abeam is increased the tensile stress in the concrete below the neutral axis will be
a) Decrease b) Increases
c) Remain unchanged d) None of this

21. The bond between steel and concrete is mainly due to
a) Pure adhesive resistance b) Frictional resistance
c) Mechanical resistance d) All of these

22. The Shrinkage in concrete slab
a) Causes shear cracks
b) Causes tension cracks
c) Causes compression Cracks
d) Does not cause and cracks

23. For a slab continuous over two equal spans\,the maximum bending moment near the centre of each span is taken as
a) $-wl^2/8$ b) $+wl^2/8$ c) $-wl^2/10$ d) $+wl^2/10$

24. Junction between the flange and web of a beam is known as
a) Lap joint b) Butt Joint c) Fillet d) Shear joint

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25. The liquid limit minus plastic limit is termed as
a) Flow index b) Plasticity index
c) Shrinkage index d) Liquidity index

26. For a sandy soil, the angel of internal friction is 300.if the major principle stress is 50KN/m2 at failure the corresponding minor principle stress will be a) 12.2KN/m2 b)16.66KN/m2
c) 20.8KN/m2 d) 27.2KN/m2

27. A soil sample has a porosity of 40 percent. The specific gravity of solid is 2.70. the voids ratio of the soil is
a) 0.247 b) 0.567 c) 1.08 d) 1.5

28. Which of the following soils has more plasticity index?
a) sand b) silt c) clay d) gravel

29. If the independent speed footing of two columns are connected by a beam it is called
a) Combined footing b) strap footing
c) raft footing d) stepped footing

30. A plate load test is useful to estimate
a) bearing capacity of foundation
b) settlement of the foundation
c) both bearing capacity and settlement of foundation
d) None of the above

31. The age of a tree can be known by examining
a) Cambium layer b) annular rings
c) medullar rays d) heart wood

32. The initial setting time for ordinary Portland cement should not be less than
a) 10 minutes b) 30 minutes
c) 60 minutes d) 600 minutes

33. A series of closely spaced contour lines represents a
a) steep slope b) gentle slope c) uniform slope d) plane surface

34. The type of surveying which requires least office work is
a) Tachometry b) Trigonometrically leveling
c) Plane table surveying d) Theodolite surveying

35. Seepage through embankments in an earthen dam is controlled by
a) drainage filters b) relief wells
c) drain trenches d) provision of downstream beams

36.Gauge is the distance between
a) center to center of rails b) running faces of rails
c) outer faces of rail d) None of the above

37. A cantilever beam AB of length l comes a concentrated load w at its mid span C. if the free end B is supported on a rigid prop then there is a point of contra flexure
a) between A and C b) between C and B
c) one between A and C and other between C and B
d) nowhere in the beam

38. In case of hand mixing of concrete ,the extra cement to be used is
a) 5% b) 10% c) 15% d) 20%

39. The slab is designed as one way if the ratio of long span to short span is
a) less than 1 b) between 1 and 1.5
c) between 1.5 and 2 d) greater than 2

40. Which of the following is a weakness of bar chart?
a) interdependencies of activities
b) project progress
c) uncertainties
d) all of the above

41.বাংলা নববর্ষ পহেলা বৈশাখ চালু করেছিলেন----
ক) ফখরুদ্দিন মোবারক শাহ্ খ) ইলিয়াস শাহ গ) সম্রাট আকবর ঘ) সম্রাট বাবর

42. অফিস সমীপে র সংক্ষেপ হল-
ক) সমক্ষ খ) পরোক্ষ গ) প্রত্যক্ষ ঘ) নিরপেক্ষ

43. স্বাধীনতা হীনতায় কে বাঁচিতে চায়--- চরনটি কার রচনা? ক) ঈশ্বরচন্দ্র গুপ্ত খ) মধুসূদন দত্ত গ) হেমচন্দ্র বন্দ্যোপাধ্যায় ঘ)রঙ্গলাল বন্দ্যোপাধ্যায়

44. নিচের কোন কাজের জন্য কম্পিউটার বেশি সুবিধাজনক-
ক) পুনরাবৃত্তিমূলক কাজ খ) প্রতিবেদন প্রণয়ন গ) হিসাবরক্ষন কাজ ঘ) গানিতিক কাজ

45. উপসর্গের কাজ কি?
ক) নতুন শব্দ গঠন করা খ) বিভক্তি নিরুপন করে গ) যতি সংস্করণ করে ঘ) সর্বনাম তৈরী করে

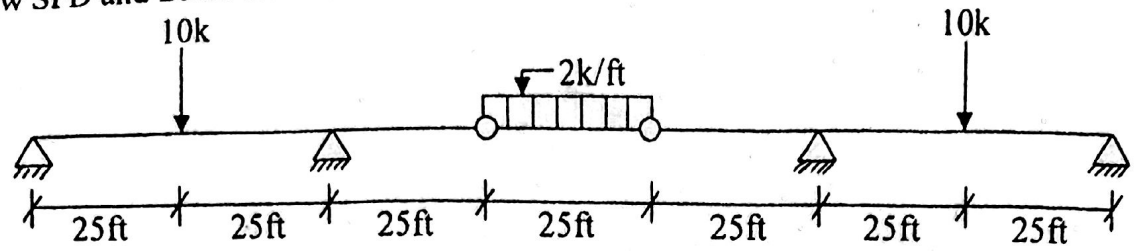
46. নিচের কোনটি সিস্টেম সফটওয়্যার?
ক) উইন্ডোজ ভিস্তা খ) এমএস একসেস
গ) ওরাকল ঘ) নোটপ্যাড

47. সাবাস বাংলাদেশ ভাস্কর্যটি কোথায় অবস্থিত?
ক) টি এস সির মোরে খ) ঢাকা বিশ্ববিদ্যালয় গ) রেসকোর্স ময়দানে ঘ) রাজশাহী বিশ্ববিদ্যালয়

48. what is the synonym of "competent"
a) Circumspect b) discrete c) capable d) pendent

BWDB-2014
Post Name. Assistant Engineer (Civil)
Venue: BUET

1) Draw SFD and BMD for below structure?



2) A square footing (2.5m x 2.5m) is to be placed on a homogeneous clay layer at 3m depth. The load on footing base from corresponding column is 50KN. Determine the net pressure on the base?

3) The unconfined compression of the soil is 50Kpa. Determine the depth of excavation without any lateral support?

4) The sequent depth ratio of a hydraulic jump in a rectangular channel is 16.48. Find fraud number at the beginning of jump and type of jump?

5) Determine the skin friction capacity of a cast in situ bored RCC pile of dia 20 inch & length 50ft in a homogeneous sand layer. The top of pile is at 10ft below the ground surface. Unit wt at saturated condition 120 pcf and angle of internal friction 30 degree. GWT is at the ground surface?

6) A canal commands an irrigation area of 350 ha, The peak field irrigation requirement is 9mm/day. Determine the design discharge of the canal at the off take, water loss is 25% ?

7) Draw a typical non-dimensional specific energy curve for triangular channel section for a given discharge. Write its application?

8) What is peak demand?

9) What is BOD, COD, and Matrix?

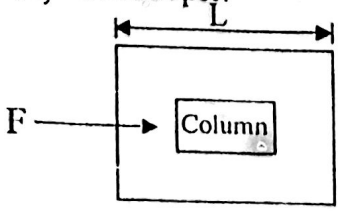
10) Define fixture unit. A building is situated in an area having intermittent water supply. Calculate the permissible water of the building. Assume reasonable value of data?

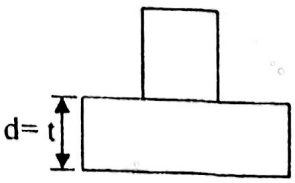
11) The CBR values are calculated after every kilometer on selected stretch of 10 kilometers having same type of soil. The values are 3.8, 2.8, 4.5, 3.9, 4.2, 2.8, 4.7, 4.0 and 4.5%. Find the design CBR values for 50% and 85% reliability?

12) Define as follows- 1) Steady uniform flow, 2) Darcy-weisbach equation.

13) Draw the qualitative Marshal test curve?

14) For the footing shown calculate ultimate punching shear capacity. If L= 10ft, a= 12inch, t= 20inch, f'_c= 3000psi, f_y= 600000psi?





15) Write down the 4 types of flood normally occurs in Bangladesh?

REINFORCED CONCRETE

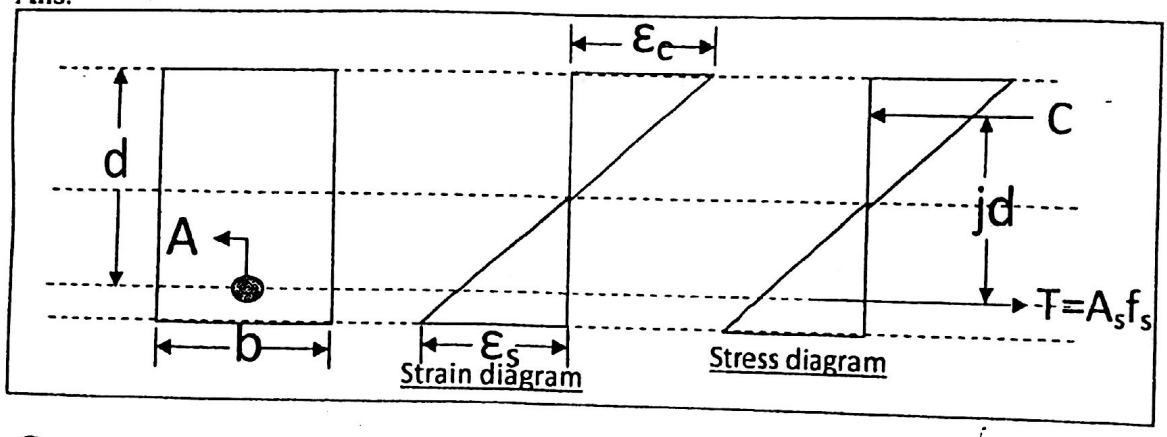
Q.1: Define R.C.C?
Ans: When reinforced used in cement concrete to gain an extra strength in this cement concrete is called reinforced cement concrete.

Q.2: Why steel is commonly used in reinforcing materials in coneretc?
Ans: Because of-
1. It is cheap and easily available
2. It is develops good bond with concrete
3. It is thermal expansion co-efficient is near to the concretc

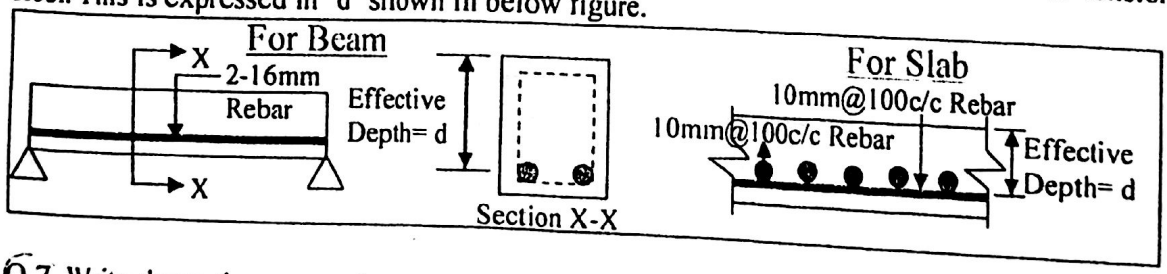
Q.3: How many reinforcing bar used in reinforced cement concretc structures?
Ans: The reinforcing bar are-
i) Mild steel and medium tensile steel bars
ii) Plain Bar
iii) Deformed bars
iv) Cold twisted bars

Q.4: What do you mean by M_{10} concretc?
Ans: The latter M refers to the mix 1:3:6 and the number denote the ultimate compressive strength of 150mm cube at 28 days expressed as N/mm^2 or Mpa. i.e. 10 Mpa = 145 x 10 =1450psi.

Q.5: Draw the Stress - Strain diagram of a single reinforced beam?
Ans:



Q.6: Write down the definition of the Effective depth of a beam?
Ans: The effective depth of beam is a distance from compression face to centroid of tension steel. This is expressed in 'd' shown in below figure.



Q.7. Write down the assumption made in RCC beam design?
Ans: The assumption are-
1. Section remains plane
2. Stress proportioned to strain
3. Concrete not takes tension
4. No concrete-steel slip

(Q.8.) Define Modular Ratio?
Ans: The modular ratio is defined the ratio of Young's modulus of steel (E_s =29 x 10^6) to the Young's modulus of concretc (E_c = 57000$\sqrt{f'c}$ (psi)). This is expressed in n =E_s/E_c

(Q.9.) If the given value of concretc crushing strength is 3400psi. Determine the allowable strength of concretc?
Sol":

We know that, Allowable strength of concretc, fc = 0.45f'c => fc = 0.45 x 3400 = 1530psi (Ans)	Given data, Concretc crushing strength, f'c = 3400 psi Allowable strength of concretc, fc = ?

(Q.10) Define under Reinforced, Over reinforced and balance reinforce section?
Ans:
Under Reinforced Section: if the steel reaches its yielding before the concretc reaches its ultimate strain.
Over Reinforced Section: when the concretc reaches its ultimate strain before yielding of steel.
Balanced Reinforced Section: when the concretc reaches its ultimate strain at the same time steel reaches its yielding.

(Q.11) Draw the Conventional or Nominal stress strain diagram of Steel, Concretc?
Ans:

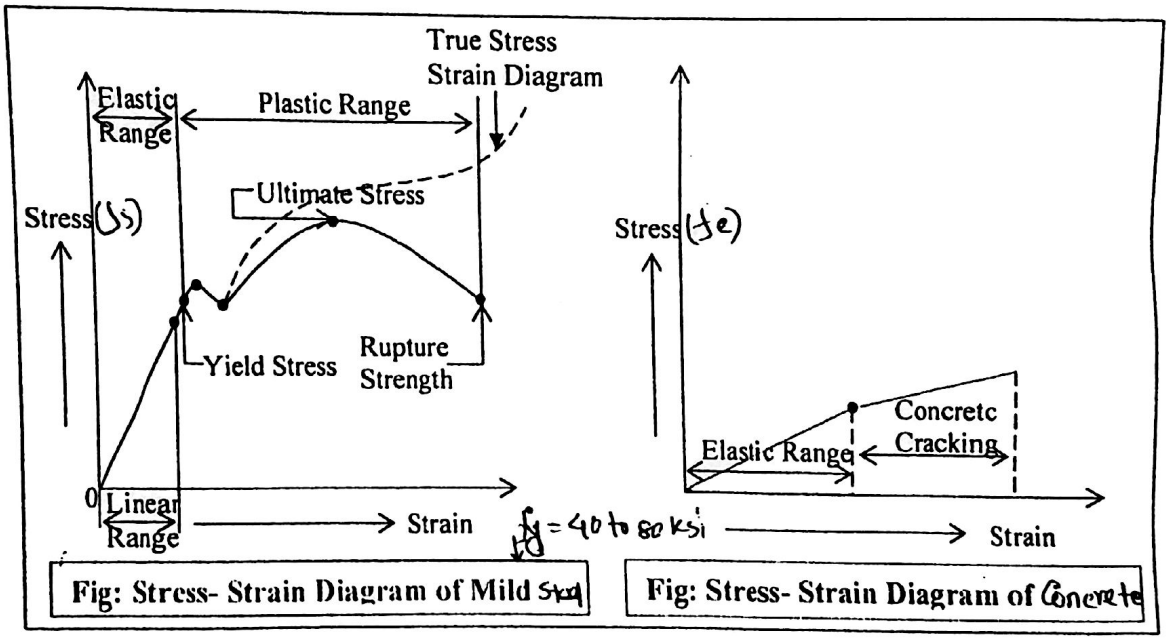


Fig: Stress- Strain Diagram of Mild Steel

Fig: Stress- Strain Diagram of Concrete

(Q.12) How much carbon used in mild steel which is used in RCC work?
Ans: Mild steel used in RCC work because one reason of 0.25% to 0.45% carbon used to prepared in this type of steel and less than 2% carbon used as wrought iron

(Q.13) Write down the support reaction load in all type of member?
Ans: The support reaction load in all type of member is DD + LL, Where LL = 20% of DL

(Q.15) Write down the relation in between tensile and compressive strength of concretc and steel?
Ans: Permissible tensile stress in concretc is about 1/10 of permissible compressive stress and for the same cross section,
And the tensile strength of steel may be as much as 300 times, while its compressive strength will be about 30 times that of concretc.
Prestressing steel –Tensile strength 2.5 to 6 times of yield strength of deformed bar

(Q.14) Write down the proportions of different ingredients of cement concrete ?

Ans: The proportions are

Grade	Concrete Mix	Uses
1. M10	1 : 3 : 6	Mass concrete in piers abutment.
2. M15	1 : 2 : 4	Normal RCC work, i.e; Beam, Column, slab, wall etc
3. M20	1 : 1.5 : 3	water retaining structure. i.e reservoirs Column & piles
4. M25	1 : 1 : 2 1 : 4 : 8	Long span archs & highly loaded columns
5. M30	1 : 5 : 10 1 : 6 : 12	Mass concrete foundation
6. M35	Post tensioned prestressed concrete	
7. M40	Pre tensioned prestressed concrete.	

(Q.) Modulus of section, $Z = I/y$

Moment of inertia, $I = \frac{bh^3}{12}$ for rectangler section

Slenderness ratio $= l/r$ where r = radius of gyration

Radius of gyration, $r = \sqrt{I/A}$.

Unit weight of (Stone chips) concrete = 140 - 152 pcf $\cong$ 145 pcf (avg)
$\cong$ 150 pcf (design)

Unit weight of (Brick chips) concrete = 120 lb/ft3

Q.16. Write down the difference between WSD and USD Method for Civil Engineering Designing?

Ans:

USD Method	WSD Method
1. It is Ultimate Strength Design Method	1. It is Working Stress Design Method
2. Designing to elastic behavior in materials	2.Designing to plastic behavior in materials
3.Consider to design critical combination of load	3. Consider to design carrying load
4. Consider to design at factored load	4. Consider to design at applied load
5. It is low cost design method	5. It is high cost that the USD method
6. Materials strength to be used for member design	6. Modular ratio used for member design
7. Stability of structure is more than the WSD	7.Stability of structure is less than the USD

Q.17. Write down the important formula in RCC structure for Beam design according to USD and WSD Method?

Ans:

USD Method for Singly Beam design	WSD Method for Singly Beam design
Ultimate moment capacity $M_u = \varphi A_s f_y(d - a/2) = \varphi\rho bd^2 f_y(1-0.59\rho f_y/f'_c)$ (Where, $a = A_s f_y / 0.85 f'_c b$) Balance steel ratio, $\rho_b = 0.85\beta\ f'_c/f_y \times (87000/(87000+fy))$ Maximum steel ratio, $\rho_{max} = 0.75\ \rho_b$ Minimum Steel ratio , $\rho_{min} = 3\sqrt{(f'c)}\ /f_y \leq 200/f_y$ **So actual steel ratio , $\rho_{max} > \rho > \rho_{min}$** **Note : $\beta = 0.85$ for 4000psi concretc** **Increase the value of compressive strength of concretc after 4000psi β value will decreases for every 1000psi is 0.05,if compressive strength is 5000psi then β is** **$= 0.85 - ((5000-4000)/1000) \times 0.05 = 0.80$**	Ultimate moment for Steel, $M_s = A_s f_s jd$ Ultimate moment for Concretc, $Mc = \frac{1}{2} f_c jkbd^2$ **Maximum Resisting moment = minimum value is acceptable above this Steel and Concretc Moment** $f_s = 0.40f_y$, $f_c = 0.45\ f'_c$ $j = 1 - k/3$ $k = n/(n+r)$ for Beam Design $k = \sqrt{(2\rho n + (\rho n)^2)} - \rho n$ Beam for analyis $n = 29 \times 10^6 / 57000\sqrt{f'_c(psi)}$ r = Stress ratio $= f_s/f_c$ $\rho = A_s/bd$ Balance Steel ratio, $\rho_e = n/2r(n+r)$ i) if $\rho > \rho_e$ Concretc reach ultimate stress before steel ii) if $\rho < \rho_e$ Steel reach yielding before concretc

Q.18. A rectangle beam has width of 12in an effective depth to the centroid of the reinforcing steel of 17.5in. It is reinforced with four no.9 bar in one row, If $f_y = 60$ksi and $f'_c = 4$ksi, what is the ultimate moment capacity of the beam?

Sol":

USD Method	Given data,
we know that, Ultimate moment capacity, $M_u = \varphi A_s f_y(d - a/2) = \varphi\rho bd^2 fy(1-0.59\rho f_y/f'_c)$ $\Rightarrow M_u = 0.90 \times 0.019 \times 12 \times 17.5^2 \times 60 \times (1 - 0.59 \times 0.019 \times 60/4) = 3136$ kips – in (Ans) Check **Balance steel ratio, $\rho_b = 0.85\beta\ f'_c/f_y \times (87000/(87000+f_y))$** **$\Rightarrow \rho_b = 0.85 \times 0.85 \times 4/60 \times (87000/(87000+60000)) \Rightarrow \rho_b = 0.0285$**	Wide,b = 12inch, d = 17.5inch $f_c = 0.45 \times 4 = 1.8$ksi $f_s = 0.40 \times 60 = 24$ksi $\beta = 0.85$ $\rho = A_s/bd = (4 \times .785 \times (9/8)^2)/(12 \times 17.5) = 0.0190$ (ok) **Maximum steel ratio , $\rho_{max} = 0.75\ \rho_b = 0.75 \times 0.0285 = 0.0214$** **Minimum Steel ratio , $\rho_{min} = 3\sqrt{(f'c)}\ /f_y = 0.10$ but $\leq 200/f_y = 0.0033$, so $\rho_{min} = 0.0033$**

Q Design the steel when acting moment of a simply supported structure are 1600 k-inch which effective depth 16.5" and width of this beam is 10". If $f'c = 4000$ psi & $f_y = 60000$ psi ?

Sol":

We know that.

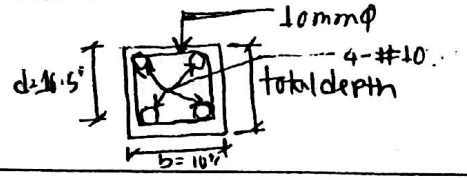
$$M = A_s f_s j d$$

$$\Rightarrow 1600 = A_s \times 24 \times 0.874 \times 16.5$$

$$\Rightarrow 1600 = A_s \times 24 \times 0.874 \times 16.5$$

$$\Rightarrow A_s = 4.6 \text{ inch}^2 \text{ (ans)}$$

Used 4 #10 bar used when actual area $A_s = 4.90 \text{ inch}^2$



Where,

$M = 1600$ kip-inch

$d = 16.5"$ $\quad \because j = 1 - k/3$

$b = 10"$ $\quad \Rightarrow j = 0.874$

$f'c = 4000$ psi

$f_y = 60{,}000$ psi $= 60$ ksi

$f_s = 0.4 \times 60 = 24$ ksi

$$n = \frac{E_s}{E_c} = \frac{29 \times 10^6}{57000\sqrt{4000}} = 8.04$$

$$r = f_s / f_c = \frac{24}{0.45 \times 4} = 13.33$$

$$k = \frac{n}{n+r} = \frac{8.04}{8.04 + 13.33} = 0.376$$

Q Design steel reavirment when ultimate moment 1600 kip-in which this structure effective depth 17" and widen 10". If $f'c = 4$ ksi & $f_y = 60$ ksi ?

Sol" Step-1

We know that.

Ultimate moment $M = \phi A_s f_y (d - a/2)$ Here, assumed, $a = 4$ inch

$$\Rightarrow 1600 = 0.90 \times A_s \times 60 \times (17 - 4/2)$$

$$\Rightarrow A_s = 1.98 \text{ inch}^2$$

Check assumed, $a = 4"$

$$a = \frac{A_s f_y}{0.85 f'c\, b} = \frac{1.98 \times 60}{0.85 \times 4 \times 10} = 3.49 \text{ inch.}$$

Step-2, assumed, $a = 3.4$ inch.

Moment, $M = \phi A_s f_y (d - a/2)$

$$\Rightarrow 1600 = 0.90 \times A_s \times 60 (17 - 3.4/2)$$

$$\Rightarrow A_s = 1.936 \text{ inch}^2$$

Check assumed, $a = 3.4"$

$$a = \frac{A_s f_y}{0.85 f'c\, b} = \frac{1.936 \times 60}{0.85 \times 4 \times 10}$$

$\Rightarrow a = 3.42$ which is nearly to assumed $a = 3.4$

2 #9 bar used of this structure, $A_s = 1.936$ inch (ans)

Q.19. A rectangle beam has width of 12in an effective depth to the centroid of the reinforcing steel of 17.5in. It is reinforced with four no.9 bar in one row, If f_y = 60ksi and f'_c = 4ksi, what is the ultimate moment capacity of the beam?

Sol":

WSD Method for Analysis We know that, Ultimate moment for Concrete, $M_c = ½ f_c jkbd^2$ $\Rightarrow M_c = ½ \times 1.8 \times 0.421 \times 0.860 \times 12 \times 17.5^2$ $\Rightarrow M_c$ = 1197.51 kips –inch Now, Ultimate moment for Steel, $M_s = A_s f_s jd$ $\Rightarrow M_s = 4 \times 24 \times 0.860 \times 17.5$ = 1445 kips-inch Now $M_s > M_c$ **So,** Ultimate Moment = 1197.51 kips-inch(Ans)	Given data, Wide,b= 12inch, d = 17.5inch $f_c = 0.45 \times 4 = 1.8$ksi $f_s = 0.40 \times 60 = 24$ksi $A_s = 4 \times .785 \times (9/8)^2 = 4.00$ inch^2 $\rho = A_s/bd = (4.00)/(12 \times 17.5) = 0.0190$ r = Stress ratio = f_s/f_c = 13.33 j = 1- k/3 j = 1- 0.421/3 or, j = 0.860	n = 29 x 10^6 / 57000 $\sqrt{f'_c}$(psi) n = Es/Ec , n = 29 x 10^6 / 57000 x $\sqrt{}$ (4000) or, n = 8.04 k = $\sqrt{(2\rho n + (\rho n)^2)} - \rho n$ Beam for analysis or, k = $\sqrt{(}$ 2x 0.019 x 8.04 +(0.019 x 8.04)^2) – 0.019 x 8.04 or, k = 0.421

Q.20 Design of a beam and amount of steel which breath is 250mm as a simply supported beam having 6m span with distribution load is 20 KN/m (Including self weight) ,Given as f'_c = 3300 psi and f_y = 50.75ksi by **WSD Method?**

Sol":

we know that, $Mc = ½ f_c jkbd^2$ or, 90 x 10^6= ½ x 10 x 0.861 x 0.416 x 250 x d^2 or, d = 448.32 mm ≈ 450mm Total Depth = 450 + 50 = 500mm (Ans) Again, $Ms = A_s f_s jd$ or, 90 x 10^6 = A_s x 140 x 0.861 x 450 or, As = 1659.2 mm^2 Used 3-28mm bar (Ans)	Given data, Assume, Clear cover = 50mm w = 20 KN/m, L = 6m $Mc = Ms = M = wL^2/8$ or, M = 20 x 6^2/8 or, M = 90 KN-m = 90 x 10^6 N-mm f_c = 0.45 x 33/145 = 10 Mpa f_s = 0.40x 50750/145 = 140 Mpa	n = Es/Ec , n = 29 x 10^6 /(57000 x $\sqrt{}$ (3300)) or, n = 10 k = n/(n+r) or,k=10/(10+140/10) or, k = 0.861 j = 1- k/3 j = 1- 0.416/3 or, j = 0.861

Q.21 Define Doubly reinforced beam?

Ans: The beam section in which the steel reinforcement is provided on both sides, i.e. in tension as well as compression sides is called a doubly reinforced section.

Q.22. When doubly reinforcement sections is preferred than another section?

Ans: The doubly reinforcement sections is preferred in the following situations-

1. Subjected to alternate external loads and the bending moment is the section reverses.
2. Subjected to loading eccentric on either side of axis.
3. Subjected to shock impact or accidental lateral loads.
4. When overall size of the beam section is limited.
5. When the beam section is continuous over several supports.

Q. 23. Write down the assumption of doubly reinforcement sections?

Ans: The assumption of doubly reinforcement sections are-

1. Tensile steel resists the tension and compression steel resists the compression,
2. Stress in compression steel is equal to the stress in tension steel and
3. No stress is developed in tension and compression concrete.

(*) According to ACI Code, Minimum depth of beam = $\frac{L}{16}$

Q.24. A rectangle beam which must carry a working live load of 2.33kips per ft and calculated dead load of 0.98kips per ft on an 18 ft simple span is limited in cross section for architectural reasons to 10 inch width and depth 20 inch. If f_y = 40ksi and f'_c = 3ksi. Check whether it is **Singly or Doubly** reinforced beam?

Sol":

USD Method	Given data,	
Ultimate design load, w =1.5DL + 1.8LL =5.66 kips/ft Span length, L = 18ft Ultimate moment, $M = wL^2/8$ or, $M = 5.66 \times 18^2/8$ or, M_{cal} = 229.2 kip-ft = 2750.76 kip-in we know that, Ultimate moment capacity $M_u = \varphi A_s f_y(d - a/2) = \varphi\rho bd^2 fy(1-0.59\rho f_y/f'_c)$ $\Rightarrow M_u = 0.90 \times 0.0278 \times 10 \times 16^2 \times 40 \times (1 - 0.59 \times 0.0278 \times 40/3) = 2001.7$ kips – in **So $M_u < M_{cal}$ then it is Doubly Reinforced Beam (Ans)**	Clear cover =4" in tension and 2.5in in compression zone Total Depth = 20inch Wide,b = 10inch, d = 20 - 4 = 16inch $f_c = 0.45 \times 3 = 1.35$ksi $f_s = 0.40 \times 40 = 16$ksi $\beta = 0.85$ Balance steel ratio, $\rho_b = 0.85\beta f'_c/f_y \times (87000/(87000+fy(psi)))$ $\Rightarrow \rho_b = 0.85 \times 0.85 \times 3/40 \times (87000/(87000+40000)) \Rightarrow \rho_b = 0.0371$ Maximum steel ratio ,$\rho_{max} = 0.75\ \rho_b = 0.75 \times 0.0371 = 0.0278$	**1. If given load this check only moment process like this Q.24. this are design problem** **2. If given rebar size and no then we calculate $\rho = A_s/bd$ And $\rho_{max} = 0.75\ \rho_b$ Now $\rho > \rho_{max}$ so it is doubly reinforced beam this are review problem**

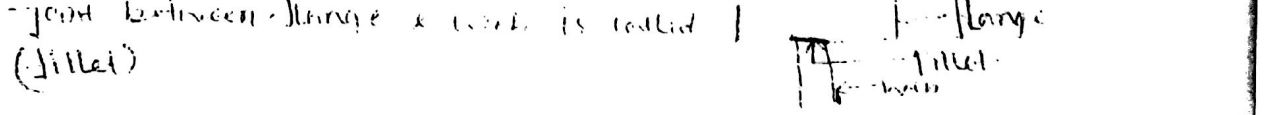
Q.25. A rectangle beam which must carry a working live load of 1.3 kips per ft and calculated dead load of 0.98kips per ft on an 18 ft simple span is limited in cross section for architectural reasons to 10 inch width and depth 20 inch. If f_y = 40ksi and f'_c = 3ksi. Check whether it is **Singly or Doubly** reinforced beam?

Sol":

WSD Method	Given data,	
Working design load, w =DL + LL =2.28 kips/ft Span length , L = 18ft Working Moment, $M = wL^2/8$ or, $M_{cal} = 2.28 \times 18^2/8$ =92.34 kip-ft = 1108.08 kip-in We know that, Maximum resisting moment capacity, $M_c = \frac{1}{2} f_c jkbd^2$ or, $M_c = \frac{1}{2} \times 1.35 \times 0.836 \times 0.439 \times 10 \times (16)^2 = 634.18$ kips – in **So $M_c < M_{cal}$ then it is Doubly Reinforced Beam (Ans)**	Clear cover = 4" in tension and 2.5in in compression zone. Total Depth, D = 20inch Wide,b=10inch,d=20-4= 16inch $f_c = 0.45 \times 3 = 1.35$ksi $f_s = 0.40 \times 40 = 16$ksi $n = E_s/E_c$, $n = 29 \times 10^6 / (57000 \times \sqrt{(3000)}) = 9.29$ r = Stress ratio = f_s/f_c =11.85 We know that, $k = n/(n+r)$ $\Rightarrow k = 9.29/(9.29+11.85) = 0.439$ $j = 1 - k/3 = 1 - 0.439/3$ $\Rightarrow j = 0.836$	**1. If given load this check only moment process like this Q.25. this are design problem** **2. If given rebar size and no then we calculate $\rho = A_s/bd$ And $\rho_{max} = n/2r(n+r)$ Now $\rho > \rho_{max}$ so it is doubly reinforced beam this are review problem**

Q.26. Write down the definition of "T –Beam"?

Ans: The section of the beam having greater width at the top in comparison to the width below neutral axis is known as T-beam

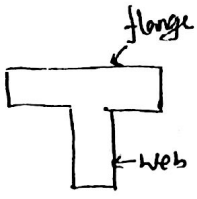


Q.27. Write down the rules of T- beam flange width?
Ans: The rules are-
i) The effective width of beam shall not exceed one –fourth of span length, $b \leq L/4$
ii) $b \leq 16t + b'$ when b' = width of web
iii) Centre to centre distance in beam
Which smallest value is Acceptable?

Q.28. A floor slab 3in thick is supported by RCC beam 5ft on centers which act as a T –beam. The beam is simply supported with 14ft span. They have web width 10 inches and with depth 20 inch. The tensile reinforced bar are consists of six No.10 bar in two rows. If f_y = 40ksi and f'_c = 3ksi. Check whether it is **T- Beam or Not?**
Sol":

USD Method i) Calculation of Effective flange width a) $b = L/4 = 14/4 = 42$ inch b) $b = 16t + b' = 16 \times 3 + 10 = 58$ inch c) $b = 5 \times 12 = 60$ inch Select Flange width ,b = 42 inch ii) Check for T- Beam or not We know that, $a = A_s f_y / 0.85 f'_c b = 7.35 \times 40 / (0.85 \times 3 \times 42) = 2.74$ inch Now $C = a/k = 2.74/0.85 = 3.22 > t$ **So, it is T- Beam (Ans)**	Given data, Span of beam, L = 14ft Web width, b'= 10 inch Thickness of flange, t = 3inch Area of Steel, $A_s = 6 \times 0.785 \times (10/8)^2 = 7.35$ in^2 f_y = 40ksi f'_c = 3ksi.

Q.29. A floor slab 3in thick is supported by RCC beam 5ft on centers which act as a T –beam. The beam is simply supported with 14ft span. They have web width 10 inches and with depth 20 inch. The tensile reinforced bar are consists of six No.10 bar in two rows. If f_y = 40ksi and f'_c = 3ksi. Check whether it is **T- Beam or Not?**
Sol":

USD Method i) Calculation of Effective flange width a) $b = L/4 = 14/4 = 42$ inch b) $b = 16t + b' = 16 \times 3 + 10 = 58$ inch c) $b = 5 \times 12 = 60$ inch Select Flange width ,b = 42 inch  ii) Check for T- Beam or not We know that, $k = [\rho n + \frac{1}{2}(t/d)^2] / [\rho n + t/d]$ $\Rightarrow k = [0.203 + 1/2 \times (3/16)^2] / [0.203 + 3/16] = 0.565$ Now , kd = 0.565 x 16 = 9.04 inch > t = 3inch **So,it is T- Beam (Ans)**	Given data, Assume Clear cover = 4 inch Effective depth,d = 20 - 4 =16 inch Span of beam ,L = 14ft Web width,b'= 10 inch Thickness of flange, t = 3inch Area of Steel, $A_s = 6 \times 0.785 \times (10/8)^2 = 7.35$ in^2 x 2 = 14.7 in^2 $f_c = 0.45 \times 3 = 1.35$ksi $f_s = 0.40 \times 20 = 16$ksi $\rho = A_s/bd = 14.7/(42 \times 16) = 0.0205$ $n = Es/Ec = 29 \times 10^6 / (57000 \times (\sqrt{3000})) = 9.28$. So, $\rho n = 0.203$

Q.30. Define below term as Prestressed Concrete?
Ans:
1. Tendon: A stretched element used in a concrete member of structure to impart prestress to the concrete.
2. Anchorage: A device generally used to enable the tendon to impart and maintain prestress in concrete.
3. Pretensioning: A method of prestressing concrete in which the tendons are tensioned before the concrete is placed. In this method, the concrete is introduced by bond between steel & concrete.
4. Post-tensioning: A method of prestressing concrete by tensioning the tendons against hardened concrete. In this method, the prestress is imparted to concrete by bearing.

Q.31. What do you mean by Prestressed Concretc?
Ans: Prestressed concrete is basically concrete in which internal stresses of a suitable magnitude and distribution are introduced so that the stresses resulting from the external loads are counteracted to a desired degree.

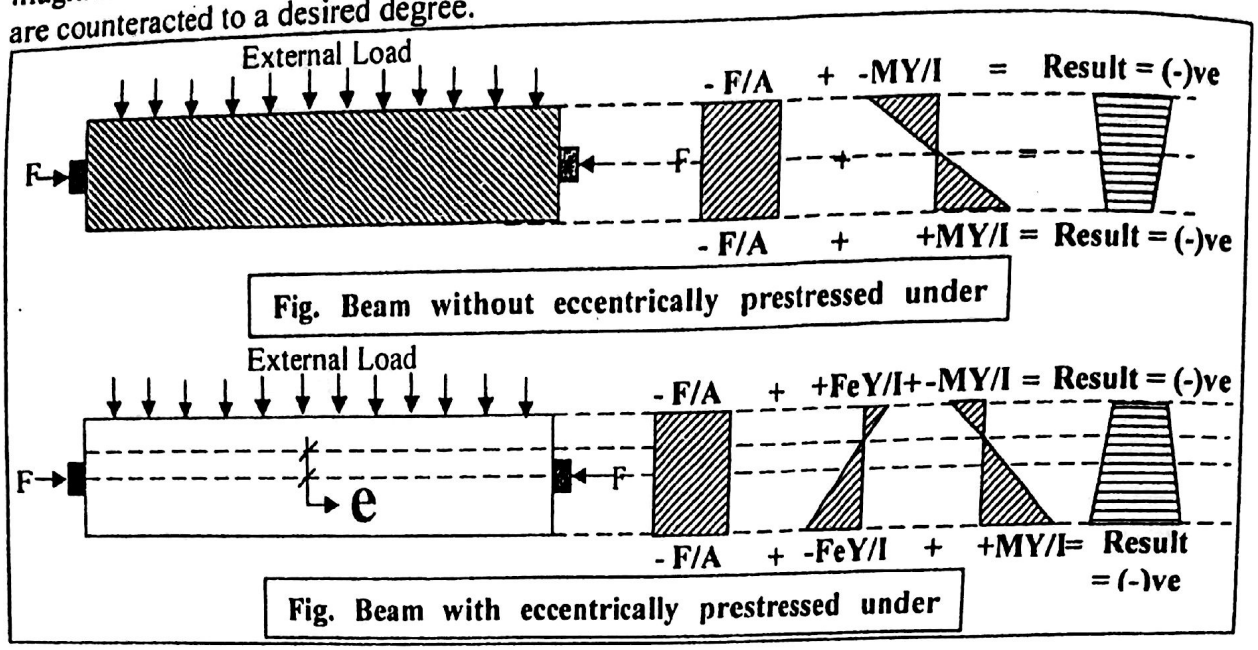


Fig. Beam without eccentrically prestressed under

Fig. Beam with eccentrically prestressed under

Q.32. Write down the constitution of high strength steel?
Ans:

Carbons	Manganese	Silica
0.7% to 0.8%	0.6%	0.1%

Q.33. Write down the covering in PCC?
Ans: Required cover in PCC 20 mm cover for pretensioned members and 30 mm or size of the cable whichever is bigger for post tensioned members. If the prestress members are exposed to an aggressive environment, these covers are increased by another 10 mm.

Q.34. What type concretc used in pre-stressed member?
Ans: Generally minimum M35 grade concrete is used for post-tensioned & M40 grade concrete is used for pretensioned members.

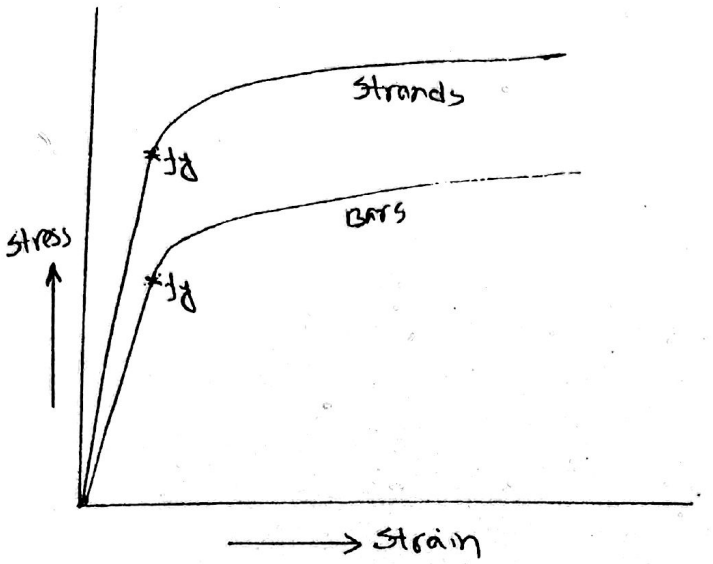
Q.35. Write down the prestressed member stress?
Ans: The losses in prestress members due to various reasons are generally in the range of 250 N/mm^2 to 400 N/mm^2.
If mild steel or deformed steel is used the residual stresses after losses is either zero or negligible. Hence high tensile steel wires are used which varies from 1600 to 2000 N/mm^2.

Q.36. Write down the advantage and disadvantage of Prestressed Concrete?
Ans: The advantage and disadvantage of Prestressed Concrete are –

Advantage	Disadvantage
1. The use of high strength concrete and steel in prestressed members results in lighter and slender members than is possible with RC members.	1. The availability of experienced builders is scanty.
2. In fully prestressed members the member is free from tensile stresses under working loads, thus whole of the section is effective.	2. Initial equipment cost is very high.
3. In prestressed members, dead loads may be counter-balanced by eccentric prestressing.	3. Availability of experienced engineers is scanty.
4. Factory products are possible.	4.Prestressed sections are brittle

Q. Draw stress-strain curves for prestressing steels?

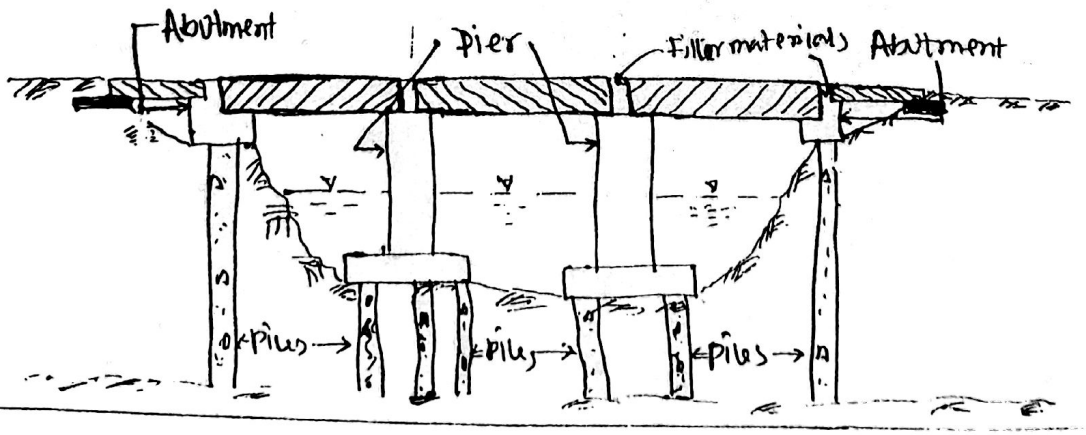
Ans:



Q. Difference between Abutment and pier?

Ans:

Abutment	Pier
1. this substructure are placed at the end of a bridge span or dam whereon the structure's superstructure rest or Contact.	1. A pier is a raised structure typically supported by well spaced piles or pillars.
2. to transfer loads from a super-structure to its foundation elements	2. It is use for multi span bridge and tansmit load to abutment
3. to resist or transfer lateral, self and wind load	3. to resist or transfer self weight, lateral loads, vehicle load and wind load to the abutment
4. to support one end of an approach.	4. to support multispan bridge



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Q.37. Write down the difference between Pretension and Post-tensioned Member?

Ans: The difference between Pretension and Post-tensioned Member are-

Pretension member	Post-tensioned member
1. In pretension prestress concrete, steel is tensioned prior to that of concrete. It is released once the concrete is placed and hardened. The stresses are transferred all along the wire by means of bond.	1. Concreting is done first then wires are tensioned and anchored at ends. The stress transfer is by end bearing not by bond.
2. Suitable for short span and precast products like sleepers, electric poles on mass production.	2. Suitable for long span bridges
3. In pretensioning the cables are basically straight and horizontal. Placing them in curved or inclined position is difficult. However the wire's can be kept with eccentrically. Since cables cannot be aligned similar to B.M.D. structural advantages are less compare to that of post-tensioned.	3. The post tensioning cables can be aligned in any manner to suit the B.M.D due to external load system. Therefore it is more economical particularly for long span bridges. The curved or inclined cables can have vertical component at ends. These components will reduce the design shear force. Hence post-tensioned beams are superior to pretension beams both from flexural and shear resistances point.
4. Prestress losses are more compare to that of post-tensioned concrete.	4. Losses are less compare to pre-tensioned concrete

Q.38. A simply supported symmetrical rectangle beam wide 20in and depth 30in with 24ft span is to carry a superimposed dead plus live load of 3kips/ft. The beam pretensioned with multiple tendon with centroid at a constant eccentricity of 5in.The prestress force 360kips. Determine top and bottom fiber stress of the beam and also check to failure of the beam for prestress load. If f'_c=5000psi and at the time of prestressing f'_{cr} = 3750psi?

We know that,

Top fiber stress, $f_{top} = -F/A + (+FeY/I) + (-MY/I)$

$\Rightarrow f_{top} = -360/600 + 360 \times 5 \times 15/45000 - 2592 \times 15/45000$

$\Rightarrow f_{top} = -0.6 + 0.6 - 0.864 = -0.864$ kips/in^2 (Ans)

Allowable or Maximum compressive stress without any prestressing loss = $0.60f'_{cr}$ = 2250psi = 2.25kips/in^2 > -0.864 kips/in^2

Hence The beam is ok at compressive zone (Ans)

Again, we know that,

Bottom fiber stress = $-F/A + (-FeY/I) + (+MY/I)$

$\Rightarrow f_{bottom} = -360/600 - 360 \times 5 \times 15/45000 + 2592 \times 15/45000$

$\Rightarrow f_{bottom} = -0.6 - 0.6 + 0.864 = -0.336$ kips/in^2 (Ans)

Allowable or Maximum tensile stress without any prestressing loss = $3\sqrt{f'_{cr}}$ = 184psi = kips/in^2 0.184 > -0.336 kips/in^2

Hence The beam is ok at tension zone (Ans)

Given data,

W = 3kip/ft and Span length, L= 24ft

For simply beam ,$M = wL^2/8$ = 216kip-ft = 2592 kips - inch

Y = 30/2 = 15ft

e = 5 inch

F = 360 kips

A= 20 x 30 =600 inch^2

I= $bd^3/12$ = 45000inch^4

Note:

1. **Allowable or Maximum compressive stress with prestressing loss = $0.45f'_{cr}$**
2. **Allowable or Maximum tensile stress with prestressing loss = $6\sqrt{f'_{cr}}$**

Q. Determine typical reinforced plan diagram of a stairs

Ans:

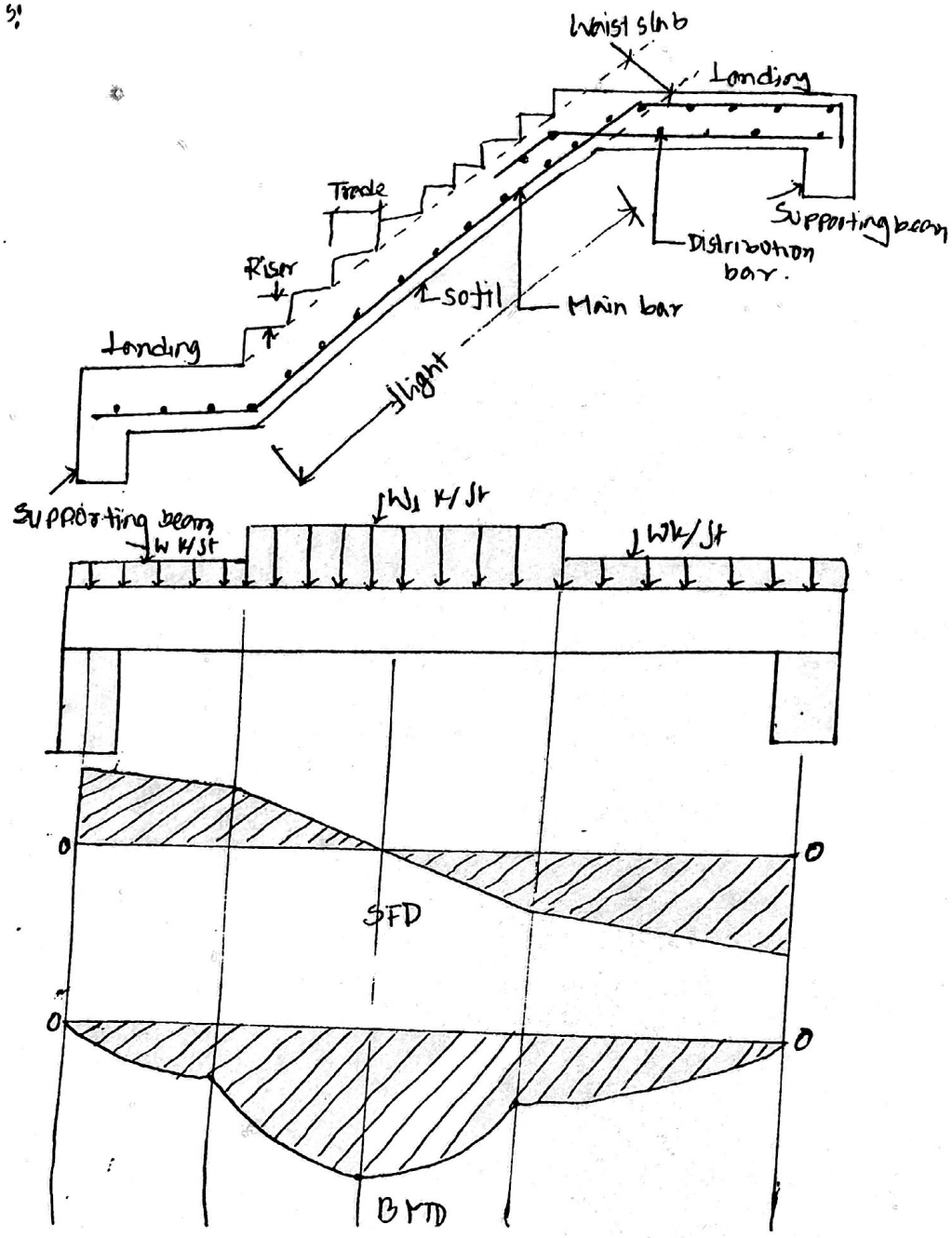
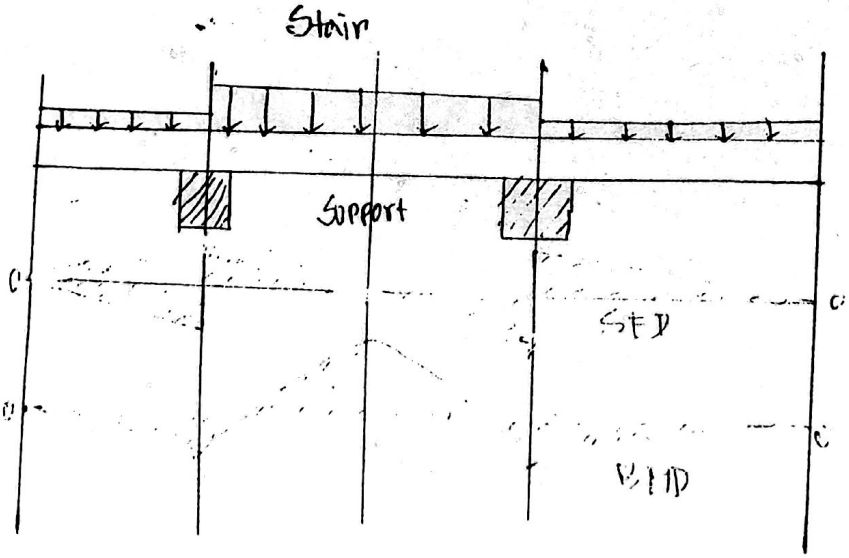


Fig: Longitudinal supported Stair

Also



Q.39) Write down the Losses in Prestress concretc?

Ans: The initial prestressing concrete undergoes a gradual reduction with time from the stages of transfer due to various causes. This is generally defined as total "Loss of Prestress". The various losses are explained below:

Losses in prestress Pretensioning	Losses in prestress Post-tensioning
1.Elastic deformation of concrete	1. No loss due to elastic deformation if all wires are simultaneously tensioned. If the wires are successively tensioned, there will be loss of prestress due to elastic deformation of concrete.
2.Relaxation of stress in steel	2.Relaxation of stress in steel
3.Shrinkage of concrete	3.Shrinkage of concrete
4.Creep of concrete	4.Creep of concrete
	5.Friction
	6.Anchorage slip

Q.40. A prestressed concretc beam 100mm wide and 300mm deep is pre-tensioned by straight wires carrying an initial force of 150KN at an eccentricity of 50mm. The modulus of elasticity of steel and concretc are 210 and 35KN/m^2 respectively. Estimate the percentage loss of stress in steel due to elastic deformation of concretc if the area of steel wires is 188mm^2?

Sol":

We known that,

Loss of stress due to elastic deformation of concretc, $\blacktriangle f_{s,(elastic)} = E_s/E_c \times f_c$ ----------(i)

Again, we know that,

Concretc stress at the level of steel (Bottom),

$f_c = -F/A + (-Fe^2/I) + (+Me/I)$

$\Rightarrow fc = -150/30000 - 150 \times 50 \times 50/225 \times 10^6 + 0 \times 150/225 \times 10^6$

$\Rightarrow fc = -0.005 - 0.00167 + 0 = -6.67$ N/mm^2

From, (i) => Loss of stress = $210/35 \times 6.67 = 40$ N/mm^2 (Ans)

Percentage of Loss = $(40/797.87) \times 100 = 5.013\%$ (Ans)

Loss due to Shrinkage of steel = $\epsilon_{sh} E_s = 0.0003 \times 210 = 0.063$KN/mm^2 = 63N/mm^2

Given data,

E_s = Modulus of elasticity of steel = 210 KN/m^2

E_c = Modulus of elasticity of concretc= 35KN/m^2

f_c = Concretc stress at the level of steel

Y = 300/2 = 150mm

e = 50mm

F = 150KN

A= 100 x 300 =30000 mm^2

I= bd^3/12 =225 x 10^{6}mm^4

Area of the steel wire = 188mm2

Initial strees of steel = 150 /188 = 0.7978KN/mm^2 = 797.87N/mm^2

ϵ_{sh} = Shrinkage Strain is varying from = 0.0004 to 0.0008, here the value = 0.0003

(Q.41) What is diagonal tension and when it creates?

Ans: The reason of applied load on a RCC beam, its develop compression stress above NA and tension stress below NA. Thus the combination of two types stress acting on a beam which is causes of diagonal crack. So these diagonal crack causes of diagonal stress, this stress are called diagonal tension.

Because of –

1. Under reinforcement used in external applied load
2. Don't proper used in web reinforcement.

(Q.42) What do you meant by "stirrup"?

Ans: A reinforcement used to resist shear and diagonal tension stresses in a concrete structural member. A steel bar bent into a "U" or box shape and installed perpendicular to, or at an angle to the longitudinal reinforcement, and properly anchored. Stirrup is used when the produce shear stress of that beam greater than the allowable shear stress, $V_{allow} = 1.33\sqrt{f'c}$.

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Q.43. Write down the purposes of shear/web reinforcement?
Ans: The purposes are-
1. Shear reinforcement increases the member strength against diagonal tension failure by
   a) Direct transfer of shear force
   b) Improvement of aggregate interlock
2. It helps to maintain the intensity of compression zone.
3. It improves the member ductility.
4. It helds the main reinforcement in proper position.

Q.44. A rectangle RCC beam which span length 6m. wide of beam is 250mm and effective depth 450mm with a distribution load is 24 KN/m (excluding self weight), Need stirrup or not? If need stirrup then design it? Given as $f'_c = 3300$psi and $f_y = 50.75$ksi?
Sol":

We know that,
Total Depth, D = 450 + 50 = 500mm
Maximum Shear $V_{max} = wL/2 = 80.82$ KN
Critical Shear, $V_{er} = V_{max} - wd$
$V_{er} = 80.82 - 26.94 \times 0.450 = 68.69$ KN
or, $V_{er} = 68.69 \times 10^3$ N

So, Actual Shear Stress $V_{ac} = V_{er}/bd$
or, $V_{ac} = (68.69 \times 10^3)/(250 \times 450) = 0.61$ Mpa
Again, Allowable shear stress, $V_c = (1.1\sqrt{f'c}$ (Mpa))/12.04
or, $V_c = 0.435$ Mpa
So, $V_{ac} > V_c$ So, Need stirrup in this beam.
Excess shear, V' = 0.61 – 0.435 = 0.19 Mpa

Length of provided stirrup, $a = (L/2\text{-}d) \times V'/V_{ac}$
or, $a = (6/2 - 0.45) \times 0.19/0.61 = 0.794$ m
Total length = a + 2d = 0.794 + 2 x 0.45 = 1.694 m

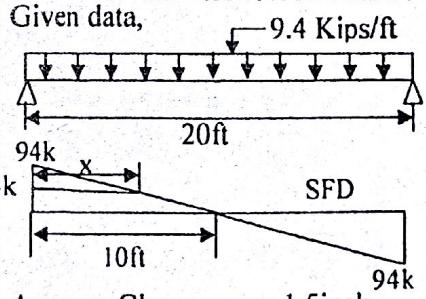
So, Used 10mm dia stirrup @225mm c/c (Ans)

Given data,
Assume, Clear cover = 50mm
Effective depth, d = 450mm
w = 24KN/m (excluding self weigth), Span Length, L = 6m
Self Wt. = $(250 \times 500)/10^6 \times 1 \times 2400 = 300$ kg/m
or, w = 300 x 9.81 /1000
or, w = 2.94 KN/m
Total Load = 24 + 2.94 = 26.94 KN/m
or, $f'_c = 3300/145 = 22.7$ Mpa
or, $f_s = 0.40 \times 50750/145 = 140$ Mpa
Spacing use 10mm bar
1. S = d/2 = 450/2 = 225m c/c
2. $S = (A_v \times fs) / V'b = (2 \times (\pi/4) \times (10)^2 \times 140) / (0.19 \times 250) = 462.97$ mm c/c
3. $S = A_v / (0.0015b) = 157/(0.0015 \times 250) = 418$ mm c/c

Q.45. A simply supported rectangle RCC beam wide 16 inch having an effective depth 22 inch carries a total factored load 9.4 Kips/ft on a 20ft clear span. If $f'_c = 4000$psi and $f_y = 60$ksi, design the web reinforcement for the beam?
Sol":

We know that,
Total Depth, D = 22 + 1.5 = 23.5inch
Maximum Shear $V_{max} = wL/2 = 94$Kips
Critical Shear at distance d(22/12) from the support face, $V_{er} = V_{max} - wd = 94 - 9.4 \times 22/12 = 76.8$Kips
So, Actual Shear Stress $V_{ac} = V_{er}/bd$
or, $V_{ac} = (76.8)/(16 \times 22) = 0.218$ kips/inch^2
Again, Design shear stress, $\varphi V_c = 2\varphi\sqrt{f'c} = 2 \times 0.75 \times \sqrt{4000} = 0.095$ kips/inch^2 = 33.4 kips
So, $V_{ac} > \varphi V_c$ So, Need stirrup in this beam.
Excess shear, V' = 0.218 – 0.095 = 0.123 kips/inch^2
Length of provided stirrup, 94/10 = 33.4/(10-x)
x = 6.45ft from support face (Ans)

Given data,

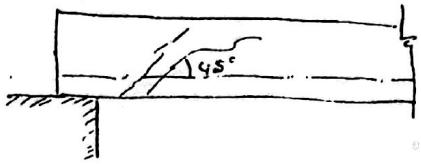


Assume, Clear cover = 1.5inch
Spacing use 10mm bar
① S = d/2 = 22/2 = 11inch c/c
② $S = (A_v \times f_y)/\varphi\sqrt{f'c}b = (2x(\pi/4) \times (10)^2 \times 60000)/(0.75 \times \sqrt{4000} \times 16) = 17.4$ inch c/c
③ $S = A_v f_y/50b = (2 \times 0.11 \times 60,000)/(50 \times 16)$
$\Rightarrow S = 16.5$ in c/c
So, Used 10 mm stirrup @11 in c/c (Ans)

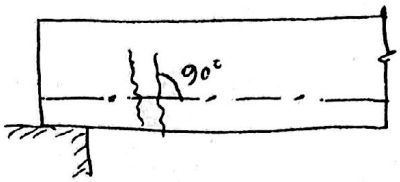
Q. show with diagrams & discuss different failure (crack in RCC beam)

Ans:

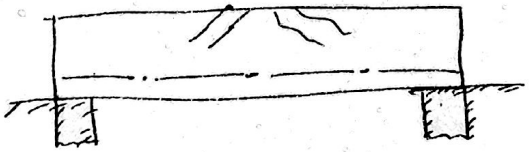
1) Diagonal tension failure: In this type of failure, diagonal cracks appear in the beam which are inclined at about 45° to the horizontal.



2) Flexural shear failure: In this type of failure, cracks appear normally at an angle 90° to the horizontal

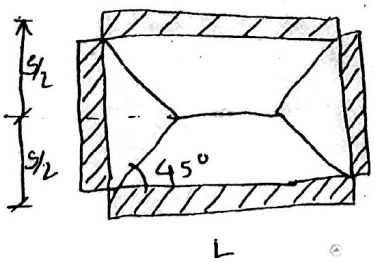


3) Diagonal compression failure: In this type of failure takes place by crushing of concrete in compression zone



Q. Load distribution of slab on a beam

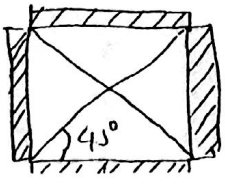
two way (all side supported rectangular)



1) Load transfered in short direction per ft of beam = $\frac{WS}{3}$

2) Load transfered in long direction per ft of beam = $\frac{WS}{3}\left(\frac{3-m^2}{2}\right)$

two way (square) S



S = c/c length along short direction
W = load including self weight of slab (psf)
$m = S/L$

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Q.46. Define Bond stress?

Ans: Bond stress defined as the shear force per unit nominal surface area of reinforcing bar. The stress is acting on the interface between bars and surrounding concrete and along the direction parallel to the bars.

Q.47. Define Development Length?

Ans: The development length is a function of the bar size, yield strength, concrete strength and other factors such as coating of the bar.It is usually 12D where D is the nominal diameter of the reinforcement. Also, the development length of a bar is dependent to whether the bar is in tension or compression.

Q.48. Write down the allowable stress for different types of member?

Ans:

Types of stress	Allowable value
Bond stress for top bar	$U_{all}= 3.4\sqrt{f'c(psi)}/D(inch) \leq 350psi$, D = Dia of bar
Bond stress for bottom bar	$U_{all} = 4.8\sqrt{f'c(psi)}/D(inch) \leq 500psi$, D = Dia of bar
Shear Stress	$V_c = 1.1\sqrt{f'c(psi)}$

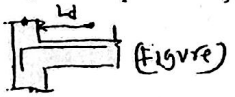
Q.49. A simply supported rectangle RCC beam wide 10inch having an effective depth 22inch carries a total factored load 4kips/ft on a 20ft clear span and use rebar 3#6. If $f'_c = 4000psi$ and $f_y = 60ksi$, Check the Bond stress of that beam when, n= 10 ?

Sol":

We know that, Bond stress, $U = V/\sum_o Jd$ $\Rightarrow U = 40/(7.07 \times 0.857 \times 22) = 0.30kips/in^2$ Again, Bond stress for bottom bar, $U_{all} = 4.8\sqrt{f'c(psi)}/D(inch) \leq 500psi$ $\Rightarrow U_{all} = (4.8\sqrt{4000})/0.75 = 0.405kips/in^2 \leq$ 500psi and $< 0.293kips/in^2$ So it is safe (Ans)	Given data, $V_{max} = wL/2 = 4 \times 20/2 = 40kips$ $\sum_o = N\pi D = 3\pi \times 0.75 = 7.07inch$ $k = n/(n+r) = 10/(10+fs/fc)$ $\Rightarrow k = 10/(10+24/1.8) = 0.428$, $J = 1- k/3 = 0.857$ d =22 inch

Q.50. A cantilever rectangle RCC beam wide 10inch having an effective depth 22inch carries a total factored load 4kips/ft on a 20ft clear span and use rebar 4#12. If $f'_c = 4000psi$ and $f_y = 60ksi$,

Determine development length of the beam when, n= 10 ?



(Figure)

Sol":

We know that, Bond stress for top bar,(Cantilever beam) $U_{all} = 3.4\sqrt{f'c(psi)}/D(inch) \leq 350psi$ $\Rightarrow U_{all} = 3.4\sqrt{4000}/1.5 = 143.36psi = 0.143ksi \leq 350psi$ We know,Development Length, $L = f_s D/4U$ $\Rightarrow L = 24 \times 1.5/(4 \times 0.143) = 62.96inch = 5.24ft$ (Ans)	Given data, f'c = 4000psi, fc = 0.45 x 4 = 1.8ksi fy= 60ksi , fs = 0.4 x 60 = 24ksi Dia of bar, D = 1.5 inch

Q.51. Draw the flexural and diagonal crack in a beam?

Ans:

Flexure cracks:

i) Start tension face and extend to Neutral axis

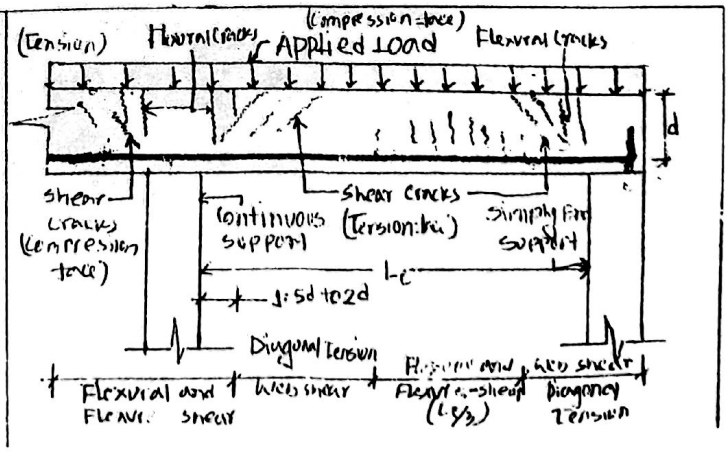
ii) Cracks width gradually decrease at tension face and reduce to distance from that face

iii) forms right angle to the span

Diagonal cracks:

i) start tension face and extend to Neutral axis

ii) forms 45° angle to the force



Q.52. What can you do when development bond stress exceeds allowable bond stress?
Ans: The developed bond stress should not exceeds allowable bond stress, if exceed then reduce of bar dia.

Q.53. Write down the longitudinal steel/rebar ratio in ACI and BNBC code?
Ans: The longitudinal steel ratio is column is 1% - 8% (ACI code) and 1% - 6% (BNBC code)

Q.54. Why does BNBC/ACI specify the longitudinal steel ratio to be kept in 1% to 8%?
Ans: Because of-
i) Ensure the resistance of the column
ii) Bending moment not accounted for code analysis
iii) Reduce the effect of creep and shrinkage of concretc under sustained compression

Q.55. Why is a smaller reduction factor used in a column compared to beam?
Ans: Because of-
i) Beam failure would normally effect of only a load region where as a column failure could result in collapse of the entire structure.

Q.56. Why the load capacity of spiral column is greater than tied column?
Ans: Because of-
i) Tied column under loaded condition the concretc fails by crushing and shearing, on the other hand spiral column under loaded condition longitudinal steel and concretc prevented by concretc core.

ii) Tied column under loaded condition the longitudinal steel buckling outward in between ties, on the other hand spiral column under loaded condition longitudinal steel buckling prevented by concretc core.

Q.57. Write down the value of reduction factor in Beam and column?
Ans:

Structure Name	Reduction factor (φ)
Beam for Bending Moment	0.9
Beam for Shear and Bond Stress	0.85
Tied Column	0.70
Spiral Column	0.75

Q.58. Write down the specification of Tie and Spiral reinforcement?
Ans:

Tie Specification	**Spiral Specification**
i) Spacing , $S = 48 \times d_{tie}$ ii) Sp;acing ,$S = 16 \times d_{main}$ iii) Spacing, S = Least dimension of Column size. **Smallest value is acceptable**	i) Spacing , $S = D_c/6$ ii) Spacing ,$S = 4a_s/\rho_s D_c$ Where,Steel ratio,$\rho_s = 0.45(A_g/A_c-1)f'_c/f_y$ Spiral reinforced area= a_s Core Dia = D_c **Smallest value is acceptable**

Q.59. Write down the specification of tensile reinforcement?
Ans:
The specifications of tensile reinforcement are as below-
1. Clear distance between two rebar, not less than of rebar dia.
2. Not less than 2.45 cm or 1"
3. Not less than 1.33 times of maximum aggregate size.

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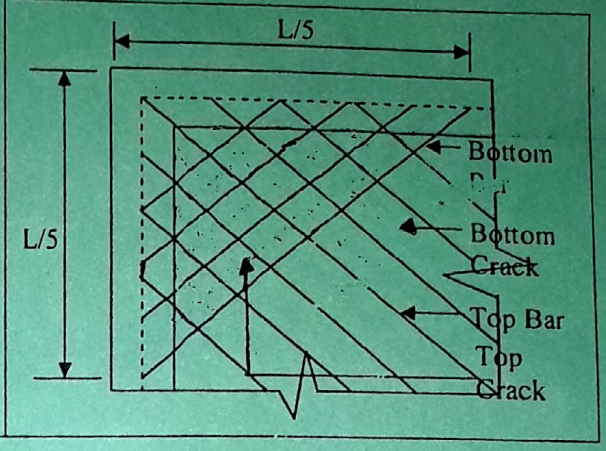
Q.60. Define corner reinforcement with sketch and why it's used?

Ans: A special reinforcement shall be provided at exterior corners in both bottom and top of the slab, for a distance in each direction from the corner equal to one-fifth the larger span of the corner panel.

Because of-

1. to resist diagonal crack
2. to resist twisting moment at exterior corner of a two way slab.



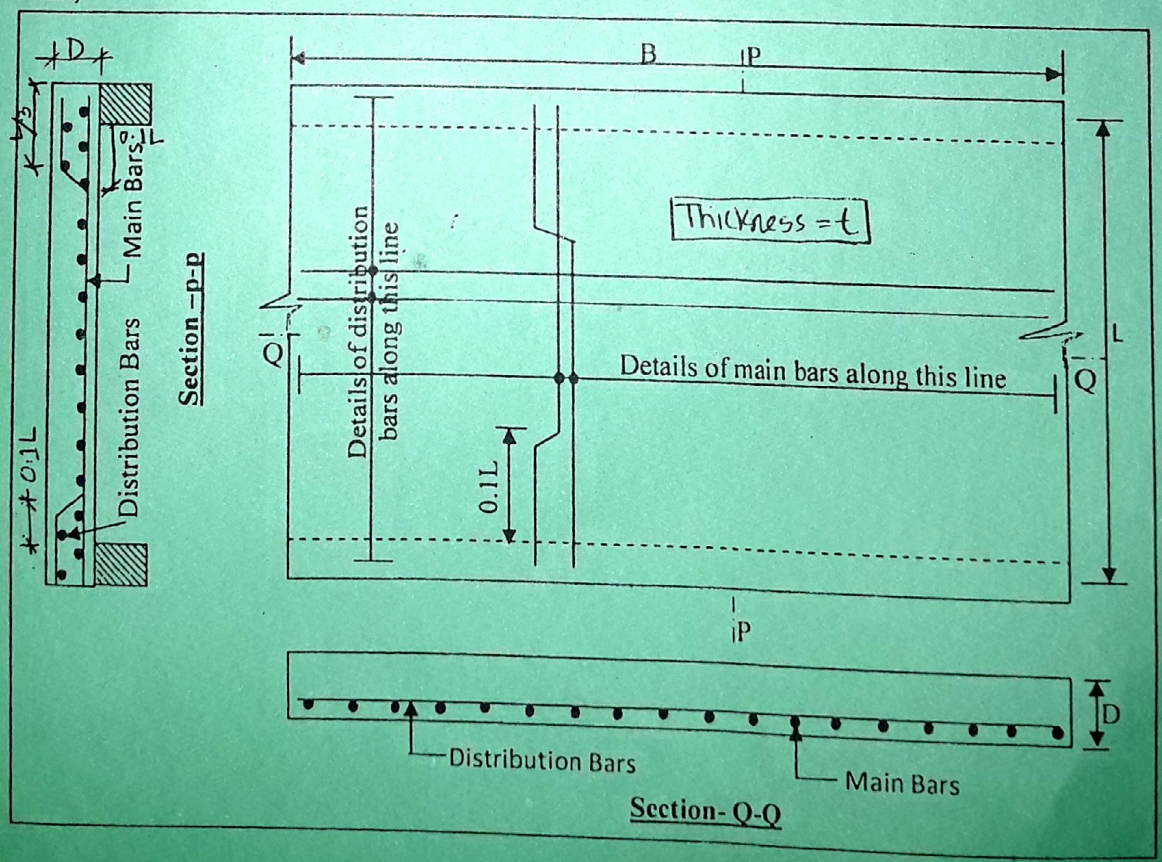
Q.61. Write down the difference between One way and Two slab?

Ans: The difference are-

One Way Slab	Two Way Slab
One way slab is supported by beams in only two sides	Two way slab is supported by beams in all four sides
The ratio of longer span panel (L) to shorter span panel (B) is equal or greater than 2. Thus, $L/B \geq 2$	The ratio of longer span panel (L) to shorter span panel (B) is less than 2. Thus, $L/B < 2$
Main reinforcement is provided in only one direction for one way slabs	Main reinforcement is provided in both the direction for two way slabs

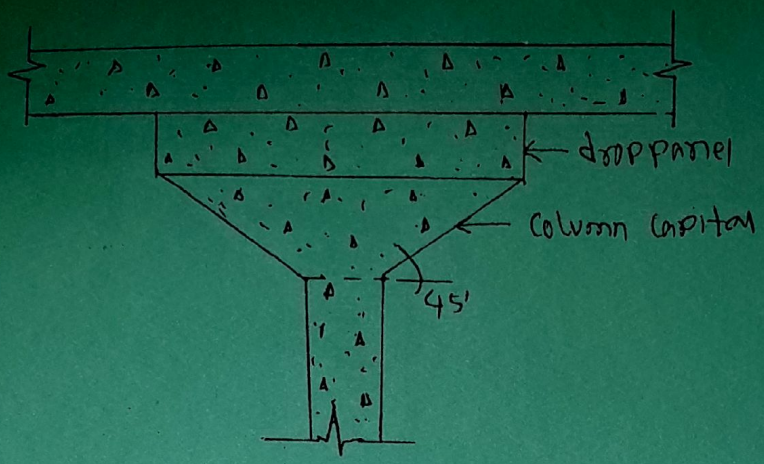
Q.62. Draw the reinforced detailed for **One way** simply supported slab?

Ans:;



Q. Write down the component of flat slab?

Ans:



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Q. Write down the one way slab thickness for the following reason?

i) Simply supported ii) One end continuous iii) Both end continuous iv) Cantilever

Ans:

i) Simply supported = $L/25$

ii) One end continuous = $L/30$

iii) Both end continuous = $L/35$

iv) Cantilever = $L/12$

Q. Draw the typical reinforcement in a one way slab with a continuous beam on column?

Ans:

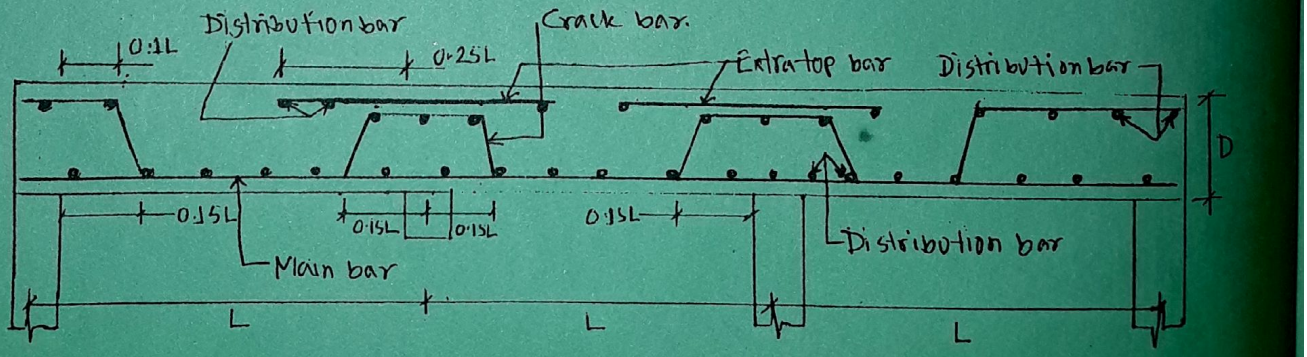

Fig: Cross section details

Q. If total thickness of slab 'D' then the Maximum diameter of bar, shall not exceed D/8. Spacing – Main bar – 3d or 300mm which is smaller

– Distribution bar – 3d or 450mm which is smaller

Where, d = effective depth of slab.

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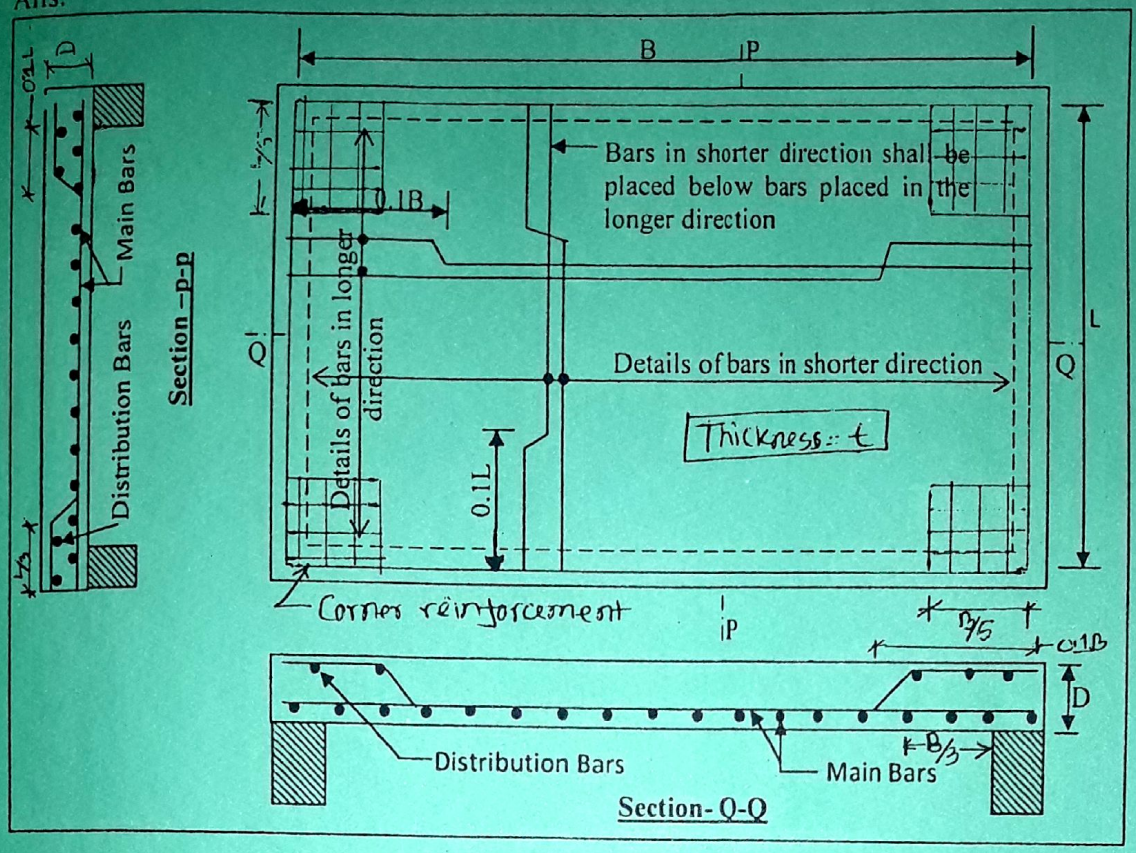
Q.63. Draw the reinforced detailed for **Two way** simply supported slab?

Ans:



Q.64. Write down the definition of slab and there types?

Ans: A widely and horizontal plate which is constructed by the RCC is called slab. It is generally horizontal to above and below surface.

There are 05 types-

1. One way slab , 2. Two way slab, 3. Flat slab, 4. RB slab, 5. Ribbed Slab

Q.65. What are the minimum temperature reinforcement in slab, beam and column?

Ans:

Slab	Minimum Beam	Minimum Column
$A_{s(min)}$= 0.002bt(50G and 40G) and 0.0018bt(60G)	$A_{s(min)}= 200/f_y$ $A_{s(Max)} = 0.75\rho_b$	$A_{s(min)}$= 1% of gross area of column $A_{s(Max)}$=8% of gross area of column

Q.66. Write down the minimum lap length in compression and tension zone?

Ans: Lap length in compression zone 24d and tension zone 30d, where d = dia of bar (IS), in the same dia of bar. But another dia of bar used in one member this dia is equal to the minimum bar dia.

Q.67. Define Slenderness ratio?

Ans: The ratio of unsupported length of column to its least radius of gyration is known as Slenderness ratio, i.e. h/r, where, r = Radius of gyration.

Q.68. Define Radius of gyration?

Ans: The ratio of square root of minimum moment of inertia to its cross sectional area (A), It is called Radius of gyration. So $r = \sqrt{(I_{min}/A)}$

Q.69. Write down the definition of Long Column?

Ans: **Long Column:** When the ratio of unsupported length of column to the least dimension of column is greater than 10 ,It is called Long column. **So, Long Column = h/t ≥ 10 = h/r(slenderness ratio) ≤ 80**

Q.70. Write down the definition Short column?

Short Column: When the ratio of unsupported length of column to the least dimension of column is equal or less than 10 ,It is called Short column.

So, Short Column: = h/t ≤ 10 = h/r(slenderness ratio) > 80

Q.71. Draw the cross section of a pile cap with column?

Ans:

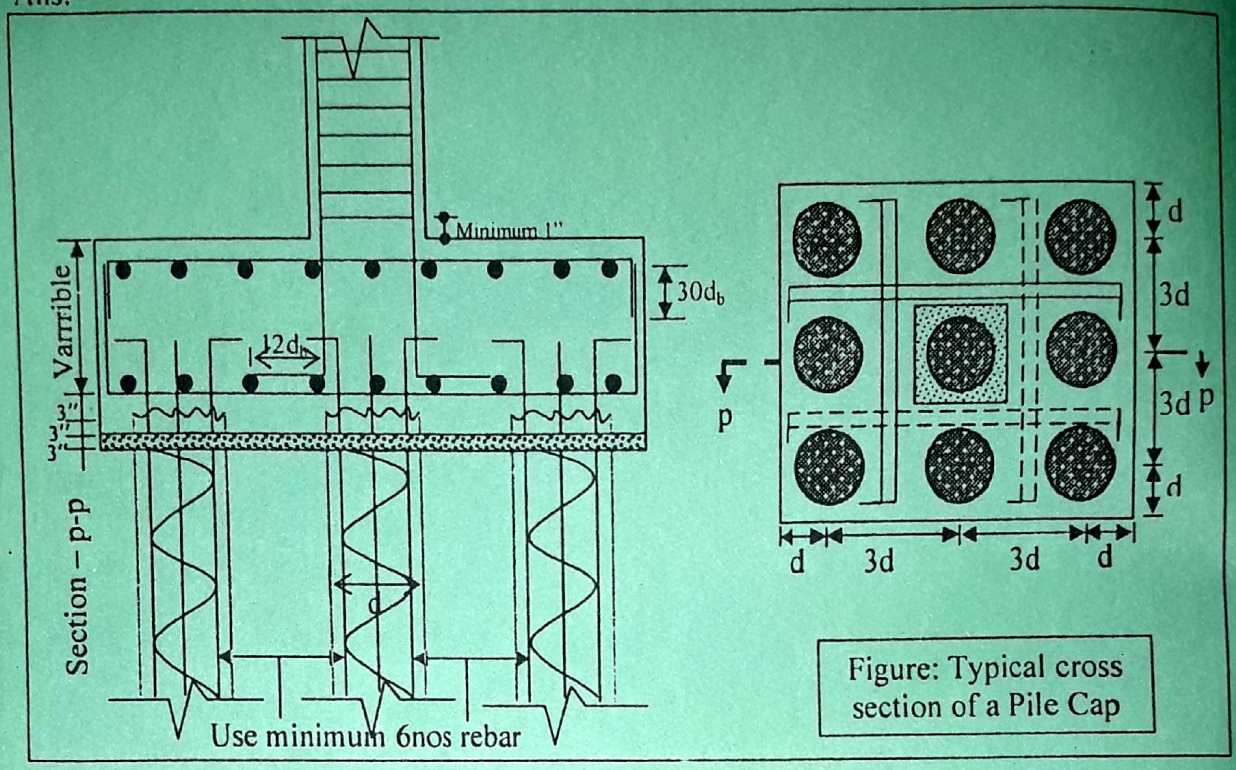


Figure: Typical cross section of a Pile Cap

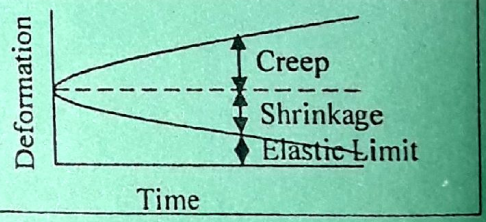
Q.72. What is Creep?

Ans:

In under any condition deformation continues when the load is held constant, this additional deformation is known as creep.

Deformation under constant load-Creep

Deformation under fluctuating load- Fatigue



Q.73. Why need to used lateral reinforcement in column?

Ans: Because of-

1. To hold the longitudinal bars in position, while the concrete is being placed
2. To prevent the highly stressed, slender longitudinal bars from bucking outward by bursting the thin concrete cover
3. To resist the shear

Q.74. What is Fatique failure?

Ans: **Fatigue** failure is **defined** as the tendency of a **material** to fracture by means of progressive brittle cracking under repeated alternating or cyclic stress.

Q.75. What are the factors of column Buckling?

Ans: Buckling depends on-

1.End restraint, 2. Stiffness, 3.Length, 4. X- Sectional area

Q.76. Why cube strength is greater than cylinder strength?

Ans: ;Because of-

1. L/r ratio is more cylinder than cube where L = Length and r = radius of gyration
2. Uniformly load distribute in the cube

[2nd]

Q. Compute the axial load of a column which size 12"×15" & used 12-20mm bar, if $f'_c = 3.5$ksi & $f_y = 60$ksi ?

Sol":

We know that the axial load of a column, $P = 0.85 A_g [0.25 f'_c + \rho_g f_s]$ $= 0.85 \times 180 [0.25 \times 3.5 + 0.032 \times 24]$ $= 251.38$ kips (Ans)	Given Data, $A_g = 12 \times 15 = 180 inch^2$ $f'_c = 3.5$ksi $f_s = 60 \times .4 = 24$ksi $A_s = \pi/4 \times (0.787)^2 \times 12 = 5.84 in^2$ $\rho_g = A_s/A_g = 0.032$ $P = ?$

[3rd]

Q. compute steel ratio/concrete ratio ($\rho_s/\rho_c = ?$), if steel uses in the column is 1% of total area of column area & steel ratio is 10?

Sol":

We know that, $f_s = \frac{\rho_s}{A_s} \times f_c = \frac{\rho_c}{A_c}$ Again, $n = \frac{f_s}{f_c}$ $\Rightarrow 10 = \frac{\rho_s}{A_s} / \frac{\rho_c}{A_c}$ $\Rightarrow 10 = \frac{\rho_s}{A_s} \times \frac{A_c}{\rho_c}$ $\Rightarrow 10 = \frac{\rho_s}{\rho_c} \times \frac{A_g - A_s}{A_s}$ $\Rightarrow 10 = \frac{\rho_s}{\rho_c} \times \frac{A_g - 0.01 A_g}{0.01 A_g}$ $\Rightarrow 10 = \frac{\rho_s}{\rho_c} \times \frac{1 - 0.01}{0.01}$ $\Rightarrow \frac{\rho_s}{\rho_c} = 0.1010$ $= 10.1\%$ (Ans)	Given data, $A_s = 1\% \text{ of } A_g$ $A_s = 0.01 A_g$ Modular ratio, $n = 10$ $\frac{\rho_s}{\rho_c} = ?$

[1st]

Q. Define column & write down their types?

Ans: Column: A column is a compression member that are transmits the load or carry load to hole structure.

Types of column:

1) Based slenderness ratio
   a) Long column
   b) Short column

2) Base on shape
   a) Rectangle column
   b) Sarvare column
   c) Circular column
   d) Polygon column

3) Base on type of loading
   a) Axially loaded column
   b) Axial load & Un-axial bending moment
   c) Axial load & Biaxial bending column

4) Base on Pattern of lateral reinforcement
   a) Tied columns
   b) Spiral columns

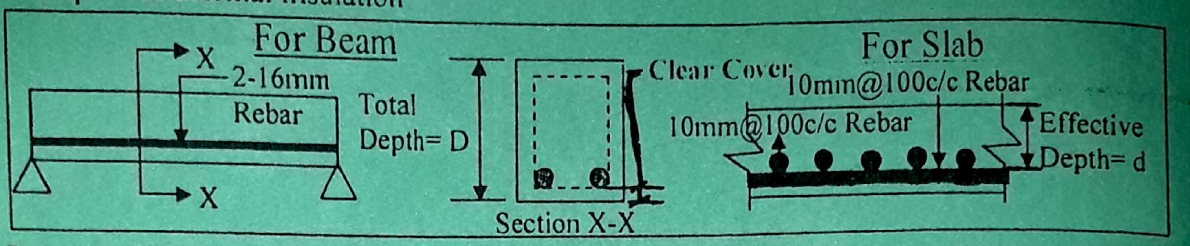
[MIST]

Q.77. What is clear cover? And why it is need? (Shimu Coal Power-2015)

Ans: A Clear cover is the distance between the top of the rebar and the top of the finished concrete surface.

Because of –

1. To protect the steel reinforcement bars from environment effects
2. To prevent the steel reinforcement bars from corrosion
3. To provide thermal insulation



P

Q.78. Write down the minimum clear covers at slab, beam and column? ⓚ Foundation - 40mm-60 ⓚ Lintel – 20mm

Ans:

Component Name	Clear Cover
Slab	15mm
Beam	25mm
Column	40mm

Q.80. Design a tied column for a concentrated allowable working load of 480k with f'_c = 4000psi and f_y = 60ksi for longitudinal?

Sol":

Design for Tied Column WSD Method

Assume steel ratio, $\rho_g = 0.02 = A_s/A_g$

We know that, $P = 0.85[\ 0.25f'_c\ (A_g - A_s) + A_sf_s\ ]$

or, $480 = 0.85\ [\ 0.25 \times 4 \times (A_g - 0.02A_g) + 0.02A_g \times 0.4 \times 60 \Rightarrow A_g = 386.784\ in^2$

$\Rightarrow b \times h = 386.784\ in^2 \Rightarrow b^2 = 386.784\ in^2$

$\Rightarrow b = \sqrt{(386.784\ in^2)} = 19.66\ in \approx 20\ in$

So, Column size = 20" x 20", Actual A_g =400 in^2

Again, $P = 0.85[\ 0.25f'_c\ (A_g - A_s) + A_sf_s\ ]$

or, $480 = 0.85\ [\ 0.25 \times 4 \times (400 - A_s) + A_s \times 0.4 \times 60 \Rightarrow A_s = 7.16\ in^2$ so, using 6# 10

Actual area of steel, $A_s = 7.6\ in^2$

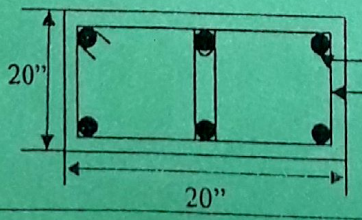
For Tie Spacing

Assume clear cover = 1.5"

Spacing (using 10mm bar = 0.3937 inch)

1. $S = 48 \times d_{tie} = 18.89\ " \approx 18"$
2. $S = 16 \times d_{main} = 16 \times 1.25" = 20"$
3. S = 20" (Least dimension of column size)

Spacing 18" c/c use 10mm bar



Design for Tied Column USD Method

Assume steel ratio, $\rho_g = 0.02 = A_s/A_g$

We know that, $P = \alpha\varphi\ [\ 0.85f'_c\ (A_g - A_s) + A_sf_y\ ]$

or, $480 = 0.8 \times 0.70 \times [\ 0.85 \times 4 \times (A_g - 0.02A_g) + 0.02A_g \times 60 \Rightarrow A_g = 188.29\ in^2$

$\Rightarrow b \times h = 188.29\ in^2 \Rightarrow b^2 = 188.29\ in^2$

$\Rightarrow b = \sqrt{(188.29\ in^2)} = 13.72\ in \approx 14\ in$

So, Column size = 14" x 14", Actual A_g =196in^2

Again, $P = \alpha\varphi\ [\ 0.85f'_c\ (A_g - A_s) + A_sf_y\ ]$

or, $480 = 0.75 \times 0.70 \times [\ 0.85 \times 4 \times (196 - A_s) + A_s \times 60] \Rightarrow A_s = 3.302\ in^2$ so, using 6#7 bar

Actual area of steel, $A_s = 3.606\ in^2$

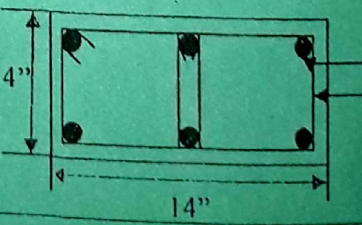
For Tie Spacing

Assume clear cover = 1.5"

Spacing (using 10mm bar)

1. $S = 48 \times d_{tie} = 18.89\ " \approx 18"$
2. $S = 16 \times d_{main} = 16 \times 0.875" = 14"$
3. S = 13.5" (Least dimension of column size)

Spacing 14" c/c use 10mm bar



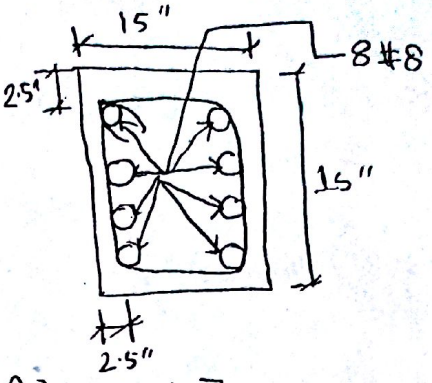
Q. A column with the cross section shown below with $f'_c = 4$ksi & $f_y = 60$ksi is subjected to a concentrated axial load. The column section is reinforced with 8 #8 bar. Calculated the ultimate load capacity of the column?

Soln:

We know that, steel ratio, $\rho_g = \frac{A_s}{A_g}$

$$\Rightarrow \rho_g = \frac{8 \times \pi/4 (8/8)^2}{15 \times 15} = 0.0279$$

So, $1\% < \rho_g > 8\%$, $\therefore \rho_g = 0.0279$



Ultimate load capacity, $P = \alpha \phi [0.85 f'_c (A_g - A_s) + A_s f_y]$

$$\Rightarrow P = 0.80 \times 0.70 \times [0.85 \times 4 (15 \times 15 - 6.283) + 6.283 \times 60]$$

$$\Rightarrow P = 627.546 \text{ Kips (ans)}$$

(x) Poission ratio = $\frac{\text{Transverse strain}}{\text{Longitudinal strain}}$

(x) Factor of safety = $\frac{\text{Ultimate}}{\text{working}}$

Q.81. Design a spiral column for a concentrated allowable working load of 480k with f'_c = 4000psi and f_y = 60ksi for spiral bar?

Sol":

Design for Spiral Column WSD Method

Assume steel ratio, ρ_g = 1% to 8% = 0.02=A_s/A_g

We know that, $P = 0.25f'_c(A_g - A_s) + A_sf_s$

or, $480 = 0.25 \times 4 \times (A_g - 0.02A_g) + 0.02A_g \times 0.4 \times 60$ => $A_g = 328.77\ in^2$

=> $\Pi D^2/4 = 328.77\ in^2$ => D= 20.46 in ≈ 20.5 in

So, Column size (Dia) =20.5",Actual A_g=330in^2

Again, $P = 0.25f'_c(A_g - A_s) + A_sf_s$

or, $480 = 0.25 \times 4 \times (330 - A_s) + A_s \times 0.4 \times 60$ => $A_s = 6.5\ in^2$ so, using 6# 10

Actual area of steel, $A_s = 7.35\ in^2$

For Spiral Spacing

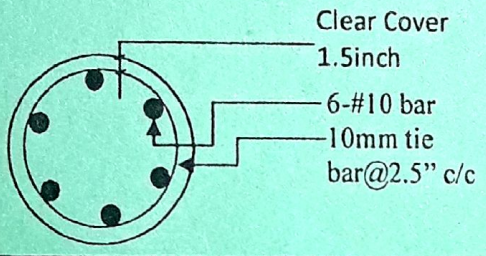
Assume clear cover = 1.5" ,Dc = 20.5-2 x1.5 = 17.5, Ac = 240.40 $inch^2$

$\rho_s = 0.45(Ag/Ac - 1)f'c/fy = 0.0111 < \rho_g = 0.02$

Spacing (using 10mm (0.3937 in) bar, a_s = 0.122 $inch^2$)

1. $S = 4a_s/\rho_sD_c = (4 \times 0.122)/(0.0111 \times 17.5)$ = 2.5" c/c
2. S = Dc/6 = 2.9"

Smallest Value acceptable so, Spacing 2.5" c/c use 10mm bar



Design for Spiral Column USD Method

Assume steel ratio, ρ_g = 1% to 8% = 0.02=A_s/A_g

We know that, $P = \alpha\varphi[0.85f'_c(A_g - A_s) + A_sf_y]$

or, $480 = 0.85 \times 0.75 \times [0.85 \times 4 \times (A_g - 0.02A_g) + 0.02A_g \times 60]$ => $A_g = 328.77\ in^2$

=> $\Pi D^2/4 = 189.13\ in^2$ => D = 15.52 in ≈ 16 in

So,Column size(Dia)= 16",Actual A_g=200.96in^2

Again, $P = \alpha\varphi[0.85f'_c(A_g - A_s) + A_sf_y]$

or, $480 = 0.8 \times 0.75 \times [0.85 \times 4 \times (200.96 - A_s) + A_s \times 60]$ => $A_s = 3.07\ in^2$ so, using 6# 7

Actual area of steel, $A_s = 3.60\ in^2$

For Spiral Spacing

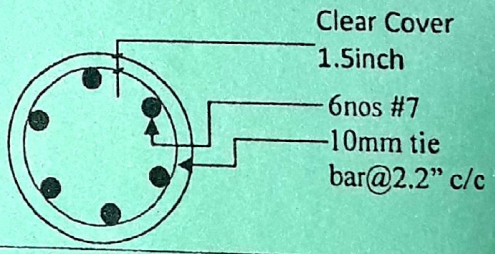
Assume clear cover = 1.5" ,Dc = 16 -2 x1.5 = 13, Ac = 132.67 $inch^2$

$\rho_s = 0.45(Ag/Ac - 1)f'c/fy = 0.0154 < \rho_g = 0.02$

Spacing (using 10mm (0.3937 in) bar, a_s = 0.122 $inch^2$)

1. $S = 4a_s/\rho_sD_c = (4 \times 0.122)/(0.0154 \times 13)$ = 2.4" c/c
2. S = Dc/6 = 2.2" c/c

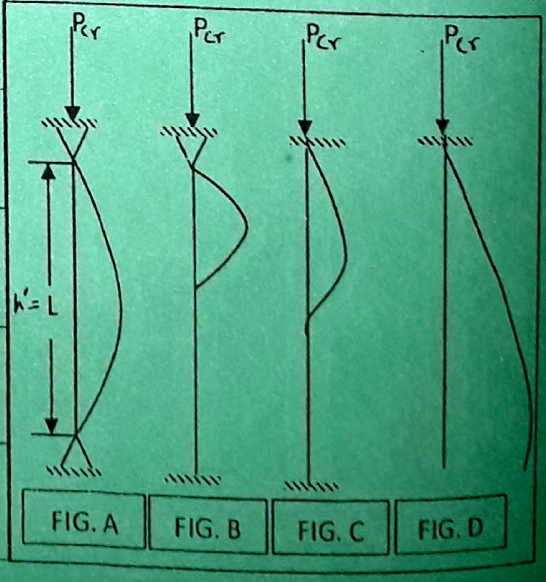
Smallest Value acceptable so, Spacing 2.2" c/c use 10mm bar



Q.82. What are the effective length of various types of column?

Ans:

Type of column	Effective length(K')
(A) Both end hinged	1.0L
(B) One end fixed and one end hinged	0.707L
(C) Both end fixed	0.50L
(D) One end fixed and one end free	2.0L



[CC]

Q. A RCC footing is 10'. Determine punching stress when depth d = 16.5" and a = 10". When that if f_y = 60ksi & f'_c = 4ksi?

Sol":

Shear force = [10×10 − (a+d)²] × soil pressure

$\Rightarrow SF = [[10\times10 - (10+16.5)^2/144] \times w]$ lb

Punching area $A_o = 4(a+d)\times d$

$= 4(10+16.5)\times16.5$

$= 1749 \text{ inch}^2$

Punching stress = $SF/A_o = \frac{[100-4.876]w}{1749 \text{ in}^2} = 0.054w \text{ lb/in}^2$ ---(I)

Allowable stress, $V_o = 2\sqrt{f'_c}$

$= 2\sqrt{4000} = 126.49$ psi ---(II)

(I) × (II) $\Rightarrow w = 2342.42$ psf

Punching stress = $SF/A_o = 0.054 \times 2342.42 = 126.49$ psi (Ans)

Q. Draw the typical yield line patterns for slabs?

Ans:

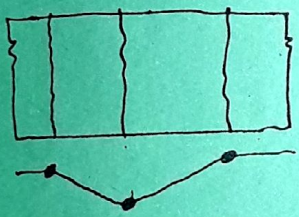


Fig. Slab continuous over parallel supports

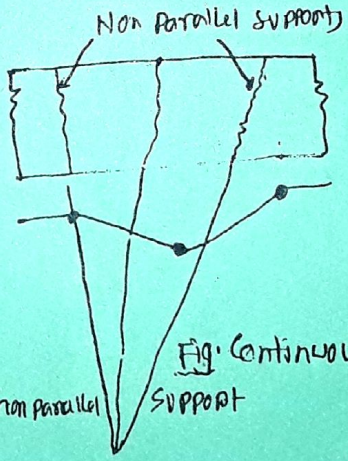


Fig. Continuous slab on non parallel support

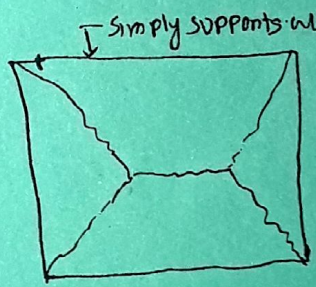


Fig. Two way slabs on simple supports

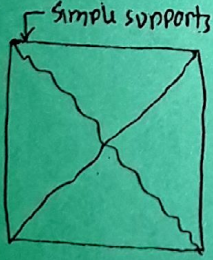
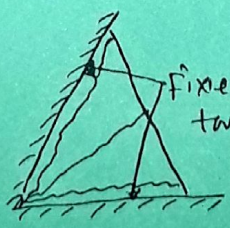
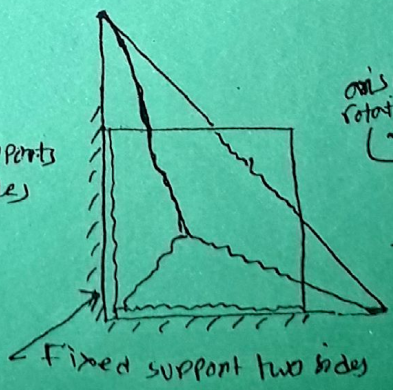
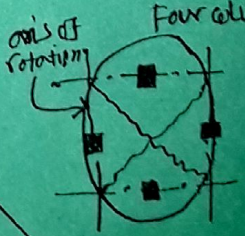


Fig. All simple supports

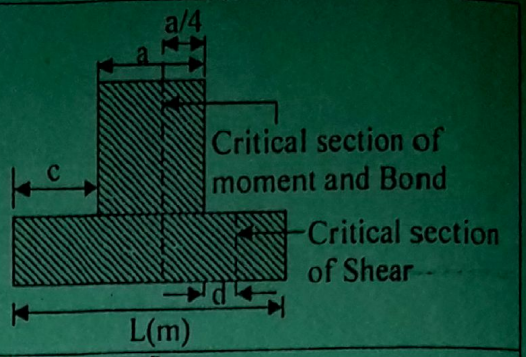
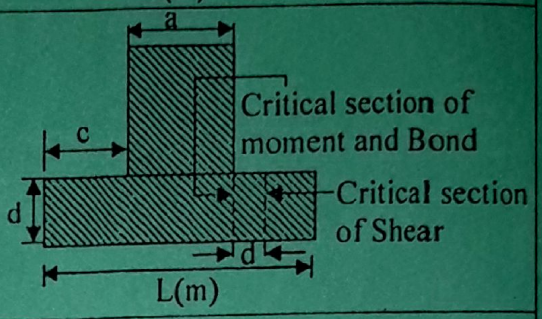
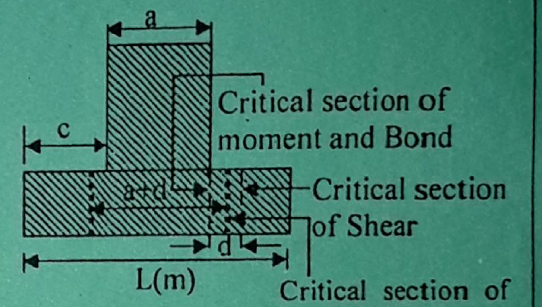






Q.83. Write down the critical section of different types of footing?

Ans:

1. Brick wall footing a) Area ,A = (L x l)m^2 b) Moment, M=w(2L-a)^2/32 c) Shear force at critical at shear section, V_v = (c-d)w d) Shear force at critical at moment and bond section, V_b = (c+a/4)w	
2. Concretc wall footing a) Area ,A = (L x l)m^2 b) Moment, M = w(L-a)^2/8 c) Shear force at critical at shear section, V_v = (c-d)w d) Shear force at critical at moment and bond section, V_b = cw	
3. Independent(RCC) Column footing a) Area ,A = (L x L)m^2 b) Moment, M = wLc^2/2 , where, c = (L-a)/2 c) Shear force at critical at shear section, V_v = (c-d)Lw ,where allowable stress, V_c = 1.1$\sqrt{f'_c}$ (psi) d) Shear force at critical at moment and bond section, V_b = cLw ,where allowable stress, V_c = 1.1$\sqrt{f'_c}$ (psi) e) Shear force at critical at Punching section, V_o = [L^2 – $(a+d)^2$]w ,where allowable stress, V_o = 2$\sqrt{f'_c}$ (psi) f) Punching area ,A_o = 4(a+d) x d	

Q.84. A 18" x 18" RCC column made a footing size 8ft x 9ft will supports a total load of 23000 lb per ft. The bearing pressure of soil is 2ton per sft. Determine footing depth at WSD method for f'c= 3000psi and fy = 40000psi?

Sol":

We know that, Shear force = [8 x 9- $(18+d)^2$/144] x Soil Pressure = [72-$(18+d)^2$/144] x 4000 lb Now, Punching area ,A_o = 4(a+d) x d => A_o = 4(a+d) x d => A_o = 4(18+d) x d $inch^2$ So, Shear stress, Ss = [[72-$(18+d)^2$/144] x 4000]/[4(18+d) x d] psi Again, allowable stress, V_o = 2$\sqrt{f'_c}$ (psi) => V_o = 2$\sqrt{3000}$ = 109.54psi Now , [[72-$(18+d)^2$/144] x 4000]/[4(18+d) x d] = 109.54 => 1.97d + 0.11d^2 = 72 – 0.007(324 +36d + d^2)----------(i)	Given data , Soil Pressure = 2ton/sft = 4000psf f'_c = 3000 psi Footing depth, d =? From (i) => => 1.97d + 0.11d^2 = 72 – 2.27 -0.252d -0.007 d^2 => 0.117d^2 + 2.222d – 69.73 = 0 => d = 16.7(Ans)

Q. Minimum live load for following :

Ans: i) Apartments → 100 psf - 150 psf
ii) Hospitals → 40 psf - 60 psf
iii) other Bldg. → 40 psf - 100 psf
iv) Schools → 40 psf - 100 psf

(Q.85) A 12 in. thick concrete wall carries a service (unfactored) dead load of 10 kips per foot and a service live load of 12.5 kips per foot. The bearing pressure of soil is 5000lb per ft^2 at the level of the base of the footing which is 5ft below the final ground surface. Determine footing depth at WSD method for f'c= 3000psi and f_y = 80000psi if density of soil is 120lb/ft^3?

Sol":

Consider 1-ft strip of footing and wall We know that, Generally depth of footing = 1 to 1.5 in wall thickness = 1 x 12=12 inch Allowable net soil pressure = 5-(1x 0.15 +4 x 0.12) = 4.37ksf Area required=(10+12.5)/4.37 = 5.2 sft of length Factored net pressure = (1.4 x 10 +1.7x 12.5)/5.2 = 6.82ksf Shear check Shear check at d away from the face of the wall d = 12 – 3in cover – ½ in wire dia = 8.75 in Vu = 6.82(16.5/12 x 1) = 9.38kips per ft $\varphi Vc = 2\varphi\sqrt{f'c}\, bd = 2 \times 0.85 \times\sqrt{3000} \times 12 \times 8.75$ =9.78 kips per ft since Vu< φVc the footing depth is ok Footing thickness d = 12inch (Ans)	Given data, Soil Pressure = 5k/ft^2 = 5000psf f'c = 3000 psi fy = 80000psi Footing depth, d =?

Q.86. Write down the definition of Bridge?

Ans: Bridge is a structure which is carrying a road, path, railroad, or canal across a river, ravine, road, railroad, or other obstacle.

(Q.87) Write down the types of Bridge?

Ans:

Types of Bridge	Span Length
1. Slab Bridge	10ft to 25 ft
2. Deck Girder Bridge	50ft to 100ft
3. Box Girder Bridge	100ft to 150ft
4. Balanced cantilever Bridge	150ft to 250ft

(Q.88) Determine Modulus of elasticity, if f'c = 4000psi?

We know that, Modulus of elasticity, $Ec = 33W^{1.5}\sqrt{f'c}$ => $Ec = 33 \times 150^{1.5} \times \sqrt{4000}$ => Ec = 3834253.512 psi (Ans)	Given Data, W = Unit Weight of concrete= 140pcf -152pcf f'c = 4000psi Ec=? Psi

(Q.89) What do you mean by welding rod 7018 ?

Ans: The welding rod 7018 means

1. 70 → Tensile strength of rebar is 70 ksi
   1 → All welding positions while 2 indicates horizontal & flat only
   8 → the type of flux coating. in this case iron powder low hydrogen AC or DC+.

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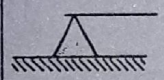
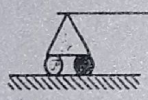
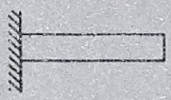
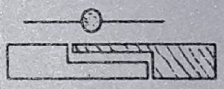
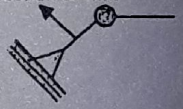
STRUCTURAL ENGINEERING

Q.1. What is structure?
Ans: Structure may be defined receive loads at certain points and transmit then safety to some other point.

Q.2. What are the types of structure?
Ans: The types of structures are-
1. Skeleton structures
   a) Joint consideration
      i) Pin joint structure
      ii) Rigid joint structure
   b) Position of Frame consideration
      i) Plane frame
      ii) Space frame
2. Surface structures
3. Solid structures

Q.3. What is supports with classification?
Ans: Support is define as to bear all part of the weight of whole structure and hold it up.
There are fine types-
1. Hinged support
2. Roller support
3. Fixed support
4. Pin of internal hinged support
5. Link support

Hinged support	Roller support	Fixed support	Pin of internal hinged support	Link support
				Link direction (One Reaction----No translation along the direction of link 

Q.4. What is Degree of Indeterminacy (DOI)?
Ans: Degree of Indeterminacy is the sum of external unknown force and reaction subtract with equilibrium equation in 'n' joint.
Degree of Determinacy(DOI), i = [m –(2j – r)]---->Pin support (Plane Frame)
Degree of Determinacy(DOI), i = [3m –(3j – r)]---->Rigid support (Plane Frame)
Degree of Kinematic Determinacy(DOKI), i = [2j – r]---->Pin support (Plane Frame)
Degree of Kinematic Determinacy(DOKI), i = [3j – r]---->Rigid support (Plane Frame)
Degree of Determinacy(DOI), i = [m –(3j – r)]---->Pin support(Space Frame)
Degree of Determinacy(DOI), i = [6m –(6j – r)]---->Rigid support(Space Frame)
Degree of Kinematic Determinacy(DOKI), i = [3j – r]---->Pin support(Space Frame)
Degree of Kinematic Determinacy(DOKI), i = [6j – r]---->Rigid support(Space Frame)
Where, m = No of member, r = No of reaction, j = No of joint, s = No of internal hinge

Q.5. What is Degree of Statically Indeterminacy (DOSI)?
Ans: The number of additional equations based on the compatibility of determinations necessary for the solution of the problem is known as DOSI.

Q.6. What is Degree of Kinematic Indeterminacy (DOKI)?
Ans: The number of independent joint displacement in a structure is called DOKI or degree of freedom.

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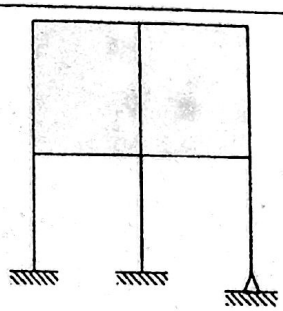
Q.7. Determinacy, Indeterminacy, stability table?

Ans:

Structure	Indeterminate and Stable	Determinate and Stable	Unstable
Frame	$3m+r > 3j+s$	$3m+r = 3j+s$	$3m+r < 3j+s$
Truss	$m+r > 2j$	$m+r = 2j$	$m+r < 2j$

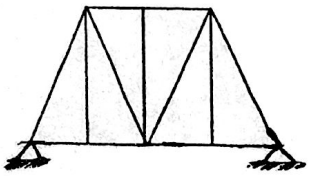
Q.8. Determine the Degree of Determinacy forms the following Frame structure?

Sol":

Now that, $3m+r = 3 \times 10 + 8 = 38$ $3j+s = 3 \times 9 + 0 = 27$ As, $3m+r > 3j+s$ the structure is Indeterminate and Stable So, Degree of Determinacy, i $= [m-(2j-r)]$ $\Rightarrow i = [10-(2 \times 9 - 8)]$ $\Rightarrow i = 0$	Given data, m = member = 10 r = reaction = 8 j = joint = 9 s = internal hinge = 0	

Q.9. Determine the Degree of Determinacy forms the following Truss structure?

Sol":

Now that, $m+r = 13 + 4 = 17$ $2j = 2 \times 8 = 16$ As, $m+r > 2j$ the structure is Indeterminate and Stable So, Degree of Determinacy, i $= [m-(2j-r)]$ $\Rightarrow i = [13-(2 \times 8 - 4)]$ $\Rightarrow i = 1$	Given data, m = member = 13 r = reaction = 4 j = joint = 8	

;

Q.10. What do you meant by "Analysis"?

Ans: Analysis means to find bending moment, shear force, axial force, and torsion at any point of a structure.

1. Planning
2. Designing
3. Implementation
4. Monitoring
5. Evaluation
6. Repairing and Strengthen

Q.11. Define Truss with their types?

Ans: A plane truss can be define as a structure composed of a number of bars, all lying in one plane and hinged together at their ends in such a manner as to form a rigid configuration.

There are –

1. Simple truss, 2. Compound truss, 3. Complex truss, 4. Roof truss, 5. Bridge Truss

Q.12. Write down the difference between Stiffness and Flexibility?

Ans:

Stiffness: Stiffness means that the deformation of structure under unit load. i,e; load per unit deformation.

Flexibility: Flexibility means that the unit load of a structure under deformation. i,e: deformation per unit load.

Q. Draw AFD, SFD & BMD for the following structure by Portal method?

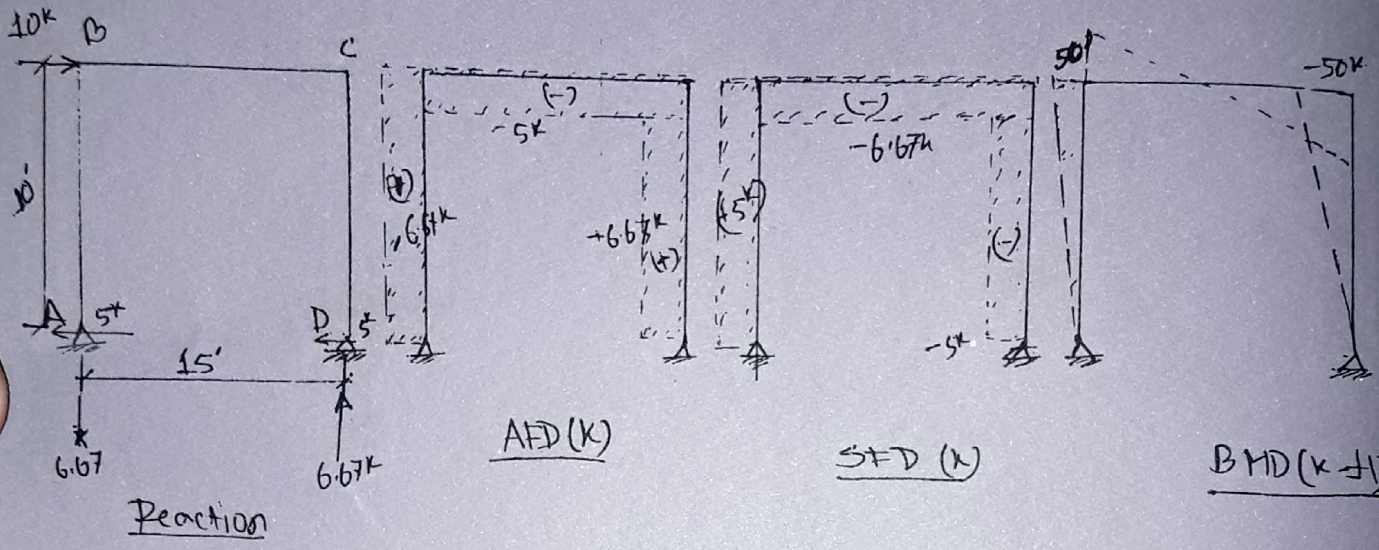
Sol":

i) for this frame. DOSI = 3×3+4−3×4 = 1 (Hinge support 2[r])

i.e; Assumption 1 ⇒ $H_A = H_D = 10/2 = 5^K$

$\therefore \leq M_A = 0 \Rightarrow 10\times10 - V_D \times 15 = 0 \Rightarrow V_D = 6.67^K$

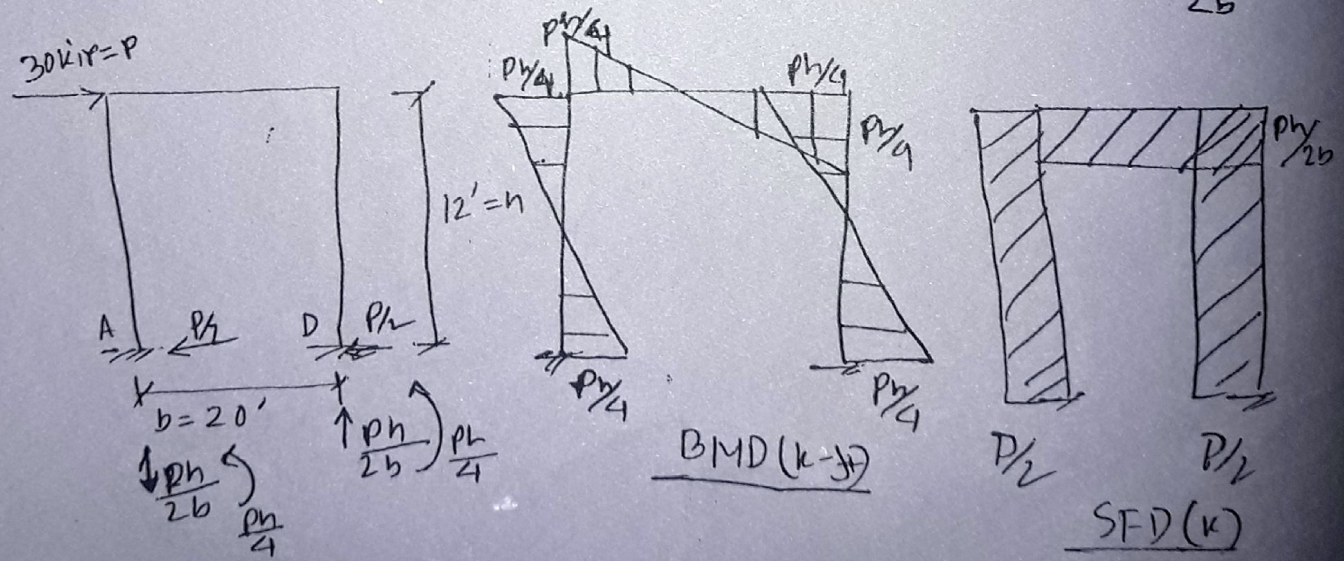
$\leq F_y = 0 \Rightarrow V_A + V_D = 0 \Rightarrow V_A = -6.67^K$



ii) for this tram DOSI = 3×3+6−3×4 = 3 (Fixed support 2[r])

i.e ⇒ $H_A = H_D = 30/2 = 15^K$ $\quad \leq F_y = 0 \Rightarrow V_A = -Ph/2b$

$\leq M_A = Ph/4$ $\quad$ & $V_D = +\frac{Ph}{2b}$



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Q.13. Determine the member force forms the following Truss structure and if the stress of steel is $250 \times 10^3 KN/m^2$ with factor of safety is 2, then find out the area of member AB and CD?

Sol":

$\Sigma M_A = 0$

$\Rightarrow 150 \times 2 - R_C \times 6 = 0$

$\Rightarrow R_C = 50KN$ ($\uparrow$+ve), $R_A = 50KN$ ($\downarrow$+ve)

Joint-A

$\Sigma Fy = 0$

$F_{AB}\sin 33.7^0 + R_A = 0$

$\Rightarrow F_{AB} = R_A / \sin 33.7^0 = 50 / \sin 33.7^0 = 90.14\,KN$ (T) (Ans)

Joint - B (Right side moment for section 1 -1)

$\Sigma M_B = 0$

$F_{CD} \times 2 - R_C \times 3 = 0$

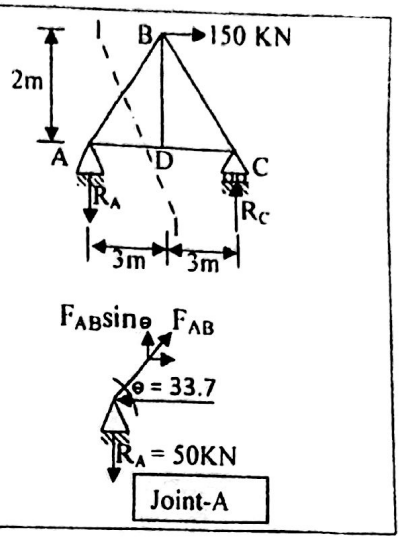
$\Rightarrow F_{CD} \times 2 - 50 \times 3 = 0$

$\Rightarrow F_{CD} = 50 \times 3 / 2 = 75KN$ (T) (Ans)

Allowable stress of steel, $S = 250 \times 10^3 / 2 = 12.5KN/cm^2$

Area of AB arm $= 90.14/12.5 = 7.21cm^2$ (Ans)

Area of CD arm $= 75/12.5 = 6\ cm^2$ (Ans)



Q.14. Define Influence Line (IL) of a civil engineering structure and uses?

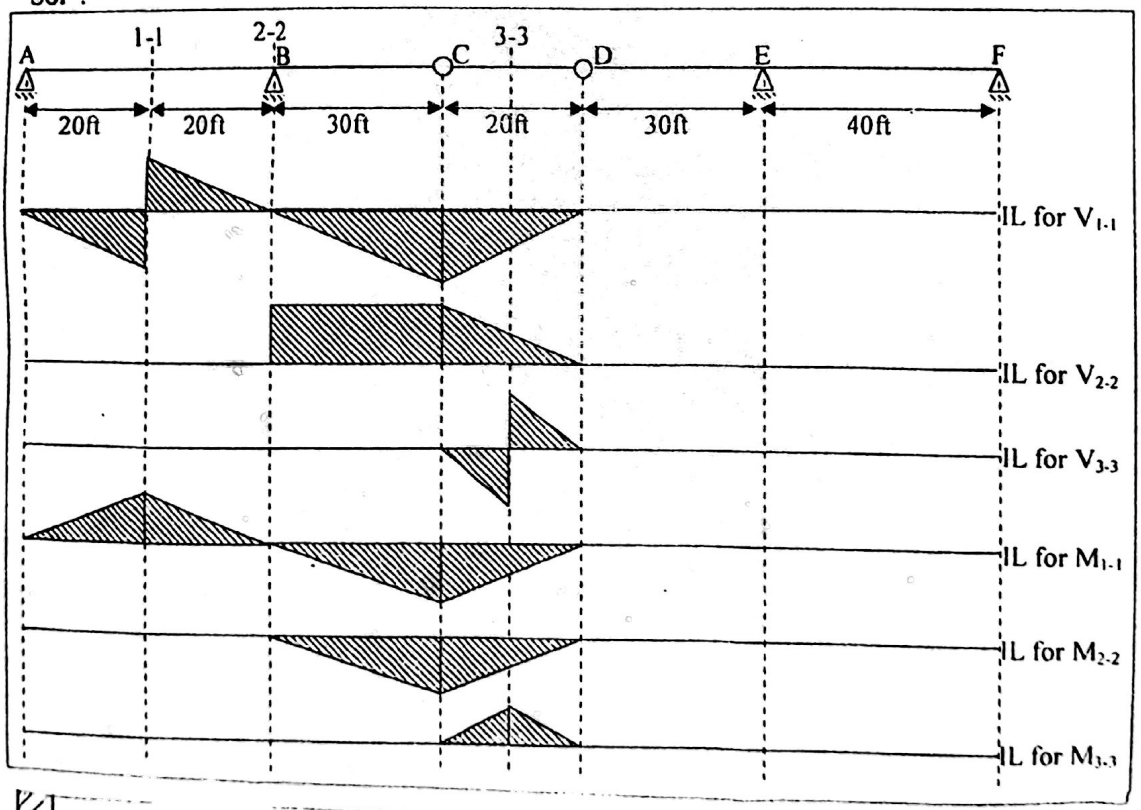
Ans: Influence line is a graphical representation of ordinates of a structural parameter with respect to position of load.

Uses--

1. To determine the structural parameter effect or actual load
2. To determine the position or direction of structural parameter

Q.15. Draw Influence Line (IL) for shear force and bending moment at section 1-1, 2-2, 3-3 at below structure? (or Draw the IL for Fig-01)

Sol":



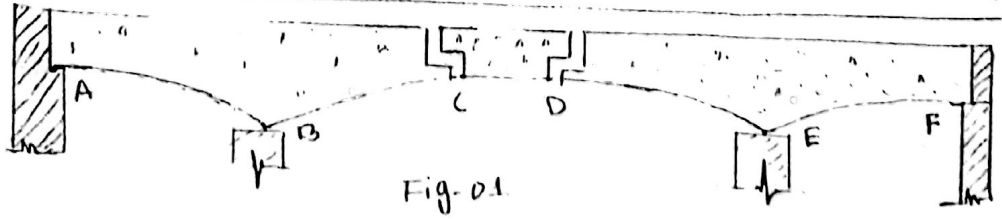
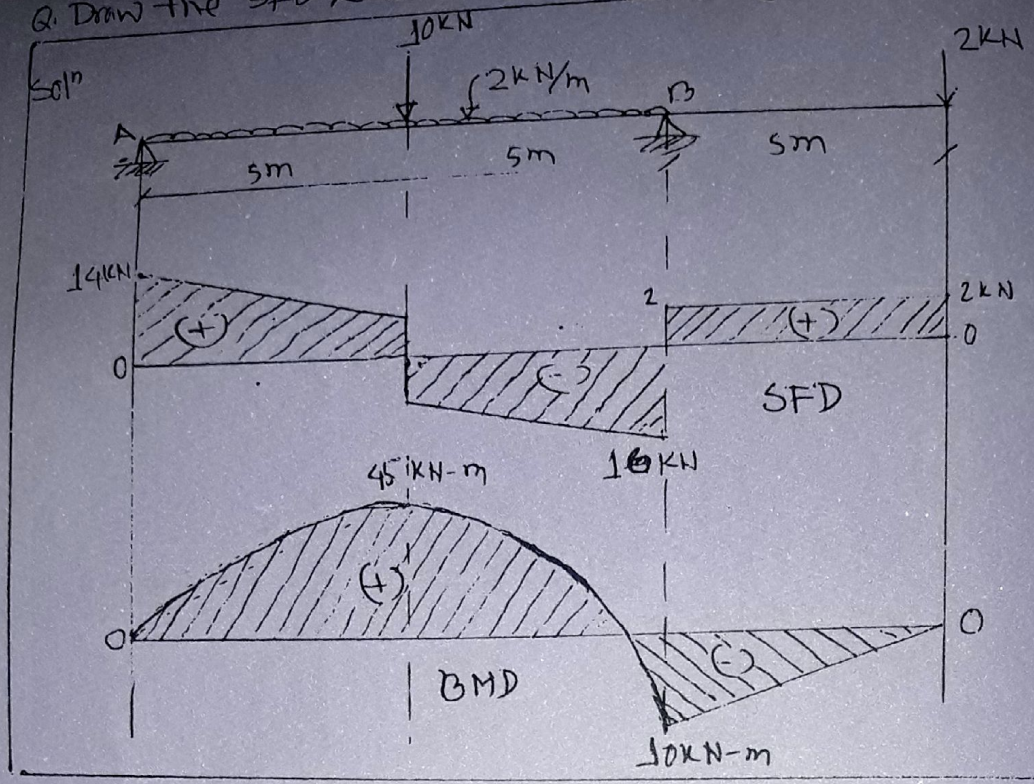


Fig-01

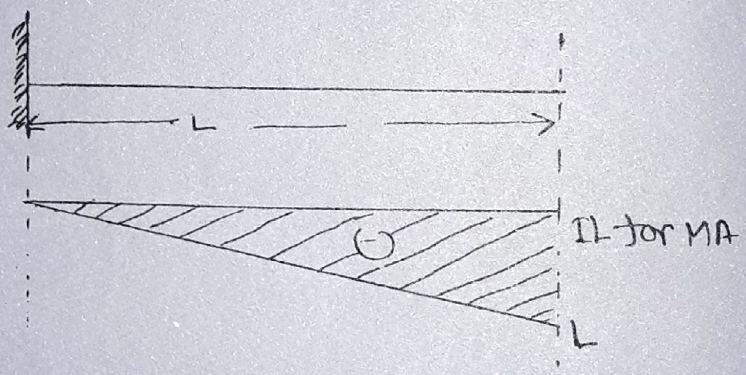
Q. Draw the SFD & BMD for following structure?



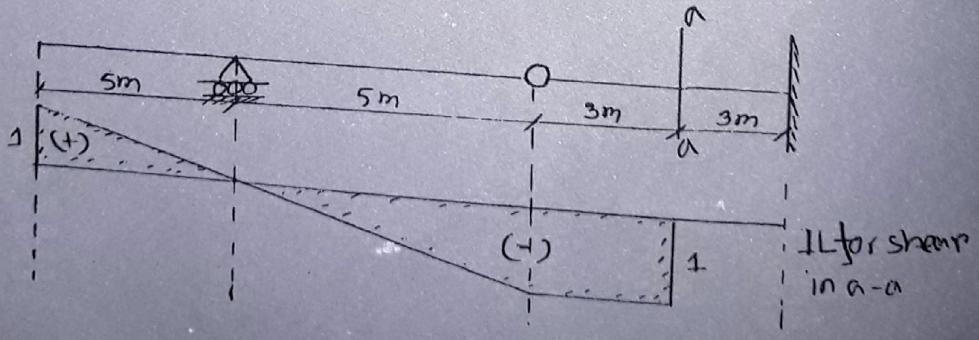
PRI

Q. Draw IL for MA of the cantilever beam?

Soln:



Q. Draw IL for shear in section (a-a)?:



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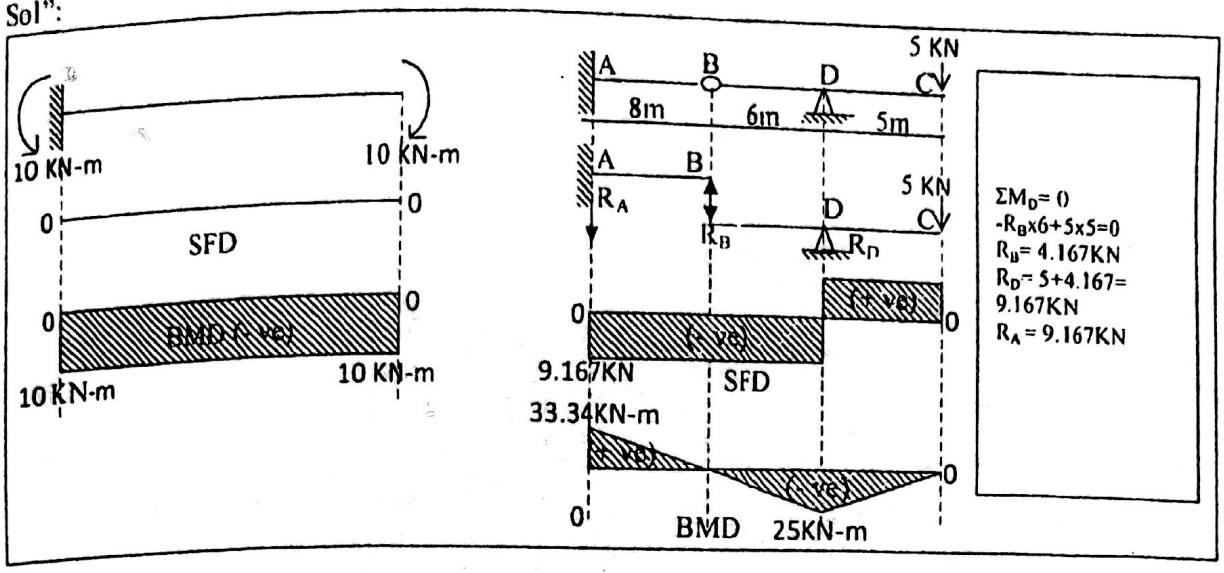
Q.16 Draw the SFD and BMD for following structures?

Sol":

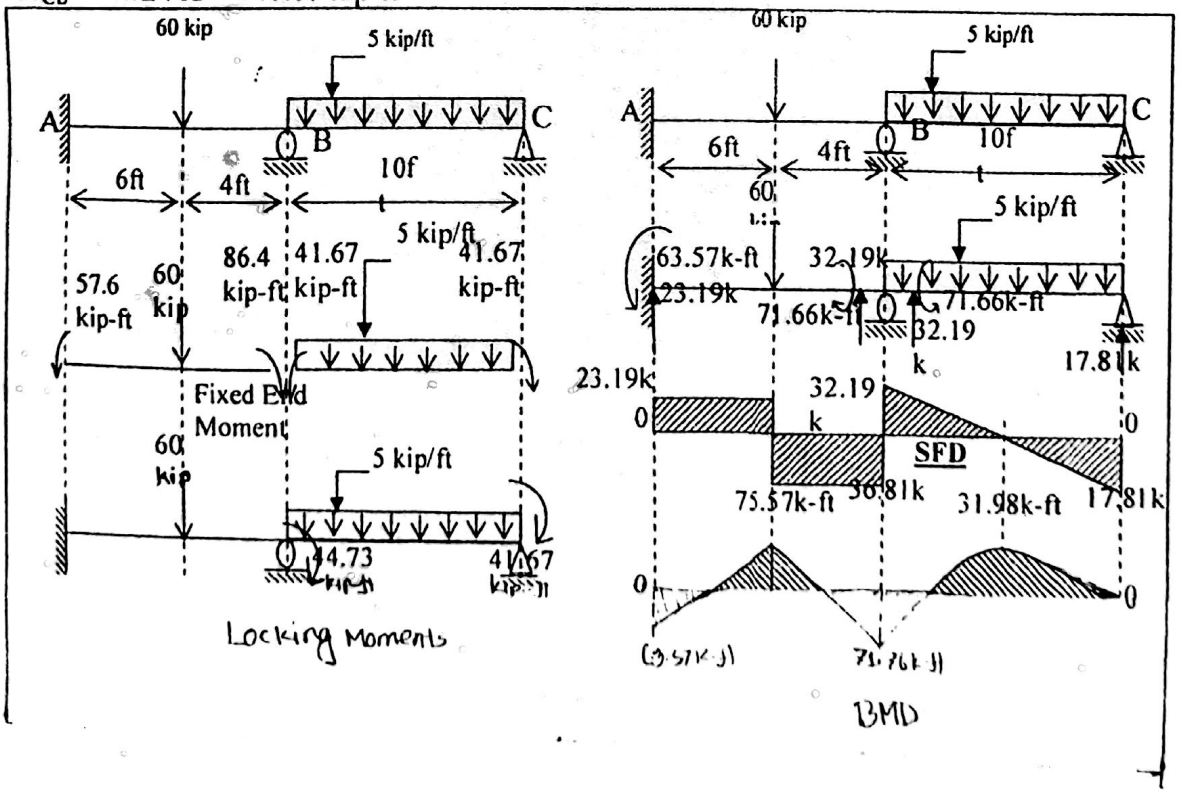


Q.17. Draw BMD and SFD for the following structure by Moment distribution method (I =2.5Ic)?

Sol": (See detailed –Indeterminate Structural Analysis-C.K. Wang,Ph.D.)

Joint	A	B		C
Member	AB	BA	BC	CB
Stiffness factor, k = 4EI/L	1 EI_C	1 EI_C	1 EI_C	1 EI_C
Distribution factor	-	0.5 s=(BA // BA +BC))	0.50 y=(BC // BA +BC))	1.00
FEM(F) BALANCE(B)	-57.6(a) 0	+86.4(b) -22.36 e=((b-c)x s)	-41.67(c) -22.36 f=((b-c)x y)	+41.67(d) -41.67 (g= -d)
FEM BALANCE	-11.18 (e/2) 0	0 (h) +10.42 j=((h-i)x s)	-20.84 (i=g/2) +10.42 k=((h-i)x y)	-11.18 (f/2) +11.18
FEM BALANCE	+5.21 0	0 -2.795	+5.59 -2.795	+5.21 -5.21
Total	-63.57	+71.66	-71.66	0

$M_{AB} = -Pab^2/L^2 = -57.6$ kip-ft, $M_{BA} = +Pa^2b/L^2 = +86.4$ kip-ft, $M_{BC} = wL^2/12 = -41.67$ kip-ft, $M_{CB} = +wL^2/12 = +41.67$ kip-ft



[PPC]

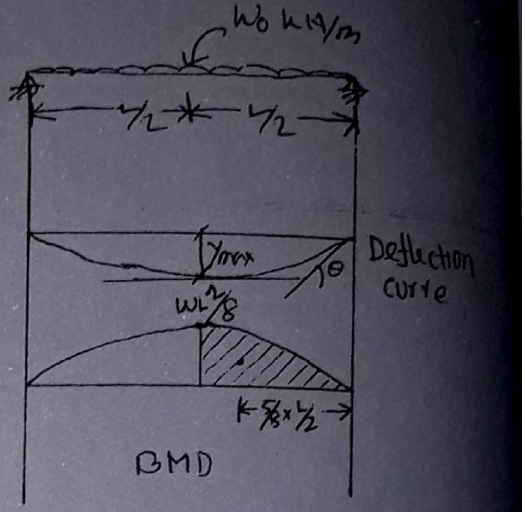
Q. Find out the maximum Deflection of the following structure when EI is constant?

Sol": we know that,

Deflection, $y = \frac{A\bar{m}\bar{x}}{EI}$

$\Rightarrow y_{max} = \frac{\frac{2}{3} \times \frac{L}{2} \times \frac{WL^2}{8} \times (\frac{5}{8} \times \frac{L}{2})}{EI}$

$= \frac{5WL^4}{384EI}$ (Ans)



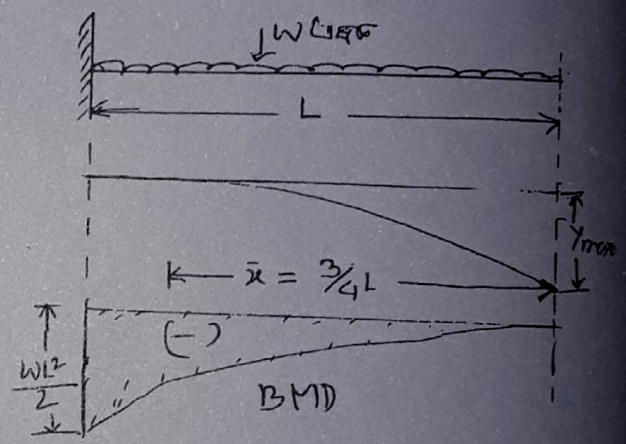
Q. Find out the maximum Deflection of the following structure when EI is constant?

Sol": we know that,

Deflection, $y = \frac{A\bar{m}\bar{x}}{EI}$

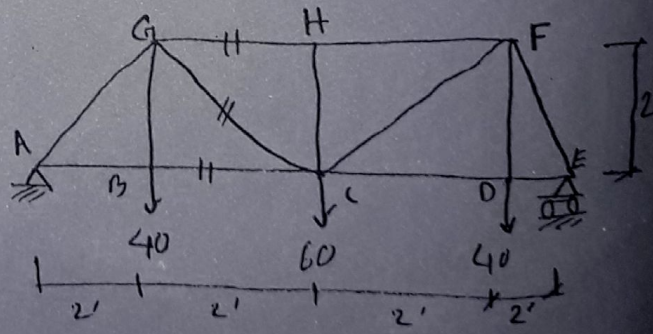
$\Rightarrow y_{max} = \frac{\frac{1}{3} \times L \times \frac{WL^2}{2} \times \frac{3}{4} \times L}{EI}$

$= \frac{WL^4}{8EI}$ (Ans)



[PPC]

(Q) Determine the member force of the following truss?



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Q.18) A suspension cable is supported at two points A & B, A being one meter above B. The distances AB belong 20m. The cable is subjected to 4 loads of 2KN, 4KN, 5KN & 3KN at distance of 4m, 8m, 12m, and 16m respectively. Find the maximum tension of cable, if dip of the cable at point of application of 1st load is 1m with respect to A. Find also the length of cable?

Sol":

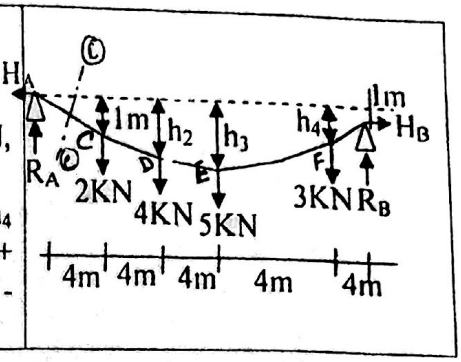
$\Sigma M_B = 0 \Rightarrow R_A \times 20 - H_A \times 1 - 2 \times 16 - 4 \times 12 - 5 \times 8 - 3 \times 4 = 0$

$\Rightarrow 20R_A - H_A = 132$ ---------(i)

$\Sigma M_C = 0 \Rightarrow R_A \times 4 - H_A \times 1 = 0 \Rightarrow 4R_A = H_A$-----(ii)

From (i) & (ii) $\Rightarrow R_A = 8.25KN$, $R_B = 5.75KN$, $H_A = 33KN$, $H_B = 33KN$, $T_{Max} = \sqrt{(R_A^2 + H_A^2)} = 34.02KN$ (Ans)

$\Sigma M_D = 0$, $h_2 = 1.76m$, $\Sigma M_E = 0$, $h_3 = 2.03m$, $\Sigma M_F = 0$, $h_4 = 1.70m$, Length of cable $= \sqrt{(4^2 + 1^2)} + \sqrt{(4^2 + (1.76^2 - 1^2))} + \sqrt{(4^2 + (2.03^2 - 1.76^2))} + \sqrt{(4^2 + (2.03^2 - 1.70^2))} + \sqrt{(4^2 + (1.70^2 - 1^2))} = 20.28m$(Ans)



Q.19) Determine the deflection in a 10m span simply supported beam below 10ton load which 10ton load place in this beam 6m from left end, where $E = 2 \times 10^6$ Kg/cm^2 and $I = 10^5$ cm^4?

Sol":

We know that, Deflection, $y = \frac{A_m \bar{x}}{EI}$

$\Rightarrow t_{B/A} = 1/EI(\frac{1}{2} \times 400 \times 24 \times 10^5) \times (2/3 \times 400) + (1/2 \times 600 \times 24 \times 10^5) \times (400 + 1/3 \times 600) = 2.8cm$

Again,

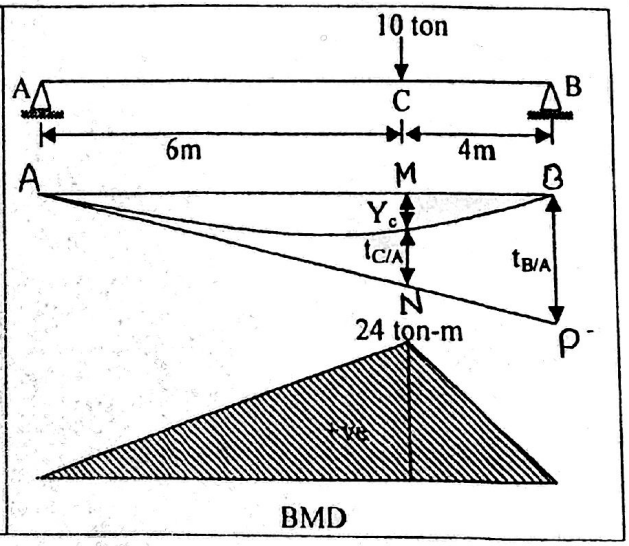
$t_{C/A} = 1/EI(\frac{1}{2} \times 600 \times 24 \times 10^5) \times (1/3 \times 600) = 0.72cm$

ΔABP and $\Delta AMN \Rightarrow$

$MN/600 = t_{B/A}/1000$

$MN = 1.68cm$

$Y_C = MN - t_{C/A} = 1.68 - 0.72 = 0.96cm$ (Ans)



Q.20. What do you mean by seismic load?

Ans: **Seismic load** is one of the basic concepts of earthquake engineering which means application of an earthquake-generated agitation to a building structure or its model. It happens at contact surfaces of a structure either with the ground, or with adjacent structures, or with gravity waves from tsunami→(Japanese word)

Q.21) What do you mean by Base Shear?

Ans: Base shear is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of a structure.

Q.22) Write down the factor of Calculations of base shear (V) ?

Ans: The factor of Calculations of base shear (V) are –

1. Soil conditions at the site
2. Proximity to potential sources of seismic activity (such as geological faults)
3. Probability of significant seismic ground motion
4. The level of ductility and over strength associated with various structural configurations and the total weight of the structure
5. The fundamental (natural) period of vibration of the structure when subjected to dynamic loading

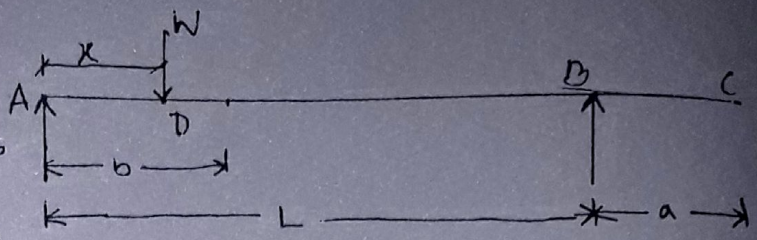
Q. Draw the role of influence line for following structure?

Ans:

$R_A = + \frac{W(L-x)}{L}$ for $0 \le x \le L+a$

$V_{D(left)} = R_A - W = \frac{W(L-x)}{L} - W$ for $0 \le x \le b$

$V_{D(right)} = R_A = + \frac{W(L-x)}{L}$ for $b < x \le L+a$



$M_{D(Left)} = R_A b - W(b-x) = \frac{W(L-x)}{L} b - W(b-x)$ for $0 \le x \le b$

$M_{D(right)} = R_A b = \frac{W(L-x)}{L} b$ for $b \le x \le L+a$

Now,

$R_A = \frac{1(8-3)}{8} = \frac{5}{8} = 0.625$

$x = 0, R_A = 1$

$x = 3, R_A = 0.625$

$x = 8, R_A = 0$

$x = 10, R_A = -0.25$

$V_{D(Left)} = \frac{W(L-x)}{L} - W$

$x = 0, V_D = 0,\ x = 3, V_D = -0.375$

$V_{D(right)} = \frac{W(L-x)}{L}, x = 3, V_D = +0.625$

$x = 8, V_D = 0$

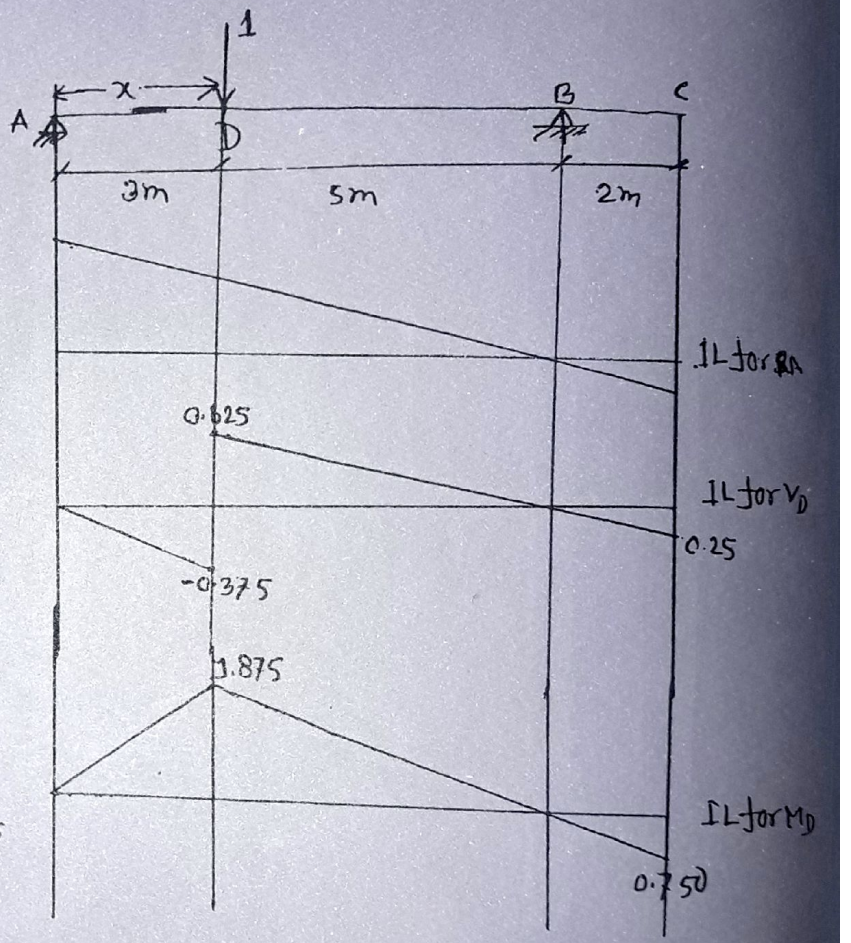
$x = 10, V_D = -0.25$

$M_{D(L)} = \frac{W(L-x)}{L} b - W(b-x), x = 0, M_D = 0$

$\Rightarrow x = 3, M_D = 1.875$

$M_{D(R)} = \frac{W(L-x)}{L} b, x = 3, M_D = 1.875$

$\Rightarrow x = 8, M_D = 0, x = 10, M_D = -0.750$



Q.23. Write down the formula of .

Ans:

Sustained wind pressure $q_z = C_c C_I C_z V_b^2$

Where, q_z = Sustained wind pressure at height z, KN/m^2

C_c = Velocity to Pressure conversion coefficient = 47.2×10^6

C_I = Structure Importance coefficient

Cz = Combined Height and Exposure coefficient

V_b = Basic wind speed in Km/h = Dhaka and Gaibandha-210, Bogra-198, Barisal-256, Bandarban- 200, CTG-260, Kustia,Gazipur-215, Jaipurhat-180, Khulna-238,Bagerhat-252

Now,

Design Wind Pressure, $P_z = C_G C_p q_z$

Where, P_z = Design wind pressur in height z, KN/m^2

C_G = Gust Coefficient

C_P = Pressure coefficient

Structure Importance category	C_I	Structure	Height above ground ,z (m)	C_z		
				Exposure A	B	C
Essential Facility	1.25	Hospital, Fire and Police Station, Garage	0 - 4.5	0.368	0.801	1.196
			6	0.415	0.866	1.263
Hazardous Facility	1.25	To be dangerous to the safety of general people	9	0.497	0.972	1.370
			12	0.565	1.055	1.451
Special structure	1.00	Jail, >300, > 250, > 500, > 5000 persons	15	0.624	1.125	1.517
			18	0.677	1.185	1.573
Standard Structure	1.00	Not in above	21	0.725	1.238	1.623
			24	0.769	1.286	1.667
Low risk Structure	0.80	Agriculture building, Construction facility, Boundary wall	27	0.810	1.330	1.706

Surface	L/B	C_P	Height above ground ,z (m)	C_G		
				Exposure A	B	C
Windward	All	0.80	0 - 4.5	1.654	1.321	1.154
Side wall	All	-0.7	6	1.592	1.294	1.140
			9	1.511	1.258	1.121
			12	1.457	1.233	1.107
			15	1.418	1.215	1.097
			18	1.388	1.201	1.089
			21	1.363	1.189	1.082
			24	1.342	1.178	1.077
			27	1.324	1.170	1.072

Q.24. Write down the Base shear formula under **Seismic** load?

Ans:

Design Base Shear, V = ZICW/R

Where, V = Design Base Shear

Z= Seismic zone coefficient

I = Structure Importance coefficient (see above)

$C = 1.25S/T^{2/3}$

S = Site coefficient for soil characteristics

T = Period of Vibration in seconds = $C_t(h_n)^{3/4}$

h_n = Height above the base to level n (m)

W = Total seismic dead load

R = Response modification coefficient for structural systems

Area	Zone	Z
Rajshahi,Khulna,Barguna,Noakhali	1	0.075
Coxbazar,Comilla,Naogoan,Rangpur	2	0.15
Bogra,Hobogonj,Sylhet,Brahmanbaria	3	0.25

Site soil characteristics	S
Rock,Stiff or dense soil depth less than 61m	1.0
Stiff or dense soil depth exceeds 61m	1.2
Soft to medium stiff clay soil less than 12m	1.5
Soft to medium stiff clay soil exceeds 12m	2.0

Type of Structure	C_t
For steel moment resisting frame	0.083
RCC and eccentric braced resisting frame	0.073
All another structure	0.049

Structure	Details	R
A. Bearing wall	1. Light	8
	2. Shear wall	6
	3. Light steel	4
	4. Braced steel	6
	5. Braced concretc	4
B. Building frame system	1. Steel eccentric	10
	2. Light frame	9
	3. Shear walls	8
	4. Concentric BF	8
c. ;Moment resisting	1. special	12
	2. Intermediate	8
	3. Ordinary steel	6
	4.Ordinary concretc	5
D.Dual system	1.St, Concretc +c1	12
	2. St, Concretc +c3	6
	3. St, Concretc +c4	9

Type of load	W
Storage and warehouse	Minimum 25% of floor live load
Where partition load included	Not less than 0.6 KN/m^2
Total weight of permanent equipment shall be included	

Q.25 What are the methods of Analysis of indeterminate structure?

Ans:

The methods of Analysis of indeterminate structure are –

i) Moment distribution method,

ii) Matrix method

iii) Flexibility method

iv) Slope deflection method

Q. Determine lateral force at the top of building for following data. ?

Sol^n We know,

Base shear, $V = \frac{ZICW}{R}$

$\Rightarrow V = \frac{0.15 \times 1.25 \times 1.11 \times 10365}{12}$

$\Rightarrow V = 179.68$ KN

Now $T > 0.7$ sec

$F_t = 0.07TV < 0.25V$

$= 0.07 \times 1.57 \times 179.68$

$= 8.81$ KN (Ans)

$T \leq 0.7$ sec, $F_t = 0$

Given data

Z = Zone co-efficient

zone-1 = 0.075

2 = 0.25

3 = 0.15

I = Importance factor = 1.25

$C = \frac{1.25S}{T^{2/3}}$ $= \frac{1.25 \times 1.2}{(1.57)^{2/3}}$ $= 1.11$

$T = C_t (h_n)^{3/4}$ $= 0.073 (60)^{3/4}$ $= 1.57$

S = site co-efficient = 1.2

Total load W = 10365 KN

R = Modification factor = 12

$V = \frac{ZICW}{R}$ = Design base shear

Total Design base shear, $V = F_t + \sum_{i=1}^{n} F_i$

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CE-120054

F_t = Concentrated force applied at the top of the structure

$\Rightarrow F_t = 0.07TV \leq 0.25V$ for $T > 0.7$ sec

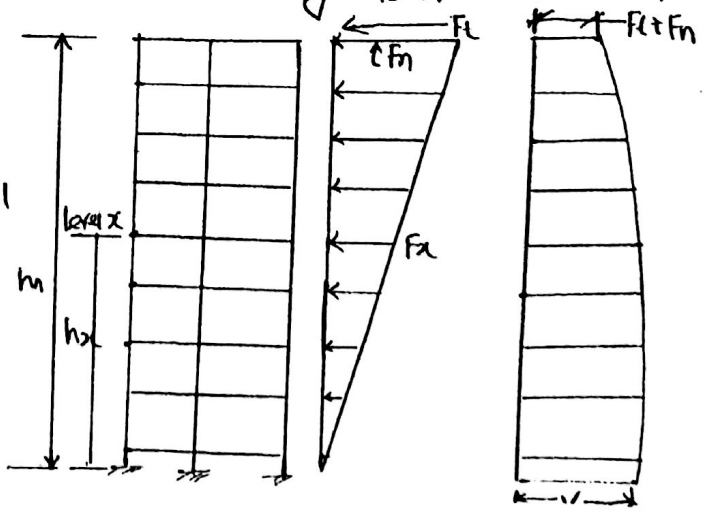
$\Rightarrow F_t = 0$ for $T \leq 0.7$ sec

The remaining portion of the base shear is distributed over the height of the structure, including the top level n, according to the expression,

$$F_x = \frac{(V - F_t) W_x h_x}{\sum_{i=1}^{n} W_i h_i}$$

Where, W_x, = Portion of W at x, i level

h_x, h_i = height to x, i level



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Q.26. The 12m wood framed office building is to be constructed in a "Punghirdighi" area in Joypurhat. The site conditions consist of deep alluvial deposits with a high water table and roof floor DL = 15 psf , typical floor load =12 psf, Partition Load = 15 psf ,Snow Load = 12.5 psf ,Exterior Wall DL = 10 psf .The building Occupancy Category II ,light structure and Class is B?

Sol":

Design Base Shear, V = ZICW/R

=> V = 0.15 x 1 x 0.580 x 222.26 /8 = 2.42kips

Roof	Area	Unit	Weight(kip)
Roof	2040	15	30.6
Exterior Wall	1120	10	11.2
Snow	2040	12.5	25.5
			67.30
Typical Floor	Area	Unit	Weight(kip)
Floor	2040	12	24.48
Exterior Wall	1120	10	22.4
Snow	2040	15	30.6
			77.48

Given data,

Z= Seismic zone coefficient = Zone -2 = 0.15

I = Structure Importance coefficient =1.00

S =Site coefficient for soil characteristics = 1.00

C_t =0.049, h_n = 12m, T = Period of Vibration in seconds = $C_t(h_n)^{3/4} = 0.049 \times (12)^{3/4} = 0.316$ sec

$C = 1.25S/T^{2/3} = 1.25 \times 1 \times /0.316^{2/3} = 0.580$

W = Total seismic dead load = 222.26kips

R = Response modification coefficient for structural systems =8

Total Building	Weight(kip)
Roof	67.3
3rd Floor	77.48
2nd Floor	77.48
Total	**222.26**

Q.27. Determine the centroid of area shown below?

Sol":

$a_1 = \frac{1}{2} \times 18 \times 16 = 144 \text{ inch}^2$

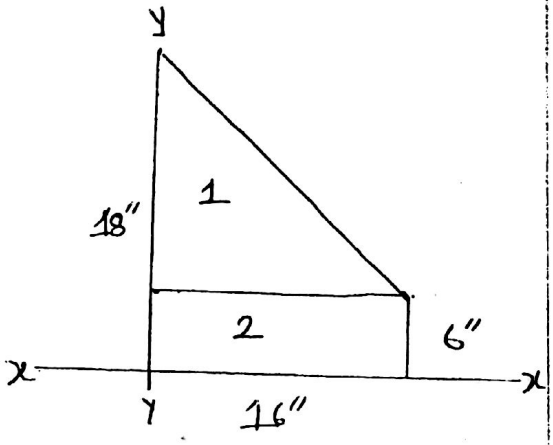
$x_1 = 0 + \frac{1}{3} \times 16 = 5.33$ inch

$y_1 = 6 + \frac{1}{3} \times 18 = 12$ inch

$a_2 = 16 \times 6 = 96 \text{ inch}^2$

$x_2 = 16/2 = 8$ inch

$y_2 = 6/2 = 3$ inch



$$\bar{x} = \frac{a_1x_1 + a_2x_2}{a_1 + a_2}$$

$$\Rightarrow \bar{x} = \frac{144 \times 5.33 + 96 \times 8}{144 + 96} = 6.398 \text{ inch from y-y axis (Ans)}$$

Again, we know,

$$\bar{y} = \frac{a_1y_1 + a_2y_2}{a_1 + a_2}$$

$$= \frac{144 \times 12 + 96 \times 3}{144 + 96}$$

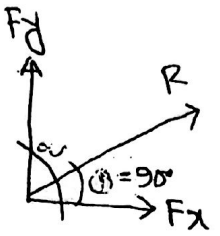
$= 8.4$ inch from x-x axis (Ans)

Q. A resultant of two force act as right angle in between small force. The value of resultant is half of another one. Determine the angle between in two forces?

Soln we know that,

$$\tan\theta = \frac{F_x \sin\alpha}{F_x + F_y \cos\alpha}$$

$$\Rightarrow \tan 90^\circ = \frac{F_x \sin\alpha}{F_x + F_y \cos\alpha} \quad \text{---} (1)$$



Again,

$$R^2 = F_x^2 + F_y^2 + 2F_xF_y\cos\alpha$$

$$\Rightarrow (F_y/2)^2 = F_x^2 + F_y^2 + 2F_xF_y\cos\alpha \quad \text{---} (ii)$$

$(1) \Rightarrow F_x + F_y\cos\alpha = 0 \Rightarrow F_x = -F_y\cos\alpha$

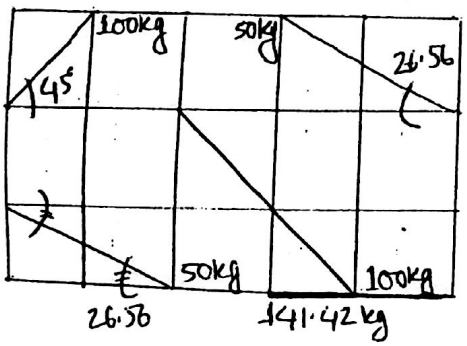
$(ii) \Rightarrow F_y^2/4 = F_y^2\cos^2\alpha + F_y^2 - 2F_y^2\cos^2\alpha$

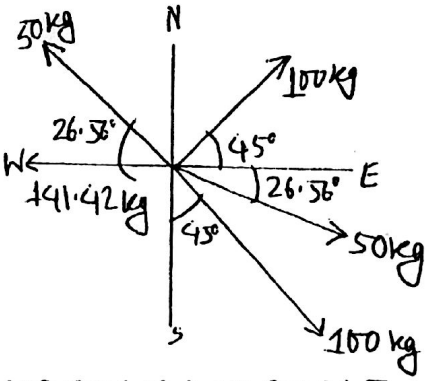
$\Rightarrow F_y^2/4 = F_y^2(1 - \cos^2\alpha)$

$\Rightarrow F_y^2 = 4(1 - \cos^2\alpha)F_y^2 \Rightarrow 1 - \cos^2\alpha = \frac{1}{4} \Rightarrow \alpha = 150^\circ$ (Ans)

Q. Determine resultant force x direction for the following force. Size of box 1cmx1cm Unit weight of force in given kg.

Soln:





Now $(\rightarrow +ve)\ \Sigma H_F = 100\cos 45^\circ - 50\cos 26.56^\circ + 100\sin 45^\circ + 50\cos 26.56 - 141.42$

$= 0$

$(\uparrow +ve)\ \Sigma V_F = 100\sin 45^\circ + 50\sin 26.56^\circ - 100\cos 45^\circ - 50\sin 26.56^\circ$

$= 0$

We know that, $R = \sqrt{[(\Sigma V_F)^2 + (\Sigma H_F)^2]}$

$= 0$ (Ans)

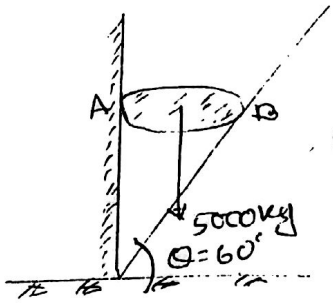
Q.28 Determine RA & RB for following figure?

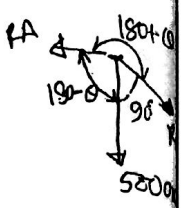
Soln:

We know that, Lamis theorum,

$$\frac{RA}{\sin 90^\circ} = \frac{RB}{\sin(180-\theta)} = \frac{5000}{\sin(180+\theta)}$$

$$\Rightarrow \frac{RA}{\sin 90^\circ} = \frac{RB}{\sin 120^\circ} = \frac{5000}{\sin 240}$$





Now, RA = +5773.50 kg
& RB = +5000 kg } (Ans)

Q.29 Determine radius of gyration about axis Z-Z and also determine moment of inertia of x-x axis?

Soln:

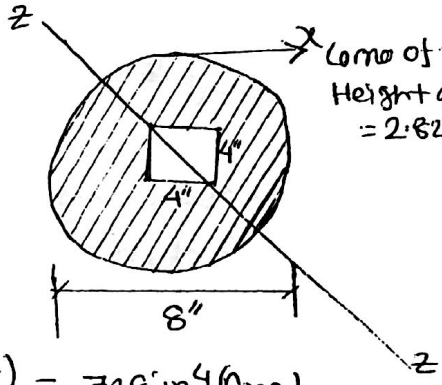
We know, radius of gyration, $K_{zz} = \sqrt{\frac{I_{zz}}{A}}$ --①

$$I_{zz} = \frac{\pi \times 8^4}{64} - 2 \times \frac{5.66 \times 2.828^3}{12}$$

$$= 179.73 \text{ in}^4$$

$$A = \frac{\pi \times 8^2}{4} - 4^2 = 34.24 \text{ in}^2$$

① $\Rightarrow K_{zz} = \sqrt{\frac{179.73}{34.24}} = 2.29 \text{ in}$ (Ans)



Cone of triangle =
Height of triangle = 2.828

Now, $I_{xx} = \left(\frac{\pi 8^4}{64} + \frac{\pi 8^2}{4} \times 4^2\right) - \left(\frac{4 \times 4^3}{12} + 4 \times 4 \times 4^2\right) = 728 \text{ in}^4$ (Ans)

$I_{xy} = \left(\frac{\pi 8^4}{64} + \frac{\pi 8^2}{4} \times 4^2\right) - \left(\frac{4 \times 4^3}{12} + 4 \times 4 \times 4^2\right) = 728 \text{ in}^4$ (Ans)

Q.30. Write down important note?

Ans: 1 HP = 550 ft-lb/sec = 746 Watt = 4500 kg-m/min = 75 kg-m/sec

efficiency $\delta = \frac{P_{out}}{P_{in}}$

$P_{in} = IHP = SHP$

$P_{out} = BHP = WHP$ for pump

for engine, $IHP = FHP + BHP$

or, $HP = \frac{HQ}{3960}$ → H = total lift head (ft)
Q = volume of water (gpm)

$HP = \frac{HQ}{1715}$ → H = inch
Q = lb/min

IHP = Indicate Horse power
FHP = Friction Horse power
BHP = Break Horse power

$H = h_s + h_f + h_v$
⇒ h_s = static head
⇒ h_f = friction head
⇒ h_v = velocity head

Q. A pump lifts 10,0000 litre of water per hour against a total head 20m. Compute the water horse power of that pump?

soln:

we know that,

$$HP = \frac{mgh}{t}$$

$$\Rightarrow HP = \frac{10,0000 \times 9.81 \times 20}{3600 \times 746}$$

$$= 7.30 \text{ HP (Ans)}$$

Given data,

$m_1 = 100000$ litre $= 10,0000$ kg

$\Rightarrow m = 100000$ kg

$g = 9.81 \text{ m/sec}^2$, $t = 1h = 3600 \text{sec}$

$h = 20 \text{m}$ $\quad 1 \text{HP} = 746 \text{ watt}$

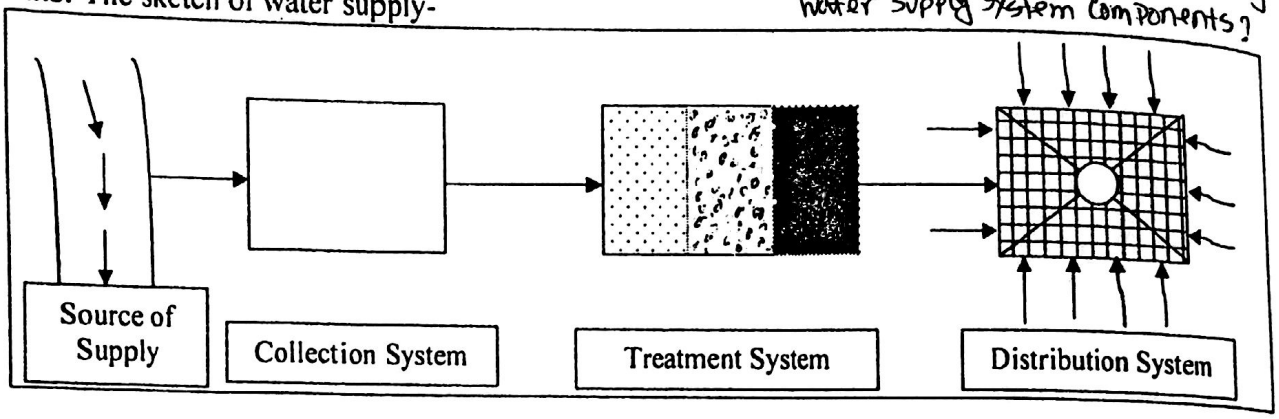
ENVIROMENTAL ENGINEERING

Q.1. What is Leaching?
Ans: Leaching the process of dissolving, the soluble salts and removing them from the layers by downward movement of water.

$$Na_2CO_3 + Ca_2So_4 \rightarrow Na_2So_4 + Ca_2CO_3$$

Q.2. What are the objective of water supply?
Ans: The objectives of water supply is-
1. To supply water in adequate quantity
2. To supply safe and wholesome water to the consumer
3. To make water easily available to the consumer

Q.3. Write down the essential element of water supply with sketch? Or, Write down the name of water supply system components?
Ans: The sketch of water supply-



Q.4. What are the basic consideration of source of supply?
Ans: The main consideration in source of supply is-
1. Quantity of water
2. Quality of water
3. Cost

Q.5. What is water treatment? Write down the objective of water treatment?
Ans: The parameter which makes water is unacceptable to consumer the process whose parameter remove is called water treatment.
Objectives are-
1. Safe to drink
2. Pleasant to test
3. Suitable for domestic uses

Q.6. Write down the most common method of water treatment?
Ans: The methods are-

1. Plain Sedimentation	5. Aeration	9. Water softening
2. Sedimentation with coagulation	6. Arsenic removal	10. Demineralization
3. Filtration	7. Iron removal	11. Desalinization
4. Disinfection	8. Activated carbon application	12. Fluoridation

Q.7. What is Plain Sedimentation?
Ans: This is the process of causing heavier solid particle in suspension both organic and inorganic to settle by retaining water in a tank or basin.

Q.8. Define terminal or settling velocity?
Ans: The heavier particle will move quickly to the bottom within an accelerate velocity unless drag force equals to gravitational force after that the particle will move with constant velocity is called settling velocity or terminal velocity.

(Q) What are the types of water distribution system?

Ans: The types are

i) Gravity flow system ii) Direct pumping system iii) Pumping & storage system

(Q) Write down the formula of peak design flow for water distribution?

Ans: peak design flow,

$$Q = \frac{fqP_f}{(1 - 0.01w)}$$

$$\Rightarrow Q = \frac{fq\,Pp(1+r)^n}{(1-0.01w)} \quad \text{---} (1)$$

Where,

P_f = future population = $Pp(1+r)^n$

Pp = Present population

n = year (Design period)

r = population rate = growth $\sqrt[n]{\frac{P_2}{P_1}} - 1$

Q = peak design flow per day (L/day)

f = peak factor → rural = 3, Upazila = 2, Zila = 2, City corporation = 1.5

q = water demand per capita per day

w = loss & wastage (%)

Q. Calculate the peak water demand of a rural community having a present population 500 for design period of 5 years. The average per capita water consumption is 50 LPCD with a peak factor of 3. The population growth rate 2% and loss & wastage is 20%?

Soln: We know that

Design Peak water demand, $Q = \frac{fq\,Pp(1+r)^n}{(1-0.01w)}$

$$\Rightarrow Q = \frac{3 \times 50 \times 500 (1+0.02)^5}{1 - 0.01 \times 20}$$

$$= 103507.58 \text{ L/day}$$

$$= 103.5 \text{ m}^3\text{/day} \quad \text{(Ans)}$$

Given data,

Peak design flow, $Q = ?$

$f = 3$

$Pp = 300$ nos

$n = 5$ years

$q = 50$ lpcd

$r = 2\% = 0.02$

$w = 20\%$

(Q) What do you ment. Per Capita water Demand (q) & factor affecting?

Ans:

Per capita water demand (q) = $\frac{\text{Total yearly water required of the city in Litre}}{365 \times \text{Design Population}}$

The factors are –

1) Population distribution
2) Climate condition
3) Quality of water
4) Pressure of water
5) Nature of supply
6) water source
7) Sanitation
8) Site of city
9) water rates

Q.9. Write down the formula of settling velocity?

Ans:

Valid for particle size 0.1cm dia and Re≤1	**Valid for particle size greater than 1cm dia and Re<2000**
$Vs = g/18 \times (s-1)d^2/\gamma$ ----------(i) This equation is called stocks law Vs= Settling velocity g= acceleration due to gravity s= specific gravity of the particle d= diameter of the particle γ = kinematic viscosity of water	$Vs = [\sqrt{(4g/3Cd)}] (s-1)d$ ----------(i) This equation is called Newton's law Vs= Settling velocity g= acceleration due to gravity s= specific gravity of the particle d= diameter of the particle Cd = Newton's co efficient of drag

Q.10. Write down the factor of settling velocity?

Ans: The settling velocity is depends upon the following factor-

1. Horizontal flow velocity of water
2. Shape and size of the particle
3. Specific gravity of the particle
4. Density of water
5. Viscosity of water

Q.11) Write down the design criteria for plain sedimentation tank?

Ans:

SOR = Q/BL = 0.20 to 1 m/hr H= 1.5m to 2.0m T= BLH/Q = 1hr to 3hr L/B = 3 to 8 **V = QT----------for rectangle tank** **$V= D^2[0.011D + 0.786H]$-----for circular tank**	SOR= Surface Loading or Surface overflow rate Q= Discharge B= Width of tank L = Length of tank T=Time for horizontal flow or Detention time V= Volume of tank D= Dia of tank

Q.12) If the flow for water supply is $1000m^3$/day. Design size of plain sedimentation tank for a detention period of 2hr .Assume B:L= 2:3 and tank depth 2m?

Sol":

We know that, Q=V/T => 41.67 =LBH / T => 41.67= 1.5B x B x 2 / 2 => B = 5.27m ≈5.5m So, L= 1.5 x 5.5 = 8.25m **Check** SOR = Q/BL = 41.67/(8.25 x 5.5) = 0.92m/h [in between 0.2 to 1 m/hr], So ok for L and B	Given data, SOR= Surface Loading or Surface overflow rate Q= $1000m^3$/day= $41.67m^3$/hr B= Width of tank=? L = Length of tank=1.5B=? T = 2hr H= 2m

Q.13. Write down the difference between plain sedimentation and sedimentation with coagulation?

Ans:

Plain Sedimentation	Sedimentation with Coagulation
1) Large particle settlement	1) Colloidal particle settlement
2) Not use chemical	2) Iron and Aluminum coagulates use
3) Test no change	3) Test change
4) Low cost and easy process	4) Its costly more than plain sedimentation

(Q) What is Disinfection & sterilization?

Ans: Disinfection: Disinfection is the destruction of all pathogenic organism.

Sterilization: Sterilization is the total destruction & removal of all micro-organism.

(Q) Write down the good characteristics of good chemical disinfection

Ans: The characteristics are -

1) Quick & effective killing of all micro organism
2) Not imparting test, order, color/turbidity
3) Easy to handle, transport, apply & control
4) Readyly available & moderate cost
5) Easy to measured in water

(Q) Write down the formula of (disinfection timing)?

Ans: For Cl2 disinfection

$$t^2 = \frac{3}{k} \log_{10} \frac{No}{Nt} \quad ---①$$

where, t = disinfection period killing of micro-organism (sec)

No = Initial no of organisms (nos)

Nt = No of organism at time 't' (nos)

for pH = 7 → (k = 1.6 × 10⁻² /sec = reaction rate = for free residuals

→ k = 1.5 × 10⁻⁵ /sec = for combined residuals

(Q) Compare the contract period necessary to give kills E-coli of 99.99 nos in water with a) free chlorine residuals of 0.2 mg/L b) Combined chlorine residuals of 1 mg/L, k values are 10^{-2}/sec & 10^{-5}/sec respectively?

Soln:

a) We know that

$$t^2 = \frac{3}{k} \log_{10} \frac{No}{Nt} = \frac{2}{10^{-2}} \log_{10} \frac{100}{0.01}$$

$\Rightarrow t = 28.28$ sec (Ans)

Given data,
No = 100 nos
Nt = 100 - 99.99 = 0.01 nos
k = 10^{-2}/sec
t = ?

b) Again, We know that,

$$t^2 = \frac{3}{k} \log_{10} \frac{No}{Nt}$$

$$\Rightarrow t = \frac{2}{10^{-5}} \log_{10} \frac{100}{0.01}$$

$\Rightarrow t = 894$ sec (Ans)

Given data,
No = 100 nos
Nt = 100 - 99.99 = 0.01 nos
k = 10^{-5}/sec
t = ?

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(Q.14) What is coagulation and write down the most common coagulants?
Ans: Coagulation is the process of addition of a salt that produces positive ions in water and application of rapid agitation for good mixing leading to destabilization of colloids and promotion of frequent contact among the particles.
The most common coagulant are-
1. Aluminum Sulphate [$Al_2(SO4)_3,nH_2O$]
2. Ferric Sulphate [$Fe_2(SO4)_3,9H_2O$]
3. Ferric Chloride [$Fe_2Cl_3,6H_2O$]
4. Ferrous Sulphate [FeSO4]

Flocculation: Flocculation is a process of aggregation of the particles into large unit

Q.15. Define filtration with write down there types?
Ans: Filtration is a process of water purification which water is allowed to pass through a bed
Types of filtration –
1. Roughing filter
2. Slow- Sand Filter(SSF)
3. Rapid- Sand filter(RSF)
4. Mixed Media Filter(MMF)

Q.16. Write down the difference between SSF and RSF?
Ans:

SSF	RSF
1. Rate of filtration 0.1 to 0.3 $m^3/m^2/hr$	1. Rate of filtration 5 to 15 $m^3/m^2/hr$
2.No pretreatment is required	2. Pretreatment is effective
3. Low cost of operation and maintenance	3. Relatively high cost of operation and maintenance
4. Total no of unit, $n = 0.5\sqrt{A}$ Where, n= Total no of rectangle unit A= Total surface area(m^2)	4. Total no of unit, $n = 0.04\sqrt{Q}$ Where, n= Total no of rectangle unit Q= Plant capacity (m^3/day)

Q.17. Write down the operational difficulties of RSF?
Ans: The operational difficulties of RSF are-
1. Negative head and air binding
2. Cracking of filter bed
3. Formation of mud ball
4. Jetting and sand boils
5. Sand leakage into the under drain system

(Q.18) What do you mean by MUD balls?
Ans: Mud balls consist of grain of sand and chemical flocks carried over from the coagulating basin.

Q.19. A rapid sand filter is to be designed for a capacity of 27000 m^3/day, what should be the number and size of the units and calculate the percentage of filtered water required to wash the filter bed and the capacity of the wash water tank?
Ans:

Assume, Rate of filtration =5$m^3/hr/m^2$ Rate of washing =35 $m^3/hr/m^2$ Length of filter run= 24hr including for filter washing and 15min for resettlement of sand bed Filtration period = 24-15=23h 45min=23.75hr Filtration rate = 5x23.75= 118.75 $m^3/day/m^2$ Filter area required=27000/118.75 = 227.36m^2 No of filter unit, $n=0.04\sqrt{Q} = 0.04\sqrt{27000}$	=> n = 6.57≈7 Area of each unit = 227.36/7 = 32.48 m^2 Let L=1.5B So, LB =32.48 => 1.5B x B =32.48 => B = 4.65m and L = 7m Size of filter= 4.65m x 7m (Ans) Actual area provided = 7 x 4.5x7 = 227.85m^2

Wash water required = $35 \times \frac{5}{60} \times 227.85 = 665m^3$
Main capacity of wash water tank = $665m^3$
Percentage of filtered water required for washing = $\frac{665 \times 100}{27000} = 2.46\%$ (Ans)

Q. Write down the name of disinfection?

Ans: The disinfections are -

1) Chlorine (Cl_2)
2) Potasium per Manganent
3) Ozone (O_3)
4) Heat
5) Ultra-violet rays

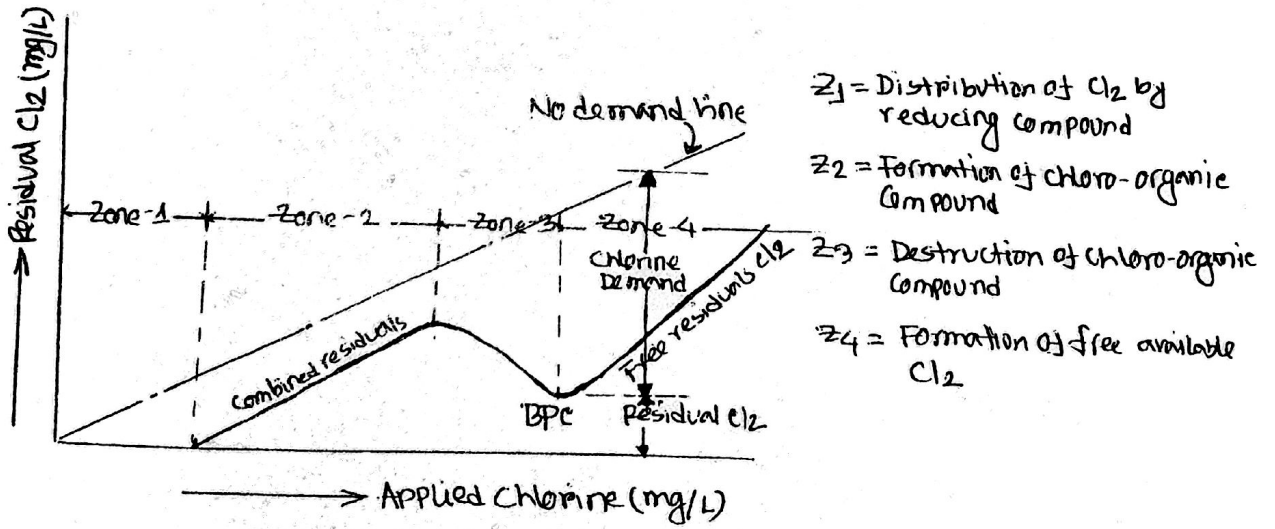
Q. Why Cl_2 is used for disinfection?

Ans: Because of -

1) It is readily available in gas, gas & powder.
2) It is cheap
3) It is easy to apply
4) Easy to transport & not harmfull to man
5) It is very toxic to organism

Q. Draw the sketch of chlorination curve or Break point of chlorination?

Ans: The addition of chlorine at the break is termed as break point chlorination. It is also known as free residual chlorination.



BPC

BWE

Q. Water to be disinfection by bleaching powder [Ca(OCl)Cl] having Cl_2 of 2.3 mg/L. If the 5000 m³/day daily Ca(OCl)Cl powder is required 25% per kg. Find the amount of Ca(OCl)Cl required per day?

2015 ms

Soln: Assume residual Cl_2 = 0.2 mg/L

Total Cl_2 demand = 2.3 + 0.2 = 2.5 mg/L

Total Cl_2 for water = 5000 m³/day × 2.5 mg/L = 5000 × 1000 L/day × 2.5 mg/L

= 12.5 × 10⁶ mg/day

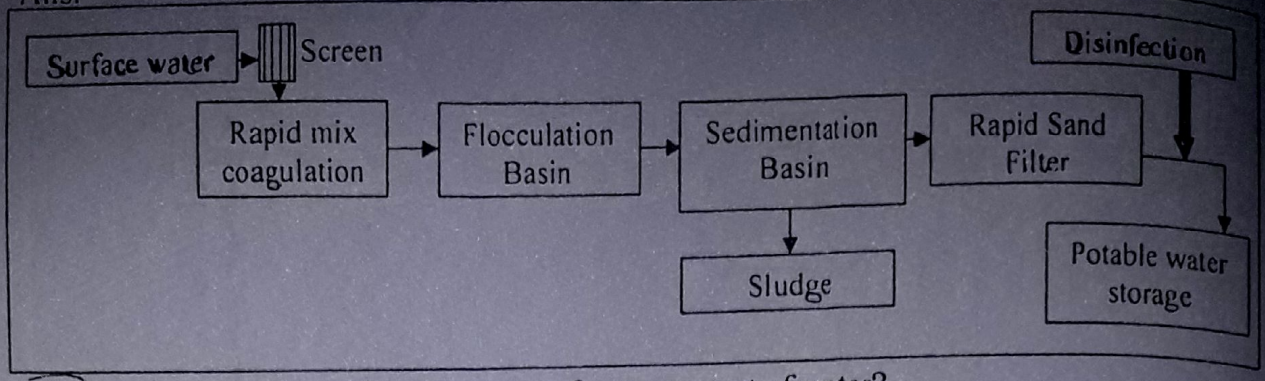
= 12.5 kg/day

Now, for 25 kg Cl_2, required Ca(OCl)Cl = 100 kg

12.5 kg " " " = $\frac{100 \times 12.5}{25}$ = 50 kg/day (Ans)

(Q.20) Draw the flow chat of conventional water treatment system?

Ans:



(Q.21) Write down the quality parameter of water or test of water?

Ans: The quality parameter of water are-

1. Physical quality parameter
   a) Temperature, Color, Turbidity, Odour test
2. Chemical quality parameter
   a) Total Solids, Hardness, Chlorine, P^H Value, Iron, Arsenic, Lead, Copper and Fluorine etc.
3. Biological quality parameter
   a) BOD (Biochemical Oxygen Demand)
   b) COD (Chemical Oxygen Demand)
4. Bacteriological quality parameter
   a) TOC (Bacteria. Coli=B-Coli, Escherichia. Coli=E-Coli)
   b) ThoD (Theoretical Oxygen Demand)

(Q.22) Write down the difference between BOD, COD and ThoD?

Ans:

BOD	COD	ThoD
The amount of oxygen is required to oxidize the organic matter of waste by the bacteria	The amount of oxygen is required to oxidize organic matter of waste water with a acid dichromate	The amount of oxygen is required to oxidize the organic matter of the waste water completely to carbon –dioxide
Bacteria can be oxidize only bio-degradable organic matter	Bacteria oxidize bio-degradable and non bio-degradable organic matter	$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ 180+192------> 300 mg/L glucose ThoD= 192 x 300/180 = 320mg/L

(Q.23) Define BOD_5?

Ans: The amount of oxygen required for the oxidation of waste by the bacteria about 5 days at 20^0C temperature is called 5 days of BOD (Bio- Chemical Oxygen Demand) or BOD_5

(Q.24) Why COD is greater than BOD?

Ans: COD process oxidizes almost all organic components to CO_2 and H_2O and the reaction proceeding to more than 95% completion; as a result the COD is greater than BOD.

(Q.25) A sample of sewage was incubated for 2 days and the sample BOD was observed to be 165ppm at 20^0c. Determine 5 days 20^0c & 10 days 20^0c BOD values, Assume K $(20^0c) = 0.1d^{-1}$?

We know that,

$Y = L_1(1 - e^{-kt_1})$

$\Rightarrow 165 = L_2(1 - e^{-0.1 \times 2})$

$\Rightarrow L_2 = 447.0$ ppm

Again,

$Y = L_2(1 - e^{-kt_2})$

$\Rightarrow Y = 447(1 - e^{-0.1 \times 5}) = 306$ ppm (Ans)

Again,

$BOD_{10} = L_2(1 - e^{-kt_2})$

$= 447(1 - e^{-0.1 \times 10})$

$= 282.56$ mg/L or ppm (Ans)

Given data,

BOD removed, $Y = 165$ ppm, $t = 2$ day

Ultimate BOD, $L_5 = ?$ & $L_{10} = ?$

$t_1 = 5$ day & $t_2 = 10$ day

$k = 0.1\ day^{-1}$

Q. Extra. 2.5ml of raw sewage has been diluted to 250 ml and D.O Concentration of diluted sample at the begining of BOD test was 8 mg/L and 3 mg/L after 5 days incubation at 20°c Determine the BOD of raw sewage?

Sol'n:

We know that,

Dilution Fraction (DF) = $\frac{\text{Wastewater}}{\text{Raw sample}} = \frac{2.5}{250} = 0.01$

Consumed BOD = 8 − 3 = 5 mg/L

BOD of raw sewage = $\frac{\text{Consumed BOD}}{DF} = \frac{5}{0.01}$

= 500 mg/L

= 500 mg/L (Ans)

Formula:
যদি আবেদনপত্রে DO দেওয়া থাকে

$BOD_5 = \frac{DO_i - DO_f}{DF}$

DO_i = Initial BOD
DO_f = Final BOD
DF = $\frac{\text{Waste water}}{\text{raw sample}}$

Q. Write down the formula of BOD determination?

Ans: The rate of BOD removal at any time is proportional of the amount of BOD present at that time.

Mathmatically, $\frac{dL}{dt} = -K_1 L$ ----①

by solving ① ⇒ $L_t = L_o e^{-kt}$ ---②

Where,
L_t = Amount of BOD remaining at time 't'
L_o = Amount of BOD at 't=0'
K = first order rate
t = time

Now, We know that,

Ultimate BOD = remaining BOD + removed BOD

$\Rightarrow L_o = L_t + y$

$\Rightarrow L_o = L_o e^{-kt} + y$

$\Rightarrow y = L_o - L_o e^{-kt}$

$\Rightarrow y \Rightarrow L_o (1 - e^{-kt})$ → BOD formula.

$\Rightarrow BOD_5 = BOD_{ult} (1 - e^{-kt})$ → Another form.

Q. Extra. What is coliform Bacteria?

Ans: These bacteria are always presents in very large number in feces. The average extreta produce about 2×10^9 coliform each day. There are two major group of coliform

i) Fecal coliform bacteria.
ii) Non-fecal coliform Bacteria

Q. What is NBOD?

Ans: The amount of oxygen is reqwired to oxidized the nitrogeneous matter of waste water is called NBOD (Nitrogeneous Bio-chemical Oxyger Demand)

$NH_3 + 2O_2 \rightarrow NO_3^- + H^+ + H_2O$

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Q.26. The 5 days 20^0c BOD of sewage is 276mg/l and the ultimate BOD is 380mg/l. Find the BOD reaction rate?

Sol":

We know that,	Given Data,
$y = L_0(1-e^{-kt})$ $\Rightarrow 276 = 380(1-e^{-k\times5})$ $\Rightarrow 1-e^{-k\times5} = 0.726 \Rightarrow e^{-5k} = 0.274$ $\Rightarrow -5k = \log(0.274) \Rightarrow -5k = -0.5622$ $\Rightarrow k = 0.112/\text{day}$ (Ans)	Removed BOD, $y = 276$ mg/L Ultimate BOD, $L_0 = 380$ mg/L BOD reaction rate $k = ?$ $(\text{day})^{-1}$ $t = 5$ days

Q27. What is hardness?

Ans: Hardness is defined as the concentration of all multivalent metallic cations in solution. For example - Ca^{2+} (Calcium), Mg^{2+} (Magnesium), Al^{3+} (Aluminum), Fe^{2+} (Iron) etc.

Q.28. What is carbonate hardness and non carbonate hardness?

Ans: **Carbonate Hardness:** Carbonate hardness (CH) associated with the anions HCO_3^- and CO_3^{2-}

Non carbonate hardness (NCH): Non carbonate hardness (NCH) associated with other anions except CO_3^{2-} and HCO_3^-

Q.29. What is Alkalinity?

Ans: Alkalinity is a measure of buffering capacity of water and is define as the quantity of ions in water that will reacts to neutralize the H^+ ion.

i,e Total Alkalinity = $HCO_3^- + CO_3^{2-} + OH^- - H+$

Q.30. Write down the formula?

Ans: Equivalent weight = Atomic weight / Valency

For example, EW of $CaCo_3$ = (40+12+16 x 3)/2 = 50g/eq = 50mg/ Milli equivalent

EW of Ca^{2+} = 40/2 = 20mg/Meq

EW of Mg^{2+} = 24/2 = 12mg/Meq

Note : Mg/L of 'X' as $CaCo_3$ = (Concentration of 'X' mg/L / EW of 'X' mg/Meq) x 50mg/meq as $CaCo_3$

Q.31. A sample of ground water has 100mg/L of Ca^{2+} and 10mg/L of Mg^{2+}. Express its Hardness in units of Meq/L and mg/L as $CaCo_3$?

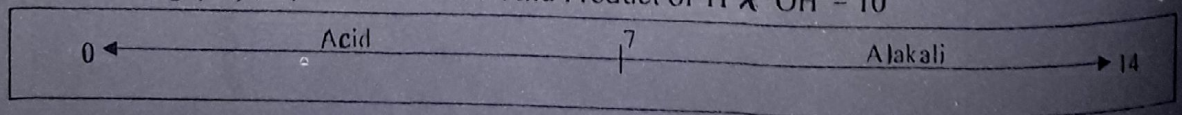
Sol":

We know that,	Again,
Total Hardness = Concentration of Ca^{2+} + Concebtration of Mg^{2+} => TH = (Concentration of 'Ca^{2+}' mg/L / EW of 'Ca^{2+}' mg/Meq) + (Concentration of 'Ma^{2+}' mg/L / EW of 'Mg^{2+}' mg/Meq) => TH = (100/20 + 10/12) = 5.82 Meq/L (Ans)	Total Hardness = Concentration of Ca^{2+} x 50mg/meq as $CaCo_3$ + Concebtration of Mg^{2+} x x 50mg/meq as $CaCo_3$ => TH = (Concentration of 'Ca^{2+}' mg/L / EW of 'Ca^{2+}' mg/Meq) x 50mg/meq as $CaCo_3$ + (Concentration of 'Ma^{2+}' mg/L / EW of 'Mg^{2+}' mg/Meq) x 50mg/meq as $CaCo_3$ => TH = (100/20) x 50 + (10/12) x 50 = 290 mg/L as CaCo3 (Ans)

Q.32. Define P^H?

Ans: The negative logarithm of hydrogen ion concentration is known as P^H.

Or, $P^H = -\text{Log}(H^+)$, Or, $P^{H+} + P^{OH-} = 14$ And Product of $H^+ \times OH^- = 10^{-14}$



Q. A slow sand filtration unit produces 900m³ of water per day. How much Ca(OCl)Cl powder with 30% available Cl_2 will be required per day to treat this water with Cl_2 dose 0.5 mg/L ?

Soln: Assure residual Cl_2 = 0.2 mg/L

Total Cl_2 demand = 0.2+0.5 mg/L = 0.7 mg/L

Total Cl_2 for water = $900\ m^3/day \times 0.7\ mg/L = 900 \times 1000\ L/day \times \frac{0.7}{10^6}$ kg/day

= 0.63 kg/day

for 30 kg Cl_2 required Ca(OCl)Cl = 100kg

0.63 kg " " " = $\frac{100 \times 0.63}{30}$ = 2.1 kg/day (Ans)

Q. A total of 60 kg Ca(OCl)Cl is used one day to disinfection volume of 50mL of water. Find the Cl_2 dose. Assume 33% available Cl_2 in Ca(OCl)Cl

Soln:

Total Ca(OCl)Cl = 60 kg/day

100kg Ca(OCl)Cl required for Cl_2 = 33 kg

60 kg " " " " = $\frac{33 \times 60}{100}$ = 19.8 kg/day

Volume of water = $50\ mL/day$

= 50×10^6 kg/day

Total Cl_2 for water = $\frac{19.8}{50 \times 10^6} = 3.96 \times 10^{-7}$ kg/day = 0.396 mg/L

Assure residual Cl_2 = 0.2 mg/L

Total Cl_2 demand = 0.2 + 0.396 = 0.596 mg/L (Ans)

Q. Write down the note of 'Chlorination' ?

Ans: Chlorination is a form of disinfection where chlorine solution is used

$$Cl_2 + H_2O \rightarrow HCl + HOCl$$

$$HOCl \rightleftharpoons H^+ + OCl^-$$

It is the HOCl (hypochlorous acid) & OCl^- (hypochlorite ion) which are responsible for the disinfection of water

Q. Calculate pH of 1 mg/L of $Ca(OH)_2$?

Soln: The molecular weight of $Ca(OH)_2$ = 40+(16+1)×2 = 74

74 mg/L contain = 2 mole of OH^-

1 " " = $\frac{2}{74}$ = 0.027 mole OH

So, $[OH^-]$ = 0.027

Now, we know, $pOH = -\log[OH^-]$

$\Rightarrow pOH = 1.57$

Now, $pH + pOH = 14$

$\Rightarrow pH = 12.43$ (Ans)

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Q.33. If a water sample after analysis found as H^+ ions concentration of $10^{-8.5}$ moles. Comments about the alkanity of water or acidity of water? if OH^- is $10^{-9.5}$. Find P^H?

Sol":

We know that, $P^H = -\text{Log}(H^+)$ $\Rightarrow P^H = -\text{Log}(10^{-8.5})$ $\Rightarrow P^H = -(-8.5)\ \text{Log}10 = 8.5$ (Alkalinity) (Ans)	Again, $P^{OH} = -\text{Log}(^{OH-})$ $\Rightarrow P^{OH} = -\text{Log}(10^{-9.5}) = 9.5$ Now, $P^{OH} + P^H = 14$ $\Rightarrow 9.5 + P^H = 14$ $\Rightarrow P^H = 14 - 9.5 = 4.5$ (Acid) (Ans)

Q.34. A sample of water at P^H 10 has 32mg/L of Co_3^{2-} and 56mg/L of HCo_3^-. Find the Total Alkalinity as $CaCo_3$?

Sol":

Given data, (i) EW of $Co_3^{2-} = [12 + 16 \times 3]/2 = 30$mg/meq (ii) Con" of Co_3^{2-} as $CaCo_3 = 32/30 \times 50$ mg/meq of $CaCo_3 = 53.33$mg/L (iii) EW of $HCo_3^- = [1 + 12 + 16 \times 3]/1 = 61$mg/meq (iv) Con" of HCo_3^- as $CaCo_3 = 56/61 \times 50$ mg/meq of $CaCo_3 = 45.9$mg/L (v) $P^H = 10$ Again, $P^H = -\text{Log}(H^+)$ $\Rightarrow 10 = -\text{Log}(H^+)$ $\Rightarrow H^+ = -10/\text{Log}_{10} = 10^{-10}$ moles/liter Now, $H^+ \times OH^- = 10^{-14} \Rightarrow OH^- = 10^{-4}$ (vi) EW of $H^+ = [1]/1 = 1$mg/meq (vii) Molecular Unit Wt. $H^+ = 1$ gm/mole (viii) Con" of $H^+ = 10^{-10}$ moles/liter x Molecular Unit Wt. $H^+ = 10^{-10}$ moles/liter x 1 gm/mole = 10^{-7} mg/L	(ix) Con" of H^+ as $CaCo_3 = 10^{-7}/(vi = 1) \times 50$ mg/meq of $CaCo_3 = 5 \times 10^{-6}$mg/L (x) EW of $OH^- = [16+1]/1 = 17$mg/meq (xi) Molecular Unit Wt. OH = 16 + 1 = 17gm/mole = 17000mg/L (xii) Con" of $OH^- = 10^{-4}$ moles/liter x Molecular Unit Wt. $H^+ = 10^{-4}$ moles/liter x 17000 mg/mole = 1.7 mg/L (xiii) Con" of OH^- as $CaCo_3 = 1.7/(X = 17) \times 50$ mg/meq of $CaCo_3 = 5$ mg/L We know that, Total Alkalinity as $CaCo_3 = Co_3^{2-} + HCo_3^- + OH^- - H^+$ $\Rightarrow TA = [53.33 + 45.9 + 5 - 5 \times 10^{-6}] =$ 104mg/L as $CaCo_3$ (Ans)

EXC[DUET]

Q.35. If the BOD_5 at 20°c of a sewage sample is 320 mg/L, Calculate its 10 day BOD at 30°c ?

Sol":

We know, $K_T = K_{20}(1.05)^{T-20}$

$\Rightarrow K_{30} = 0.1\,(1.05)^{30-20} = 0.163$/day

Again, $y_5 = L_o(1 - e^{-K_{20}t_1})$

$\Rightarrow 320 = L_o(1 - e^{-0.1 \times 5})$

$\Rightarrow L_o = 467.99$ mg/L

Where,
T = 30°c
$K_{20} = 0.1$/day (না দেওয়া থাকলে)
$t_1 = 5$ day
$y_5 = 320$ mg/L

Again, $y_{10} = L_o(1 - e^{-K_{30}t_2})$

$\Rightarrow y_{10} = 467.99(1 - e^{-0.163 \times 10})$

$\Rightarrow y_{10} = 457.02$ mg/L Ans

$L_o = 467.99$ mg/L
$y_{10} = ?$
$t_2 = 10$ day
$K_{30} = 0.163$/day

(2) Extra. Write down the Bar chart of Problem Q.36

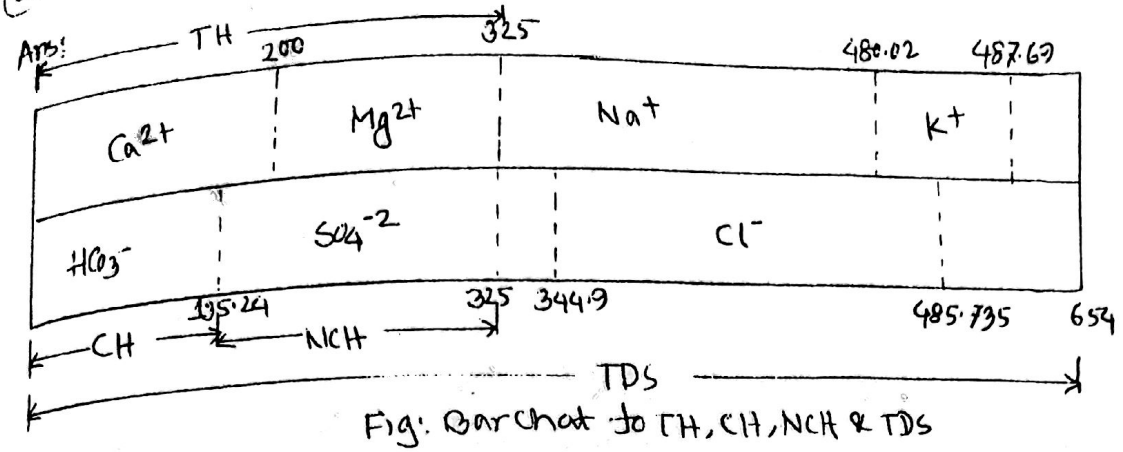


Fig: Barchart to TH, CH, NCH & TDS

(Q) An analysis of a sample of water produce the following concentration (mg/L). Determine concentration of Na^+ ion & TH, CH & NCH? as $CaCO_3$?

Cations	Anions
Ca^{2+} = 40	Cl^- = 11.0
Mg^{2+} = 10	SO_4^{2-} = 67.2
Na^+ = ?	HCO_3^- = 11.0
K^+ = 7.0	-

Soln:

Ion	Concentration (mg/L)	Molecular weight (MW)	Valency (n)	Equivalent Wt. (EW)	mg/L as $CaCO_3$
Ca^{2+}	40.0	40	2	20	$40/20 \times 50 = 100$
Mg^{2+}	10.0	24	2	12	41.67
Na^+	x	23	1	23	$2.2x$
K^+	7.0	39	1	39	8.97
Cl^-	11.0	35.5	1	35.5	15.49
SO_4^{2-}	67.2	96	2	48	70
HCO_3^-	11.0	61	1	61	90.16

We know, $\leq$ Cations $=$ $\leq$ Anions

$\Rightarrow 100 + 41.67 + 2.2x + 8.97 = 15.49 + 70 + 90.16$

$\Rightarrow x = 11.4$ mg/L (Ans)

Now TH $= Ca^{2+} + Mg^{2+} = 141.67$ mg/L as $CaCO_3$ (Ans)

CH = 90.16 mg/L as $CaCO_3$ (Ans)

NCH = 141.67 − 90.16 = 51.51 mg/L as $CaCO_3$ (Ans)

Q.36. An analysis of a sample of water with P^H 7.5 produce the following concentration (mg/L)

Cations	Anions
$Ca^{2+} = 80$	$Cl^- = 100$
$Mg^{2+} = 30$	$So_4^{2-} = 201$
$Na^+ = 72$	$HCo_3^- = 165$
$K^+ = 6$	

Calculate Total Hardness, Carbonate Hardness (CH), Noncarbonated Hardness(NCH), The Alkalinity as per CaCo3 and Find also Total dissolved Solid(TDS) in mg/L?

Sol":

(A) Determination of TH

(i) Con" of Ca^{2+} as $CaCo_3$ = 80/20 x 50 = 200 mg/L

(ii) Con" of Mg^{2+} as $CaCo_3$ = 30/12 x 50 = 125 mg/L

(iii) Total Hardness (TH) = 200 + 125 = 325mg/L as $CaCo_3$ (Ans)

(B) Determination of CH

(i) Con" of HCo_3^- as $CaCo_3$ = 165/ [(1+12+16 x 3)/1] x 50 = 135.24 mg/L

(ii) Carbonate Hardness , CH = $Co_3^{2-} + HCo_3^-$

=> CH = 0 + 135.24 mg/L (Ans)

(C) Determination NCH

(i) Again , We know that,

TH = CH + NCH

=> 325 = 135.24 + NCH

=> NCH = 325 – 135.24 = 189.7 mg/L (Ans)

(C) Determination of Alkalinity

The P^H is nearly neutral, So the concentration of H^+ and OH^- can be neglected. Hence, the Alkalinity is given by

Alkalinity = $HCo_3^- + Co_3^{2-} + OH^- - H^+$

=> Alkalinity = 135.2 + 0 + 0 – 0

=> Alkalinity = 135.2 mg/L as $CaCo_3$ (Ans)

(D) Determination of TDS

The total dissolved solid (TDS) is simply the sum of all anions and cations.

TDS = $Ca^{2+} + Mg^{2+} + Na^+ + K^+ + Cl^- + So_4^{2-} + HCo_3^-$

=> TDS = 80 + 30 + 72 + 6 + 100 + 201 + 165

=> TDS = 654mg/L (Ans)

Q.37. What do you mean by Total Dissolve Solid (TDS) , Total Solid (TS) and Total Suspended Solid(TSS)?

Ans: **Total Solid (TS) :** Total Solid is the sum of total dissolve solid(TDS) and total suspended solid (TSS),i.e, TS = TDS + TSS

Total Suspended Solid (TSS) : The materials which retains by the filter is the total suspended solids ,i.e, TSS= TS – TDS

Total Dissolved Solid (TDS) : The materials which passes through the filter of 2 micro-m or smaller size is known as total suspended solids (TDS) ,i.e, TDS = TS – TSS.

Q.38. Write down the Drinking standard (BDS – Bangladesh Standard) for Bangladesh and WHO?

Ans:

Water Quality Parameter	BDS	WHO
Arsenic and Lead	0.05mg/l	0.01mg/l
Chlorine	0.2mg/l	0.6 to 1.0mg/l
Iron and Maganise	0.3 to 1.0mg/l	0.3mg/l
P^H	6.5 to 8.5	-
Color	15 TCU	15 TCU
Turbidity	10 NTU	5 NTU
Chloride	150 – 600mg/L	250mg/L
Dissolved Oxygen	6mg/L	-
Hardness as $Caco_3$	200 – 500mg/L	-

for Domestic Uses → Temperature = 10°c to 15°c

→ Color = 10 ppm to 20 ppm

BOD_5 at 20° → 0.02 mg/L Flouride → 1.0 mg/L → BDS / WHO 1.5 mg/L

COD → 4.0 mg/L

Q. For a waste water of a sample 5 day BOD at 20°C is 250 mg/L and is 70% of the ultimate. What will be the 4day BOD at 30°C ?

Soln: Now from problem, 70% Ultimate

Ultimate BOD, $L_0 = \frac{250}{0.7} = 357.14$ mg/L

We know, $y_5 = L(1 - e^{-K_{20} t_1})$

$\Rightarrow 250 = 357.14 \times (1 - e^{-K_{20} \times 5})$

$\Rightarrow K_{20} = 0.105$/day

Again, $K_{30} = K_{20}(1.05)^{30-20} = 0.166$/day

Now, $y_4 = L_{30}(1 - e^{-K_{30} t_2})$

$\Rightarrow y_4 = 357.14(1 - e^{-0.166 \times 4}) = 280$ mg/L (Ans)

Given data,
$K_{20} = ?$ /day
$t_1 = 5$ day
$t_2 = 4$ day
$y_5 = 250$ mg/L
$L_0 = 357.14$ mg/L
$K_{30} = ?$
$L_{30} = ?$
$t_2 = 4$ day
$y_4 = ?$

Q. A wastewate flow 5000 m^3/day is treated in a facultative stabilization pond that is 2.0 m deep with a surface area of 20 hector. The waste water was a BOD_5 of 250 mg/L and a reaction rate co-efficient of 0.30/day Determine the BOD_5 of the (effluent→যাওয়া পানি) ?

Soln: We know that, $L_i = L_f(1 + Kt)$

$\Rightarrow 250 = L_f(1 + 0.3 \times t)$ — ①

Now,
$Qt = AD$
$\Rightarrow 5000 \times t = 20,0000 \times 2$
$\Rightarrow t = 80$ days

$Q = 5000 m^3$/day
$A = 20$ hector $= 200000 m^2$
$D = 2m$
$t = ?$

from ① $\Rightarrow 250 = L_f(1 + 0.3 \times 80)$

$\Rightarrow L_f = 10$ mg/L (Ans)

Where
L_i = initial BOD before treated
L_f = final BOD or effluent BOD through facultative Stabilization Pond = ?
$K = 0.30$/day
$L_i = 250$ mg/L
$t = ?$

Q. A settling tank 3m deep, 60m long. What is the flow velocity of the particle size 0.025m at 25°C. specific gravity 2.65 & kinetic viscosity of water, $\gamma = 0.01 m^2/s$

Soln: we know, $V_s = \frac{g}{18}(S-1)\frac{d^2}{\gamma} = \frac{9.81}{18}(2.65-1)\frac{(0.025)^2}{0.01}$

$\Rightarrow V_s = 0.056$ m/sec

Now, $\frac{V}{V_s} = \frac{L}{h}$

$\Rightarrow \frac{V}{0.056} = \frac{60}{2.5} \Rightarrow V = 1.35$ m/sec (Ans)

Given data,
Settling velocity $V_s = ?$
flow velocity, $V = ?$
$g = 9.81$
$S = 2.65$
$\gamma = 0.01 m^2/s$
$d = 0.025m$
$L = 60m$
freeboard $= 0.5m$
$h = 3 - 0.5 = 2.5m$

Q.39. Write down the definition of septic tank and function with draw sketch?

Ans:

Septic tank is a watertight box usually made of concrete or fibreglass with an inlet & outlet pipe. Wastewater flow from the home to the septic tank through the sewer pipe.

Functions are septic tank -

1. to seperate solids from wastewater
2. to flow waste water through outlet sewer pipe
3. to naturally treats the wastewater

Function of soak well -

1.

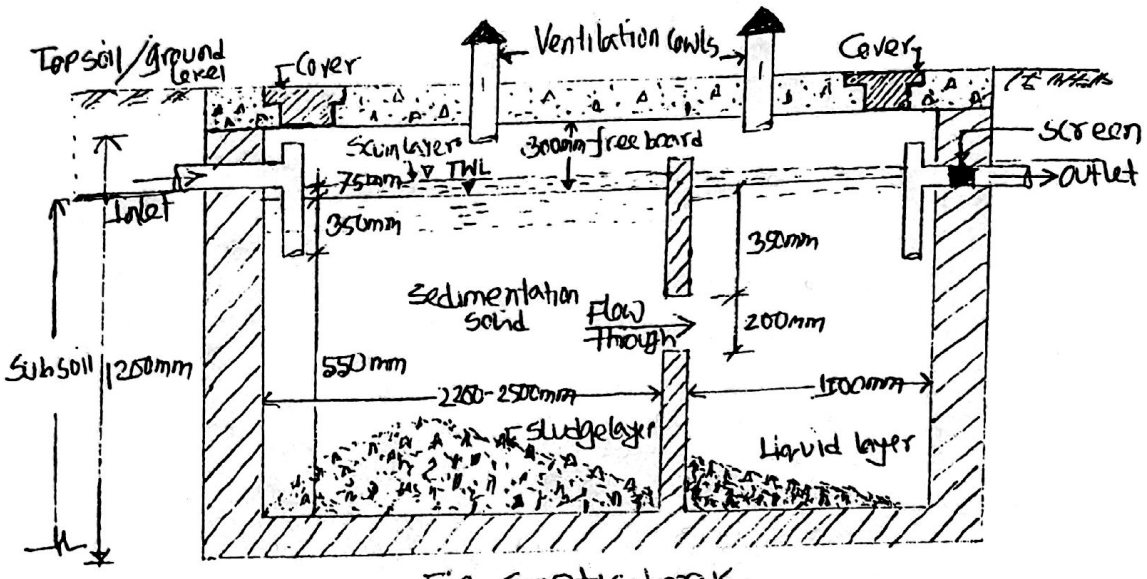


Fig. Septic tank

Q.40. Write down the method of future population?

Ans: The method are-

1) Uniform growth rate method (UGRM).
2) Uniform percentage growth rate method (UPGRM).
3) Depressing growth rate method (DGRM).
4) Graphical extension method (GEM).
5) Graphical comparison method (GCM).
6) Geometric method (GD).

$F = P(1 + r)^n$

Where, $r = [\sqrt[n]{(P_2/P_1)}]$ - 1

7) Least square parabola method (LSPM).

Q.41. Determine the population in year of 2000. If population of 1980 and 1990 is 180000Lac and 220000Lac respectively?

Sol":

Rate of yearly population, $r = [\sqrt[n]{(P_2/P_1)}] - 1$ $\Rightarrow r = [\sqrt[10]{(220000/180000)}] - 1$ $\Rightarrow r = 0.02203$ We know that, $F = P(1 + r)^n$ $\Rightarrow F = 220000 \times (1 + 0.02203)^{10}$ $\Rightarrow F = 268$[illegible]Lac (Ans)	Given data, Future Population in year 2000, F =? Present population in year 1990, P = P_2 = 220000Lac And Past Population in year 1980, P_1 = 180000Lac n = No of year = 2000-1990 = 10 years r = rate of yearly population

(Q) Design an oxidation pond for treating sewage from a hot climate residential colony having a population about 5000 persons. The contribution of sewage is at a rate of 120 lpcd and 5 day BOD_5 is 300 mg/L ?

Soln:

Quantity of sewage treated per day = $5000 \times 120 = 6 \times 10^5$ Litre

BOD Content = $300 \text{ mg/L} \times 6 \times 10^5 \text{ L}$

$= 300 \times 10^{-6} \text{ kg/L} \times 6 \times 10^5 \text{ L}$

$= 180 \text{ kg}$

Assume, organic loading = 300 kg/hector/day

Surface Area = $\frac{180}{300} = 0.6 \text{ hector} = 6000 m^2$

$\Rightarrow L \times B = 6000$

$\Rightarrow 2B \times B = 6000. \Rightarrow B \cong 55m$ & $L = 2B = 110m$ (Ans)

Assume depth = 1.2m [0.9 ~ 1.5m)

So, Capacity of pond = $110 \times 55 \times 1.2 = 7260 m^3$ (Ans)

BUET

(Q) A sample of sewage is mixed with water in the ratio 1 & 20 (i.e 1 mL sewage is diluted to 20 mL by adding water) for BOD test. The initial DO is 8.5 mg/L and final DO after 5 day is 3.1 mg/L. Calculate BOD_5 of the sewage ?

Soln:

Dilution factor, DF = $\frac{1}{20} = 0.05$

Consumed BOD = $8.5 - 3.1 = 5.4 \text{ mg/L}$

BOD of the sewage = consumed DO / DF

$= 5.4 / 0.05$

$= 108 \text{ mg/L}$ (Ans)

IST

(a) Write down the methodology of EIA ?

Ans: It is based on environmental evaluation system -

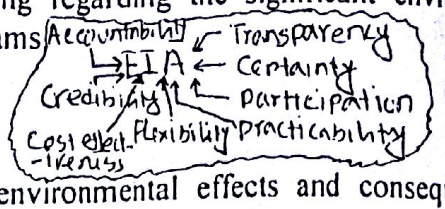
$$EIV = \sum_{i=1}^{n} (v_i) W_i$$

Where, v_i = relative change in the value of environmental parameter i

W_i = relative importance / weight of parameter

MLSU

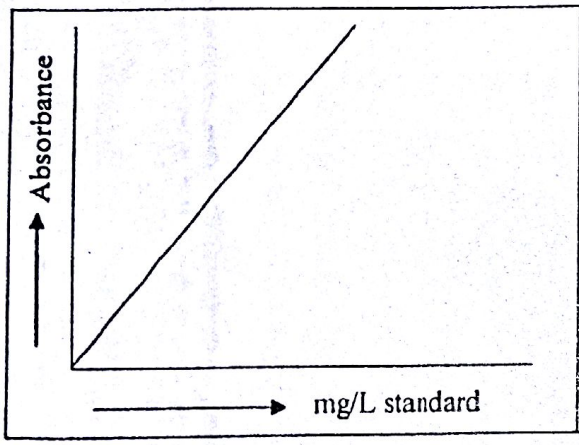
Q.42. What do you mean by Environment Impact Assessment (EIA)?
Ans: EIA is systematic processes to identify predict and evaluate the environmental effects of propose action in order to aid decision making regarding the significant environmental consequences of projects development and programs.



Q.43. Write down the purposes of EIA?
Ans: The purposes of EIA are-
1. To inform and facilitate consideration of environmental effects and consequences in development decision making.
2. To ensure important ecological function and commonly values are more consistent with sustainable development principles.
3. To promote the optional adjustment.

Q.44. Define Blue- Baby?
Ans: The body is denied essential oxygen and in extreme cases, the victim suffocates, because oxygen starvation results in a bluish discoloration of the body, nitrates poisoning has been referred to as the blue baby syndrome.

Q.45. Draw the standard curve for iron determination and Definition of 1TCU and 1NTU?
Ans:



1 TCU: 1TCU is the corresponds to the amount of color exhibited by a solution containing 1mg of platinum per liter of water in the form of chloroplatinium ion.
TCU = True Color Unit → Color unit

1NTU: Nephelometric Turbidity unit

Q.46. Write down the responsible pathogens for the following diseases?
Ans:

Diseases	Pathogen Types
Cholera	Vibro Cholerae (Bacteria)
Amoebiasis (Amoebic Dysentery)	Endamoe Bahistolytica
Bacterials Enteritis (Diarrhoea)	E- Coli, Salmonella SPP(Bacteria)
Typhoid	Bacillus Typhi
Hepatitis –A (Jaundice)	Hepatitis- A Virus

Q.47. What is waste water?
Ans: Waste water may be defined as combination of the liquid or water carried water remove from institution, residence, commercial, industrial establishment together with ground water, surface water and storm water as may be present.

Q.48. Write down the composition of the sewage?
Ans: Sewage = Water (99.9%) + Solid (0.1%)

Solid (0.1%) = Organic (70%) + Inorganic (30%)

Organic (70%) = Proteins (65%) + Fats (10%) + Carbohydrates (25%)

Inorganic (30%) = Grits + Salts + Metals

Q. Draw a flow chart of different treatment units to treat a water source having the following impurities?

total dissolved solids (TDS) - 1200 mg/L
Iron (Fe) - 5 mg/L
Arsenic (As) - 0.06 mg/L
Color - 30 TCU

Ans:

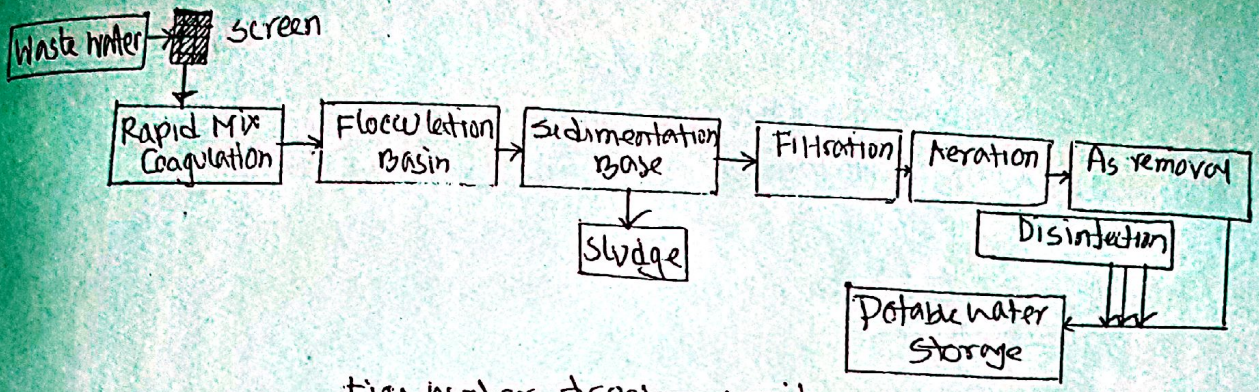


Fig: Water treatment unit

Why collect 5-day BOD or Why 5-day BOD in laboratory measured?

Ans: Because of

1. Dissolved oxygen (DO) is maximum at 5 days.
2. 95% Decomposition at 5 days
3. Measured DO content, be incubated under controlled conditions
4. Temperature controlled at 20°C
5. Biochemical processes are carried out by bacteria.

How Collect 5 day BOD in laboratory?

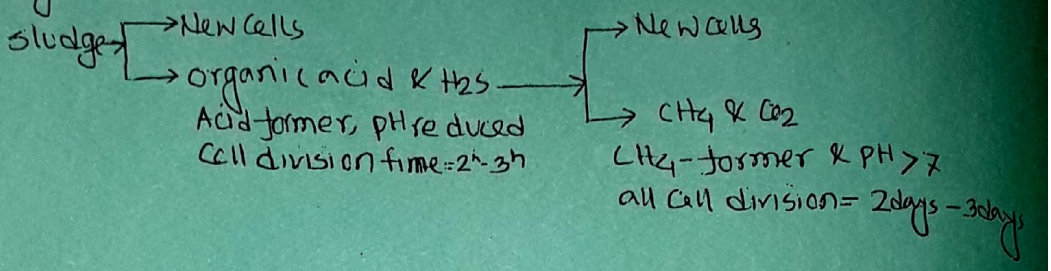
Ans: At first stage:

→ 1000 ml sample + 1ml Manganese sulphate + standard Alkaline Potassium iodide
→ then mixed 1ml of Conc. H_2SO_4
→ After 5 min, withdraw 100ml sample into Erlenmeyer flask + sodium thiosulfate was added drop by drop until yellow color disappeared.
→ then 1ml sodium thiosulfate added just got blue color, taken burette reading
→ Dissolved oxygen (DO) mg/L = ml of 0.025N Sodium thiosulfate added * 2
→ BOD = $(DO_i - DO_f) \times DF$
Where, DF = Dilution factor

(Q.49: Define Night- Soil?
Ans: Night soil is a euphemism for human faces collected at night from cesspools, privies etc. and sometimes used as a fertilizer.

Q.50. What do you mean by "Activated Sludge Process"?
Ans: High F/M ratio, micro-organisms are in the exponential growth phase. Low F/M ratio, overall metabolic activity in the aeration tank may be consists endogenery.

Aerobic digention:



(Q.51) Write down the Sanitation system in Bangladesh?

Ans: The sanitation system are

i) On-site system
ii) Off-site system
iii) Dry system
iv) Wet system

On site system - When the waste are collected, treated and disposal at the point of generation it is called on-site system

Off-site system - When the waste are collected, transported to some where else for treatment and disposal. It is called Off-site system

(Q.52) Write down the waste treatment process?

Ans: 1) physical treatment process
a) solidification
b) carbon absorption
c) sedimentation
d) filtration
e) flocculation
f) Evaporation

2) chemical treatment process
a) Neutralization
b) Coagulation
c) Ion exchange
d) chlorination
e) ozonization
f) wet air oxidation

3) Biological treatment process
a) Waste stabilization pond
b) Activated lagoon
c) Activated sludge
d) Trickling filter
e) Anaerobic process
f) Absorption on plants

Q.53 Write down the factor affecting generation of waste?

Ans: The factors are

i) Geographic location
ii) season of the year
iii) Collection frequency
iv) characteristics of population.

Q.54 Why a water seal is provided is the pour flush latrine?

Ans: The water seal incorporated between the seat & pit which prevents unpleasent odours & insects from entering the latrine compartment

Q.55 Design low cost simple pit latrine for a family of six persons, for the design period of 5 years. Ground water table is below the pit?

Soln:

We know,

Volumn of pit, $V = 1.33CPN$

$= 1.33 \times 0.06 \times 6 \times 5$

$= 2.4\ m^3$

Where
C = Constant = $0.06\ m^3$/person/year
P = Person = 6
N = No of year = 5

For circular section

Assume dia = 1.25 m

Depth, $h = V/A = \frac{2.4}{\pi/4 \times 1.25} = 2.4$ m

Pit size = dia 1.25m x depth 2.4m

For rectangular section

Assume site L x B = 1.25m x 1.25m

Depth, $h = V/A = \frac{2.4}{1.25 \times 1.25} = 2.56$ m

* Capacity = Discharge x Detention

Q.57) What is fire hydrant?

Ans: A fire hydrant is an outlet provided in water pipe for tapping water mainly in case of a fire. It is use for fire fighting purposes.

Fire demand

i) National Board of fire, $Q = 1020(\sqrt{P} - 0.01P)$

ii) Kuichling, $Q = 7000\sqrt{P}$

Where, Q = fire demand in gallon/minute (gpm)

P = population in thousand

Fire stream

i) No of fire streams, $F = 2.8\sqrt{P}$ → population in thousand

Distance between two fire hydrants is 200 ft to 300 ft.

Q.58. Define with sketch of waste stabilized pond and also write down their function?

Ans:

Waste stabilized pond: Waste stabilization ponds (WSPs) are large, man made water bodies in which Blackwater, greywater or faecal sludge are treated by natural occurring processes and the influence of solar light, wind, microorganisms & algae. Waste stabilization pond individually or linked in a series for improvent treatment. There are three types of ponds

a) Anaerobic ponds b) Facultative pond c) Aerobic pond (Maturation)

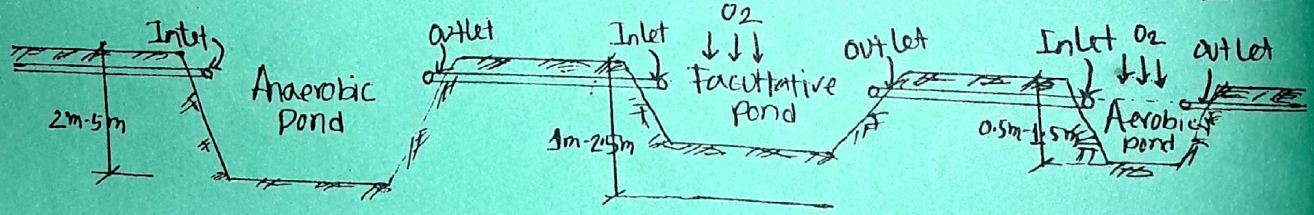


Fig: Typical scheme of WSPs

Functions of that ponds

Anaerobic ponds

1) BOD removal
2) Settle materials
3) Dissolve organic materials
4) Break down biodegradable materials

Facultative pond

1) Aerobic oxidation of organic material
2) Reduce odour
3) Reduce some disease
4) Store residues at bottom sludge

Aerobic pond

1) Faecal & bacteria removal
2) virus and microorganisms removal
3) is used for algae or fish harvesting also nitrogen & phosphorus removal

Q. Write down the formula of primary sedimentation tank design for waste stabilization pond?

Ans:

$$SOR = \frac{Q}{A} = 20 - 40 \text{ m/day}$$

Retention time, $T = \frac{V}{Q} = 1.5h - 2.5h$

Weir loading $= \frac{Q}{\text{weir length}} = 125 - 500 \text{ m}^2/\text{day}$

Q. Design a circular flow of radial circular sedimentation tank for a flow of $15000 \text{ m}^3/\text{day}$

Sol^n:

Given data,

$Q = 15000 \text{ m}^3/\text{day}$

Assume, $SOR = 25 \text{ m/day}$

Assume, $T = 2h$

$D = ?$ & $H = ?$

We know,

$$SOR = \frac{Q}{A}$$

$$\Rightarrow 25 = \frac{15000}{A}$$

$$\Rightarrow A = 600 \text{ m}^2, \quad \frac{\pi D^2}{4} = 600$$

$$\Rightarrow D = 27.64 \text{ m (Ans)}$$

Again, $T = \frac{V}{Q}$

$$\Rightarrow 2 = \frac{AH}{15000} \Rightarrow 2 = \frac{600 \times H}{15000}, \quad H = 2.08 \text{ m}$$

Check: Weir loading $= \frac{Q}{\text{weir length}} = \frac{15000}{\pi \times 27.64} = 172.7 \text{ m}^2/\text{day}$

Which is $125 - 500 \text{ m}^2/\text{day}$ (OK)

Q. Prove that $pH + pOH = 14$?

Proof: we know that, $H_2O \rightleftharpoons H^+ + OH^-$

at 25°C, $K_w = \frac{[H^+][OH^-]}{[H_2O]} = 10^{-14}$ and Concentration of $[H_2O] = 1$

$$\Rightarrow [H^+][OH^-] = 10^{-14}$$

$$\Rightarrow \log[H^+] + \log[OH^-] = \log 10^{-14}$$

$$\Rightarrow -\log[H^+] - \log[OH^-] = -\log_{10}^{-14}$$

$$\Rightarrow pH + pOH = 14 \text{ (Proved).}$$

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[Ques]

Q. Write down the effects of climate change in Bangladesh?

Ans: The effects of climate change in Bangladesh are-

1) people will be affected by water stress in low lying costal region

2) to occur extreme weather condition such as cyclones are Vulnerable to rise the sea level

3) Change of temperature

4) Redva the ozone layer under green house effect.

5) Increasing the vulnerable to varrious type of diseases

6) Rising salinity threatens sundarban

7) To increasing the disappearance of sundarbon, the Bengle tiger & birds.

[Ques]

Q. What is sewer? Why is circular sewer section preferable?

Ans: A sewer is a pipe of conduit, generally used to carry off sewage and sometimes surface water.

Because of-

i) Cross section area is greater using same amount of each another

ii) Fabrication is convenient

iii) Good hydraulic quality

iv) Stable in shape

[2+1]
Q. Draw the mutualism diagram of algae-bacteria in waste stabilization pond? / Symbiosis Procedure?

Ans: Waste stabilization pond can be define of biological activity occurring in a pond. This are three types

i) Anaerobic ponds
ii) Facultative ponds
iii) Maturation ponds

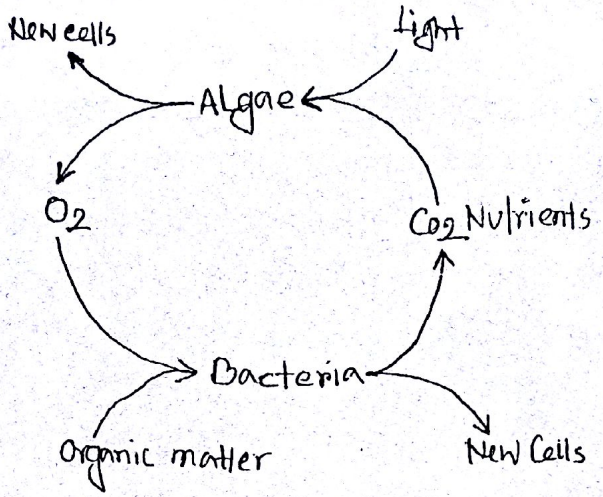


Fig: Algae-Bacteria Mutualism in waste stabilization ponds / Symbiosis of algae-bacteria.

Q. Stone media Trickling Filter (TF) Design?

Calculate the BOD loading, Hydraulic loading, BOD removal efficiency and effluent BOD concentration of a single stage trickling filter on following data. Influent flow = 1530 m^3/d, Recirculation ratio = 0.5, Primary effluent BOD = 130 mg/L, Diameter of filter = 18m, Depth of media = 2.1m & water tem. 18°C.

Sol": i) BOD loading rate $= \frac{\text{BOD Load}}{\text{volume of filter}} = \frac{\text{BOD Conc} \times \text{influent flow}}{\text{Surface area of filter} \times \text{depth}} = \frac{130 \times 1330}{\frac{\pi \times 18^2}{4} \times 2.1m}$

$= \frac{130\ mg/L \times 1530\ m^3/d}{533\ m^3} = \frac{1989\ kg/d}{533\ m^3} = 0.37\ kg/m^3/day$ (Ans)

ii) Hydraulic loading rate $= \frac{\text{Total flow to the media}}{\text{area of filter}} = \frac{\text{Influent + recirculation flow}}{\frac{\pi \times (18m)^2}{4}}$

$= \frac{1530\ m^3/d + (1530\ m^3/d \times 0.5)}{254\ m^3} = 9.04\ m^3/m^2/d$ (Ans)

iii) BOD removal efficiency (E_1) for first stage filter at 20°C, %

$E_1 = \frac{100}{1 + 0.4432\sqrt{\frac{W_1}{VF}}} = \frac{100}{1 + 0.4432\sqrt{\frac{0.37 \times 533\ kg/d}{533 \times 1.36}}} = 81.2\%$

W_1 = BOD loading (kg/day)
V = volume of filter (m^3)
F = Re-circulation factor $= \frac{1+r}{(1+0.1r)^2}$
$= (1+0.5)/(1+0.1\times0.5)^2 = 1.36$
r = recirculation ratio = 0.5

Now, $E_{18} = E_{20}(1.035)^{18-20}$

$\Rightarrow E_{18} = 81.2(1.035)^{-2}$

$= 75.7\%$ (Ans)

iv) Effluent BOD (mg/L) $= 130 \text{ mg/L} \times \frac{100-75.7}{100}$

$= 130 \text{ mg/L} \times \frac{24.3}{100}$

$= 31.59 \text{ mg/L}$ (Ans)

[MIST]

Q. Why need to determine BOD?

Ans: Because of

i) to determine the polluting strength of sewage and industrial waste in terms of oxygen.

[MIST]

(a) Describe 4 phase of bacteria growth, with figure.

Ans: The four phase of bacterial growth -

1) Lag Phase

a) turning on metabolic and replication enzymes

b) The cells are not dividing at this time

2) Log Phase

a) Optimal growth

b) Rapid exponential growth

c) Generation time: time required for a cell to divide

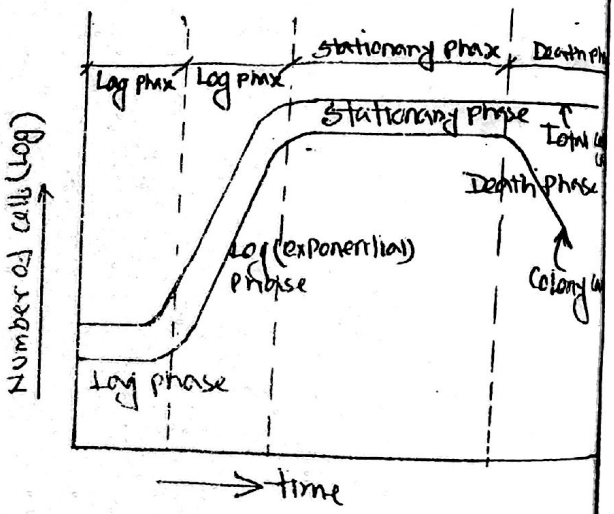


Fig. Phase diagram for bacterial growth.

3) Stationary phase

a) No more nutrient, accumulation of toxic metabolites

b) If the rate of cell division balances the rate of cell death

4) Death/Decline phase

a) Nutrients depleted and cell number declines exponentially

b) More cell dying then are dividing and net decrease in the number of cell

Q. What is potable and palatable water, which one can be used for drinking purposes? What are the basic requirement of drinking water?

Ans: Potable water: Potable water is a water safe for drinking. being free from contamination/impurity

Palatable water: Palatable water is a water that is pleasing to drink but not necessarily safe. and also palatable water is potable water that tastes good.

Potable water can be used for drinking purposes

The basic requirement of drinking water are -

i) Quantity and Quality
ii) Location
iii) Cost and sustainability
iv) Protect source of water
v) Appropriate treatment of raw water
vi) Safe distribution of treated water

Q.1. Write down the different test (1-6) or physical properties (1-5) of cement?
Ans: The test are-
(1) Setting time test → initial and final setting time
(2) Fineness test
(3) Soundness test
(4) Strength test → Tensile and Compressive strength test
(5) Heat of Hydration
(6) Test for chemical composition

Q.2. Define Initial and Final setting time?
Ans: Initial setting time: Initial setting time is a stage in the process of hardening that after this any crack in the concretc.
The initial setting time of ordinary and rapid hardening cement should not less than 30 minutes, Initial setting time for quick setting cement is 5 min (min)
Final setting time: Final setting time is the stage in the process of hardening of cement when concretc acquires sufficient strength.
The final setting time of ordinary and rapid hardening cement should not more than 10 hours and Quick setting cement final setting time max 30 min

Q.3. What do you mean be Heat of Hydration?
Ans: The chemical reaction between water and cement compounds is known as Hydration, during hydration of the cement sufficient heat is generate which is known as Heat of Hydration.

APPLY
Q.4. Write down the different test of Brick?
Ans: The test are-
1. Absorption test
2. Crushing strength test
3. Hardness test
4. Shape and size test
5. Soundness test
6. Test for presence of soluble salt

Q.5. Write down the definition of Efflorescence?
Ans: Some of the soluble salt may be process of bricks coming in contract with water, the soluble salt get when wet bricks will dry, the soluble salt are left at the surface in forms of white powder ,The process of deposition of white powder on the surface of bricks is known as Efflorescence.

APPLY
Q.6. Write down the standard site of Bricks

Ans:

SI system – i) Without morter = 19 cm × 9 cm × 9 cm
ii) With morter = 20 cm × 10 cm × 10 cm

FPS system – i) Without morter = 9.5 inch × 4.5 inch × 2.75 inch
ii) With morter = 10 inch × 5 inch × 3 inch

Q.7. Write the below formula?
1 bag cement = $0.033 m^3 = 1.25 ft^3$ Rebar weight = 7850 kg/m^3 = 490 lb/ft^3
Rebar weight = $D^2 m/532$ kg/ft

Q. Write down the function of Iron oxide (Fe_2O_3) makes Bricks?

Ans: The function are -

1) It is impervious & sustain to makes brick
2) Red color depend upon it
3) Standard 8% Fe_2O_3 required in brick.

Q. Calculate the number of Bricks for 100 cft Brick work?

Soln

$$\text{Number of Bricks} = \frac{100}{\frac{10}{12} \times \frac{5}{12} \times \frac{3}{12}} = 1152 \text{ nos (Ans)}$$

Q. Amount of Cement and sand for 100 cft morter if mixing ratio 1:6?

Soln: Dry volume $= 100 \times 1.2 = 120$ cft [20% extra for morter]

$= 120$ cft.

$$\text{Cement} = \frac{120}{1+6} \times 1 = 17.14 \text{ cft} = 137 \approx 14 \text{ bags}$$

$$\text{Sand} = \frac{120}{1+6} \times 6 = 102.86 \text{ cft}.$$

(Ans) Cement = 14 bag and sand 102.86 cft.

Q. What is formwork? Write down the characteristic of a good formwork?

Ans: Formwork is a temporary construction for cast in situ Concrete in a particular shape.

The characteristic are

i) smooth surface
ii) Appropiate level
iii) Self support
iv) watertight
v) .

Q.8. Write down the characteristic of 1st , 2nd, 3rd class and Jhama bricks?

Ans: The characteristic of brick are-

First Class Bricks	Second Class Bricks	Third class Bricks	Jhama Bricks
1. it should be uniform color ,shape and size 2. Not absorb 20% of its own dry weight of water impress in 24h 3. Uniformed dish color	1. it should be rough surface and not perfect rectangular shape 2. not absorb 22% of its own dry weight of water impress in 24h 3. Over burnt	1. it perfect rectangular shape 2. not absorb 25% of its own dry weight of water impress in 24h 3. Under burnt	1. its irregular shape 2. Dark bluish color 3. over burnt
4. it should be sound compact 5. weight of each brick is 6 lb 6. compressive strength is 5ksi to 8 ksi 7. perfect burnt in 24 hours in 1000^0c to 1500^0c and cool in 12 days for unloading 8. Specific gravity 2 and size 19cm x 19cm x 9cm 9. Need earth 1.5 to 2.5 m^3 for 1000nos bricks			

Q.9. Write down the Constitution of Cement and Brick?

Ans:

Constitution of Cement **(Mind it SALIMSB-Just opposite of value-122363722)**	Constitution of Brick **(Mind it SALIMO-Just opposite of value- 15813055**
Lime – 63%	Lime – 1%
Silica – 22%	Silica – 55%
Alumina - 7%	Alumina - 30%
Iron Oxide – 3%	Iron Oxide – 8%
Magnesia – 2%	Magnesia – 5%
SO_3 – 2%	Organic matter – 1%
Base matter – 1%	

Q.10. Write down the effect of excess alumina, silica, lime use in the clay makes bricks?

Ans: The effect of excess alumina, silica, lime use in the clay makes bricks are-

1. The excess alumina in the clay makes the brick crack and warp on dying
2. The excess silica in the clay makes the brick brittle and weak
3. The excess lime in the clay makes the brick to melt and distort during burning

Q.11. Define fineness modulus (FM)?

Ans: Fineness modulus is an empirical formula obtained by taking the sum of the cumulative percentage of sand retain on the standard sieves (3",1.5", 0.75", 0.375", #4, #8, #16, #30, #50 and #100) and diving the sum by 100.

(10 no Standard Sieves)

Q.12. Define Segregation?

Ans: Segregation can be defined as separation of constitution of a concrete mixture so that their distribution is no longer.

Q.13. Define Slump test and test mould size?

Ans: Slump is a test used in site work. The slump test measures the workability of concrete. The test mould size is Top dia = 10cm and Bottom dia = 20cm and Height = 30cm

Q.14. Specific Gravity of cement =3.15, Sand = 2.65 and Coarse aggregate = 2.8 also get maximum workability we can use maximum 25 liter water use in per bag cement.

Q. Write down the values of slump?

Ans: i) RCC footing → 20mm - 80mm ii) Beam → 20-100mm iii) Column → 20-10
iv) Pavement & slab → 20-80mm v) Canal lining → 70-80mm.

Q. Write down the two characteristic for the following ?

Ans:

i) Railway sleeper → i) Shock Absore ii) .

ii) sewer pipes → i) Carry storm water without flooding.
ii) Drains sewer without carring any health risk

iii) Well irrigation → i) Back flow protection ii) Pump connected to potable water

iv) varnishing → i) to transparent, hard and protective film above the surface
ii) Contained aresin, a drying oil and a solvent

v) seasoned timber →

Q. Write down the uses of following terms ?

Ans:

i) River training

ii) Canal lining
a) reducing seepage loss of irrigation water
b) Improve discharge capacity.

iii) piles

iv) Damp proofing

v) Sewage treatment

Q. Name 5 different types of Partition walls depending on the construction materials ?

Ans: The partition wall are
i) Brick wall ii) Ferro cement iii) Hardboard iv) Hollow Brick v) Glass

Q.15. Estimate the Yield / Produced of Concretc per bag of cement for concretc mix – proportion is 1:3:6?

Sol": Thumb Rule

Volume of One bag cement = $0.035m^3$

Yield of Concretc per bag of cement = $2/3(0.035 \times 1 + 0.035 \times 3 + 0.035 \times 6) = 0.233\ m^3$ (Ans)

Absolute Volume method

Yield of Concretc per bag of cement = Volume of cement + Volume of sand + Volume of coarse aggregate + Volume of Water

=> Yield = Weight of cement / (Specific Gravity of cement x Unit weight of water) + (3 x 0.035 x 1600)/ (2.65 x 1000) + (6 x 0.035 x 1500)/ (2.8 x 1000) + (25)/ (1 x 1000)

=> Yield = 50/ (3.15 x 1000) +0.060 + 0.106 + 0.025

=> Yield = $0.020 + 0.063 + 0.113 + 0.025 = 0.221m^3$ (Ans)

Q.16. Determine the volume of different ingredients of cement concretc for mix proportion 1:3:6?

Sol": Assume, wet volume of CC = 1 cft

Dry volume of CC = 1.5 x 1 = 1.5 cft

Required cement = 1.5/ 10 = 0.15cft =0.15 /1.25 = 0.12 bags (Ans)

Required F.A = (3 x 1.5) / 10 = 0.45 cft (Ans)

Required C.A = (6 x 1.5) / 10 = 0.9 cft = 0.9 x 9 = 8.1 nos ≈ 8 nos (Ans)

Required water = cement x 30% + (F.A + C.A) x 5% = 0.15 x 0.3 + (0.45 + 0.90) x 0.05 = 0.113cft

So, w/c = 0.15/0.113 = 0.75 (Ans)

Q.17. Determine the earth volume of a channel whose bottom length 20m and wide 12m.The channel is sloped by 2:1 and depth 4m .given that the top of channel is level before dug?

Sol":

We know that, Prisomoidal Rule, $V = k/6(A_1 + A_2 + 4A_m)$ => $V = 4/6 \times (240 + 1008 + 4 \times 560)$ => $V = 2325.33\ m^3$ (Ans)	Given data, $A_1 = 20 \times 12 = 240\ m^2$ $A_2 = (20 + 4 \times 2 \times 2) \times (12 + 4 \times 2 \times 2) = 1008m^2$ $A_m = (20 + 36)/2 \times (12 + 28)/2 = 560m^2$ K = depth = 4m , V = Volume =?

Q.18. Marble is an example of metamorphic rock and specific gravity of granite 2.64; compressive strength 70 to $130MN/m^2$.Quartzite is used as a road metal, railway ballast or in concretc. Gypsum used in 1% to 3% in cement to lengthen the initial setting time.

Q.19. Design a concretc mix by the minimum void method for following data, voids of C.A is 40% , voids of F.A is 30%, size of C.A is ¾" to 1", size of F.A is 3/16" to ¼".Allow an excess of 10% for cement and 7% for fine aggregate (F.A)?

Sol": Assume, C.A = 100cft

So, F.A = 40% x C.A x (1+7%) = 0.4 x 100 x 1.07 = 42.8cft

Cement = 30% x F.A x (1+ 10%) = 0.30 x 42.8 x 1.10 = 14.14cft

So, Cement: F.A: C.A = 14.14: 42.8: 100 = 1: 3: 7 (Ans)

Q. Determine earthwork excavation by prismiodal formula, slop 1H:2V?

Sol" :

We know that, prisomoidal rule, $V = \frac{K}{6}(A_1 + A_2 + 4A_m)$ $\Rightarrow V = \frac{2}{6} \times (120 + 360 + 4 \times 224)$ $= 458.67\ m^3$ (Ans)	Given data, $A_1 = 10 \times 12 = 120\ m^2$ $A_2 = (10 + 2 \times 2 \times 2) \times (12 + 2 \times 2 \times 2)$ $= 360\ m^2$ $A_m = (10 + 18)/2 \times (12 + 20)/2 = 224m^2$ K = depth = 2m, V = volume = ?

Q Calculate the number of bricks required for constructing a room of 8' (width) x 10' (long) x 9' (height) with 10" wall?

(Q.21) Combined fineness modulus of two types of soil is 2.75 and whose total mass 100gm.First fineness modulus is 2.65 with mass 60gm.Find the F.M and mass of second sample of soil?

Sol":

Given data, m=Total mass of soil sample = $m_1 + m_2$ =100gm => 100 = 60 + m_2 => m_2 = 100 – 60 = 40gm (Ans) We know that, $F_{com} = (F_1m_1 + F_2m_2) / (m_1 + m_2)$ => 2.75 = (2.65 x 60 + F_2 x 40) / (60 + 40), => F_2 = 2.9 (Ans)	Given data, F_{com} = Combined fineness modulus = 2.75 F_1 = First fineness modulus = 2.65 F_2 = Second fineness modulus =? m_1 = First sample mass = 60gm m_2 = Second sample mass =? m=Total mass of soil sample = $m_1 + m_2$ =100gm

(Q.22) Fineness modules of kaliakair sand are 2.4 and sylhet sand is 5.7 also combined FM is 4.4. Shrinkage modulus 0.7 and volume 10m^3 of the sample. Determine the each volume of C.A and F.A?

Sol":

We know that, $R = (F_1 - F_{com}) / (F_{com} - F_2)$ =>R = (5.7 – 4.4) / (4.4 – 2.4) = 0.65 => R : 1 = 65 :100 = $F_{fine\ sand}$: $F_{coarse\ sand}$ Sum of proportion = 100 + 65 = 165 Volume of kaliakair sand = (14.28 x 65)/165 = 5.625m^3 (Ans) Volume of sylhet sand = (14.28 x 100)/165 = 8.654 m^3 (Ans)	Given data, F_1 = FM of sylhet sand = 5.7 F_2 = FM of kaliakair sand = 2.4 F_{com} = Combined fineness modulus = 4.4 Total volume = 10/0.7 = 14.28m^3 [Note→ R value don't never negative which is depends on F_1 and F_2]

(Q.23) Define False set and Flash set of concretc?

Ans: **False set:** It is the rapid development of rigidity of a freshly mixed concretc without the generation of much heat in which the concretc becomes stiffer that can be regained by further mixing the concretc without addition of water.

Flash set: it is also the rapid development of rigidity of freshly mixed concretc with the generation of much heat in which the concretc under goes permanent rigid and cannot be regained by mixing of water.

(Q.24) What is admixture and write down their objective?

Ans: Admixtures are materials that are added to concretc either before or during its mixing.

Objective-

(1) To accelerate setting and hardening
(2) To improve workability
(3) To increases strength
(4) To decreases permeability

(Q.25) The normal consistency of Portland cement is about 25% and it is 90micron sieve should not exceed 10% .

(Q.26) What is curing and why it is used?

Ans: Curing is the process of maintaining satisfactory moisture content and temperature in freshly cast concretc for a definite period of time.

Because of-

(1) It prevents the loss of moisture from the concretc
(2) It maintain temperature for hydration to occur for a definite period

Q. Determine FM the following Data of sand?

Soln

Sieve Size	#4	#8	#16	#30	#40	#50	#100	#200	Pan
% of retained	0	4	9	22	12	23	10	8	1

We know,

$$FM = \frac{\text{Cumulative sum of \#4, 8, 16, 30, 50, 100 no sieve}}{100}$$

$$FM = \frac{(0+4) + (0+4+9) + (0+4+9+22) + (0+4+9+22+23) + (0+4+9+22+23+10)}{100}$$

$$\Rightarrow FM = 1.78 \quad \text{(Ans)}$$

Q. Write down the F.M range of Construction materials?

Ans:

Construction Materials	Types	FM
Sand 1. More than 3.2 is not used for making good concrete 2. FM > 1.6 it is suitable for plastering	Fine sand Medium sand Coarse sand	2.2 - 2.6 2.6 - 2.9 2.9 - 3.2 best concrete FM = 3.0
Coarse aggregate	Coarse aggregate	6.5 - 8.0

Q.27. Write down the method of curing?
Ans: The method of curing are-
(1) Spraying with water
(2) Ponding with water
(3) Covering the surface be wet sand or earth straw or wetted cotton mats
(4) Application of curing membrane
(5) Curing by shading

Q.28. Determine FM for sand which total retains 100% on #30 sieves?
Sol"

Sieve size	Wt. of Ret.	% of Ret	Cumulative total	FM
#4	-	0	0	FM = 300/100 or, FM = 3 (Ans)
#8	-	0	0	
#16	-	0	0	
#30	-	100	100	
#50	-	0	100	
#100	-	0	100	
#200	-	0	-	
Pan	-	0	-	
Total	-	-	300	

Q.29. Write down the properties of Engineering Materials or Concretc?
Ans: The properties are –
1. Physical properties – i) Specific gravity, ii) Specific heat, iii) Elasticity, iv) Plasticity, v) Porosity
2. Mechanical properties – i) Strength. ii) Hardness, iii) Toughness, iv) Brittleness, v) Ductility, vii) Creep and slip, viii) Fatigue
3. Thermal properties – i) Conductivity
4. Electrical properties – i) Conductivity
5. Magnetic properties – i) Ability of materials to act as a magnet.

Q.30.Important note in different jobs?
Ans: The sedimentary rock formed due to gradual deposition of materials like sand ,clay, etc generally setting water

Q.31. Important note?
Ans: 1. The durability of concretc is proportional to cement –aggregate ratio.
2. The strength of cement concretc increases with increases in the size of aggregate.
3. The shrinkage of concretc increases with the increases in the percentage of concretc.

Q.32. What is seasoning and write down their types?
Ans: The process of dying timber or removing moisture in a freshly felled in tree is called seasoning. There are two type of seasoning –
1. Natural seasoning or air seasoning
2. Artificial seasoning or kiln seasoning

Q.33. Define F.A and C.A?
Ans: F.A dia less than 10mm and C.A dia greater than 10mm , (4.75mm Passing, Retain 0.075mm
fine Sand, → 75mm Passing 4.75mm retain coarse)

Q. Find FM for the following data: [only calculate standarded 10 sieve]

Soln:

Sieve No	opening (mm)	Retained	% of Retained	Cumulative
3"	75	10	2.25	2.25
1.5"	37.5	30	6.74	8.99
0.75"	18.75	05	1.12	10.11
0.375"	9.38	50	11.12	21.23
4	4.75	60	13.48	34.71
8	2.36	80	17.98	52.69
16	1.18	110	24.72	77.41
30	0.60	20	4.49	81.90
50	0.30	40	8.98	90.88
100	0.150	15	3.37	94.25
200	0.075	05	–	–
		Total = 445gm	Total = 474.42	

(10 standard sieve)

$$FM = \frac{474.42}{100}$$

$$= 4.74 \text{ (no)}$$

Q. Write the Notes of below terms?

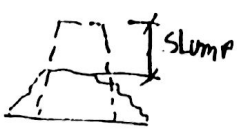
i) Water Cement ratio ii) Consistency of concrete.

Ans: 1) Water Cement ratio: The water-Cement ratio is the ratio of the weight of water to the weight of Cement used in a concrete mix. A lower ratio leads to higher strength and durability but may takes the mix difficult to work with and form.

ii) Consistency of concrete: The concrete slump test is an empirical test that measures workability of fresh concrete. the test measures consistency of concrete in that specific batch.

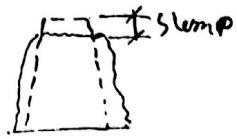
Types of slumps:

i) Collapse slump



ii) Shear slump

iii) True slump



Q.35. Define workability?

Ans: The property of fresh concretc which is indicated by the amount of useful internal work required to fully compact the concretc without bleeding of segregation in the finish product.

Factor affecting workability is -

1. Water content
2. Amount of cement
3. Aggregating grading
4. Nature of aggregate
5. Method of concretc placement

How to improve the workability of concretc are -

1. Increases water/cement ratio
2. Increases of size of aggregate
3. Increases the mixing of time
4. Increases the mixing temperature

Q.36. Define volume expansion of sand? or Bulking of sand ?

Ans: To occur expansion of dry sand with mixing of water (Moisture) is called volume expansion of sand. It adding water in his own weight 5% to 8% then the expansion is 25% to 30%.

Q.37. Determine volume expansion of sand when dry sand volume is $20m^3$ and after adding water his volume is $60m^3$?

Sol":

We know that, Volume expansion of sand, $b = (V_m/V_s) \times 100$ $\Rightarrow b = (20/60) \times 100 = 33.33\%$ (Ans)	Given data, V_m = Dry volume of sand = $20\ m^3$ V_s = Wet volume of sand = $60m^3$ b= volume expansion of sand = %?

Q.38. Define All- in –Aggregate?

Ans: The materials composed of a mixture of coarse aggregate and fine aggregate is called All-in –Aggregate.

Q.39. Write down the relation between trade and riser of a stair?

Ans The relation are –

1. Trade + 2x Riser = 60cm → for example 30+ 2*15 =60cm or 27 or 25 + 2* 16.5 or 17.5 = 60cm
2. Trade x Riser = $400cm^2$ to $450cm^2$ → for example 30 x 15 =$450cm^2$ or 2x7.5 or 25 x 16 or 17.5 = $440cm^2$ or $437.5cm^2$
3. Trade + Riser = 40cm to 45cm → for example 30 + 15 =45cm or 27.5 or 25 + 16 or 17.5 = 43.5cm or 42.5cm
4. Trade =30cm and riser = 14cm then riser increases 1cm and trade decreases 2cm then 15cm x 28cm or 16cm x 26cm or 17cm x 24cm

Q.40. Draw a typical cross-section of stair & Determine nos of trade?

Ans:

Assume, Total Rise hight = 10ft = 330cm

Rise site = 14 cm & Trade = 30cm

no of riser = $\frac{330}{14}$ = 22 nos

We know that, T = R-1

= 22-1

= 21 nos (Ans)

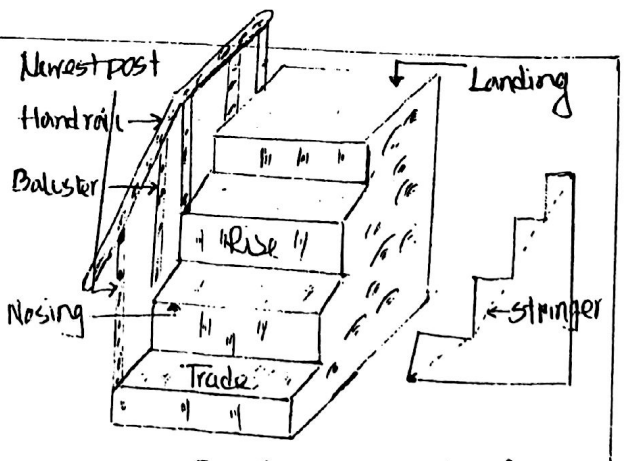


Fig: Cross section of stair

Q: Write down the 10 check list before slab casting?

Ans:

1) The check list (before) casting:

1) Check all type of machineries which are used for casting work.
2). Materials will be insure.
3) Check all type of safety support
4) Check block provided accurately
5) Check rebar provided as per drawing
6) Check for all type of formworks
7) Check electrical lines carry a pipe
8) Check for staging
9) Check available manpower for casting work
10) Check leveling and chair.

2) Check of run to casting work:

1) Check level tripod (Paya)
2) Check mixing ratio
3) Check timely apply vibrator nozzle
4) Re-Check block position
5) Re check shuttering and staging
6) Must be casting start from rigid point
7) Check of Construction joint

3) Check of after casting work:

1) Check leveling
2) Water barrier will be provided
3) Curing work will be insure
4) Check curing period
5) Check appropriate curing.

Q. Why is desert sand not used for construction?

Ans: Because of -

i) the extended weather effect of desert sand are finer & smoother compared to orginary construction sand

ii) the smoother surface not able to multidirectional chemical leakages

iii) thies sand particles are so small, the slurry would slip and concrete would have poor strength.

iv) the poor strength of concrete is prohibited to construction work.

Q. Draw the relationship curves between strength and w/c ratio of concrete?

Ans:

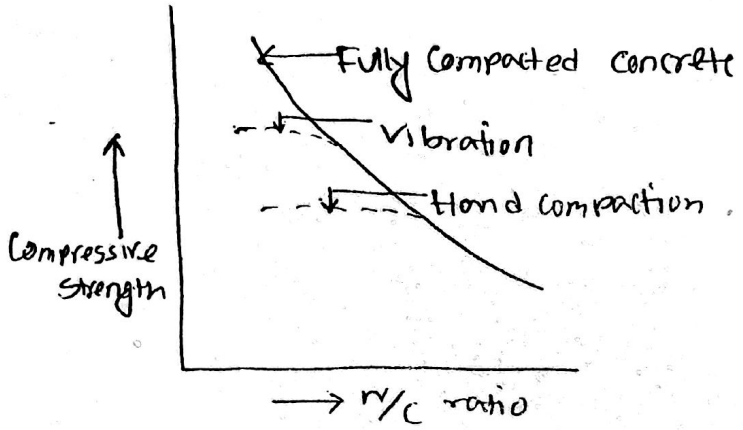


Fig: Strength and w/c ratio curves in concrete.

(xx) Q. 10% extra cement used in practical work than the theoritical calculation of cement in RCC work.

12. Write down the defect of plastering?

Ans: The defect of plastering

i) Blistering (Blowing) ii) Flaking (iiv) Peeling iv) Crazing v) popping vi) Cracking vii) efflorescence.

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GEOTECHNICAL ENGINEERING

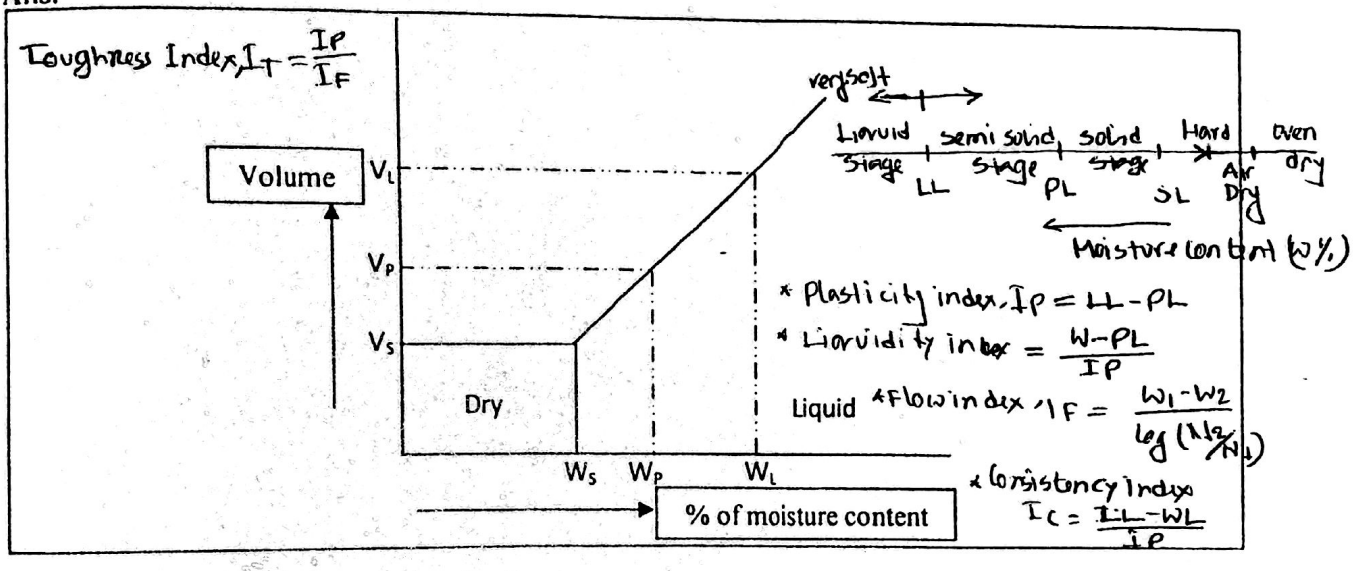
Q.1. What is consistency limit or Atterberg limit?
Ans: The water content at which the soil changes from one state to another state is called consistency or Atterberg limit. This limits are 1) Liquid limit (L_L or W_L) 2. Plastic limit (P_L or W_P) 3. Shrinkage limit (S_L or Ws)

Q.2. What is liquid limit?
Ans: The water content at which the soil changes from liquid state to plastic state is called W_L or L_L

Q.3. What is Plastic limit?
Ans: The water content at which the soil changes from plastic state to semi solid is called W_P or P_L

Q.4. Define Shrinkage limit?
Ans: The soil changes from semi solid to solid state is called W_S or S_L

Q.5. Draw the consistency limit or Atterberg limit? or Draw a curve relation between liquid limit, Plastic limit and Shrinkage limit?
Ans:



Q.6. Important formula?
Ans: Void ratio, e = volume of void/ volume of solid = V_v/V_s = wG (for fully saturated, S=1)
Porosity, n = volume of void / total volume = V_v/V
Degree of saturation, S_r = Volume of water / volume of void = V_w/V_v => Se = wG
Percentage of air voids, η_a = Volume of air/ total volume = V_a/V $\left(G_1 = \frac{\gamma_s}{\gamma_w}\right)$
Water content, w = Mass of water/mass of solid = W_w/W_s
Bulk unit weight, γ= Total wt. / Total vol" = W/V = $((G+Se)\gamma_w) / (1+e)$
Dry unit wt(γ_d)= Wt of solid/ total volume = $W_s/V = \gamma/(1+w) = G\gamma_w/(1+e)$ → (when dry cond", S=0)
DPDG
For fully saturated, S=1, $\gamma_{sat} = ((G+e)\gamma_w)/(1+e)$
For submerged $\gamma' = \gamma_{sat} - \gamma_w = ((G-1)\gamma_w)/(1+e)$
Specific gravity, G= Mass of given vol" of solid / Mass of equal vol" of water 4°c

Q.7. Define Specific Gravity?
Ans: Specific Gravity is define as the ratio of the unit weight of a given materials to the unit weight of water. This value for soil is 2.6 to 2.8

Q. Write the important note?

Ans:

1) plasticity index. $I_p = W_L - W_p$ Consistency Index $I_c = \frac{W_L - W}{W_L - W_p}$

Liquidity index, $I_L = \frac{W - W_p}{W_L - W_p}$

Density index, $I_d = \frac{e_{max} - e}{e_{max} - e_{min}}$

2) Uniformity co-efficient, $C_u = \frac{D_{60}}{D_{10}}$ [>4]

Co-efficient curvature, $C_c = \frac{D_{30}^2}{D_{60} \times D_{10}}$ [1~3]

D_{60} = dia corresponding to 60% finer

D_{30} = dia corr. to 30% finer

KKKK ⊛ D_{10} = Effective grain size = The dia in the GSD curve corresponding to 10% finer is known as effective size (D_{10}) (Grain size distribution)
(well graded soil or sand by S-shape curves)

Uniformity co-efficient, $C_u > 4$ - for gravel (well graded)
$C_u > 6$ - for sand (well graded)
well graded soil - $1.0 < C_c < 3.0$

DPDC

Q. A dry soil unit weight 112 lb/ft3. When specific gravity 2.7 then compute ~~saturated~~ unit weight of the soil?

Soln:

We know that,

$\gamma_d = \frac{G\gamma_w}{1+e}$

$\Rightarrow 112 = \frac{2.7 \times 62.5}{1+e}$

$\Rightarrow e = 0.507$

Again,

$\gamma_{sat} = \frac{(G+Se)\gamma_w}{1+e}$

$\Rightarrow \gamma_{sat} = \frac{(2.7 + 1 \times 0.507) \times 62.5}{1+0.507}$

$\Rightarrow \gamma_{sat} = 132.714$ lb/ft3 (Ans)

BUET

Q. In a liquid limit test, the moisture content at [70%] (W_1) blows was [10] (N_1) and that at [100] (N_2) blows was [20%] (W_2) what is the liquid limit of that soil?

Soln: We know that,

liquid limit, $W_{L1} = W_1 \left(\frac{N_1}{25}\right)^{0.121} = 70 \times \left(\frac{10}{25}\right)^{0.121} = 62.7\%$

Liquid limit, $W_{L2} = W_2 \left(\frac{N_2}{25}\right)^{0.121} = 20 \times \left(\frac{100}{25}\right)^{0.121} = 23.7\%$

Required liquid limit = 62.7 - 23.7

= 39% (Ans)

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Q.8. Prove that, $n = e/(1+e)$ or $e = n/(1-n)$?
Proof: we know that, $e = V_v/V_s$
or, $e = V_v/(V-V_v) = (V_v/V)/(1-V_v/V)$
or, $e = n/(1-n)$ (proved)

Q.9. Find void ratio, dry density, unit weight of sand if S= 0.46, Degree of saturation if w= 14% and submerged unit wt. of sand when n= 30% and G= 2.7?
Sol" We know that,
(1) Void ratio, $e = n/(1-n) = 0.3/(1-0.3) = 0.4286$
(2) Dry density, $\gamma_d = G\gamma_w/(1+e) = (2.7 \times 1)/(1+0.4286) = 1.89$ gm/cc
(3) $\gamma_{s=0.46} = ((G+Se)\gamma_w)/(1+e) = ((2.7 + 0.46 \times 0.4286) \times 1)/(1+0.4286) = 2.06$ gm/cc
(4) $Se = wG \Rightarrow S \times 0.4286 = 0.14 \times 2.7 \Rightarrow S = 0.882$
(5) For submerged $\gamma' = ((G-1)\gamma_w)/(1+e) = ((2.7-1) \times 1)/(1+0.4286) = 1.189$ gm/cc

Q.10. The dry mass of a sample of aggregate is 1982gm. The mass is a saturated surface dry condition is 2006.70gm. The net volume of the aggregate is 734.4cm^3. Find the apparent specific gravity, Bulk specific gravity and the percentage absorption?
Sol":

We know that, Volume of Absorption water, $V_{ab} = W_{ab}/\rho$ $\Rightarrow V_{ab} = 24.7/1 = 24.7cm^3$ So, Bulk Volume, $V_B = V_D + V_{ab}$ $\Rightarrow V_B = 734.4 + 24.7 = 759.1cm^3$ Apparent Specfic gravity, $G_A = W_D/V_D$ $\Rightarrow GA = 1982/734.4 = 2.699$ Bulk Specfic gravity, $G_B = W_D/V_B$ $\Rightarrow GB = 1982/759.1 = 2.61$ % of absorption = 24.7/1982 x 100 = 1.25%	Given data, Dry Mass of Agg. W_D = 1982gm Saturated Mass of Agg. W_{sat} = 2006.70gm Absorption in water of Agg. W_{ab} = 2006.70 – 1982 = 24.7gm Net Volume $V_D = 734.4cm^3$ Unit Weight of water, $\rho = 1gm/cm^3$

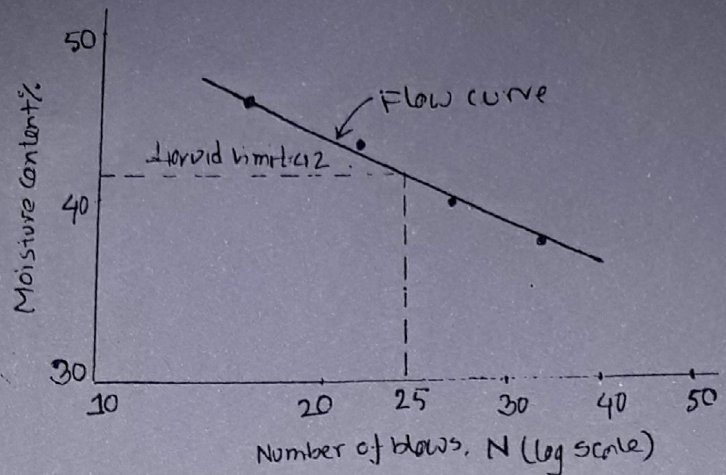
Q.11. A 100% saturated soil has a wet unit weight of 120 lb/ft3 and water content of 36%, determine void ratio and specific gravity (G)?
Sol" we know that,
For fully saturated, $e = wG \Rightarrow e = 0.36G$ ---------- (i)
For fully saturated, $\gamma_{sat} = ((G+e)\gamma_w)/(1+e) = ((G+0.36G) \times 62.5)/(1+0.36G) = 85\,G/(1+0.36G)$
$\Rightarrow 120 = 85\,G/(1+0.36G) \Rightarrow 120 + 43.2G = 85\,G \Rightarrow G = 2.87$ (Ans)
From (i) $\Rightarrow e = 0.36 \times 2.87 = 1.03$ (Ans)

Q.12. The dry unit weight of a soil having 15% moisture content is 17.5 KN/m^3. Find the bulk unit weight, saturated unit weight and submerged unit weight. Assume G =2.7?
Sol":

We know that, Dry unit weight, $\lambda_d = \lambda/(1+w)$ $\Rightarrow 17.5 = \lambda/(1+0.15)$ $\Rightarrow \lambda = 20.13$ KN/m^3 (Ans) Again, Dry unit weight, $\lambda_d = G\lambda_w/(1+e)$ $\Rightarrow 17.5 = 2.7 \times 9.8/(1+e)$ $\Rightarrow e = 0.512$ Now, Saturated unit weight, $\lambda_{sat} = (G+e)\lambda_w/(1+e)$ $\Rightarrow \lambda_{sat} = (2.7+0.512) \times 9.8/(1+0.512)$ $\Rightarrow \lambda_{sat} = 20.82$ KN/m^3 (Ans) Submerged unit weight, $\lambda' = \lambda_{sat} - \lambda_w$ $\Rightarrow \lambda' = 20.82 - 9.8 = 11.02$ KN/m^3 (Ans)	Given data, Dry unit weight, $\lambda_d = 17.5$ KN/m^3 Moisture content, w = 15% =0.15 Bulk unit weight, λ =? Saturated unit weight, λ_{sat} =? Submerged unit weight, λ' =? Assume G =2.7? Unit weight of water, $\gamma_w = 9.8$ KN/m^3 Unit weight of water, $\gamma_w = 62.5$ lb/ft^3

Q. Draw the flow curve for liquid limit determination of a clayey silt.

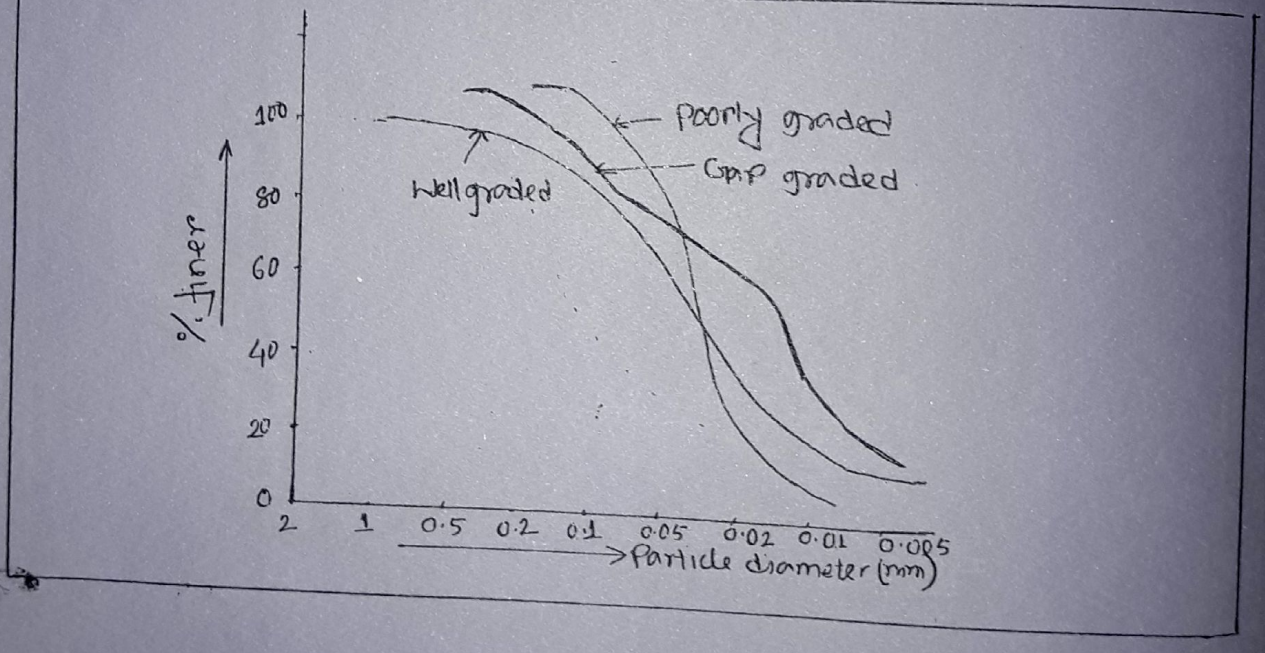
Ans:



Q. Draw the different types of particle size distribution curve? or

Ⓧ Draw the well graded, poorly graded and a Gap graded soil particle size distribution curve?

Ans:



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Q.13. A pipe is to be laid in a purely cohesion soil having undrained cohesion C_u = 30kpa. Calculate the maximum depth upto which a vertical trench can be excavated in the soil without providing any lateral support?

Sol":

We know that, Maximum depth of soil, $h = (4C_u/\gamma)\tan\alpha$ $\Rightarrow h = (4 \times 30/20) \times \tan 45$ $\Rightarrow h = 6m$ (Ans)	Given data, $1\ kPa = 1\ kN/m^2$ C_u = 30 kpa = 30 kN/m² γ = Unit weight of soil = 20 KN/m³ $\alpha = 45 + \varphi/2 = 45 + 0/2 = 45$ For cohesion soil, $\varphi = 0$ Maximum depth of soil, h = ?

Q.14. Write down the laboratory and field test of soil?

Ans:

Laboratory test of soil	Field test of soil
1. Determination of Atterberg limit 2. Determination of Grain size analysis 3. Determination of Compaction test 4. Determination of Permeability test 5. Determination of Consolidation test 6. Determination of Unconfined consolidation test	1. SPT (Standerd Penetration Test) 2. VST (Vane Shear Test) 3. CPT (Cone Penetration Test)

Q.15. When SPT value needed correction?

Ans: Because of-

1. If drill rod length is more
2. Linear is sample measurement
3. For bore hole dia
4. Release mechanism
5. Water table

Q.16. Define shear- strength of soil?

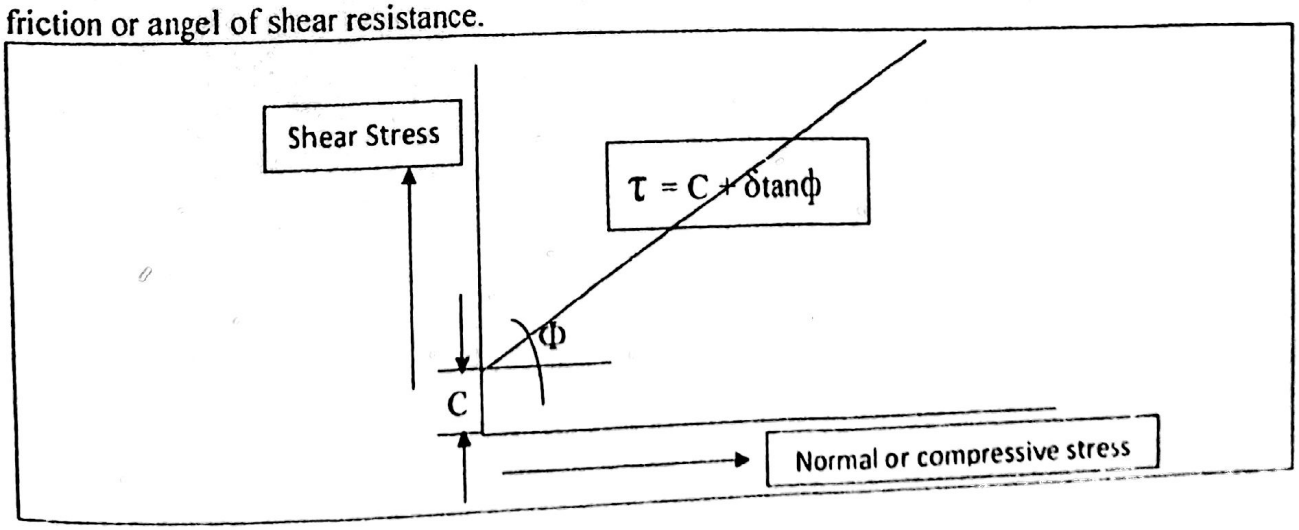
Ans: The shear strength of soil is the resistance to deformation by continuous shear displacement of soil particles or a lamp mass soil upon the action of a tangential stress.

Q.17. Write down the coulombs law of shear strength of soil with specification and sketch?

Ans: The fundamental shear strength equation proposed by the French engineer **coulomb** is

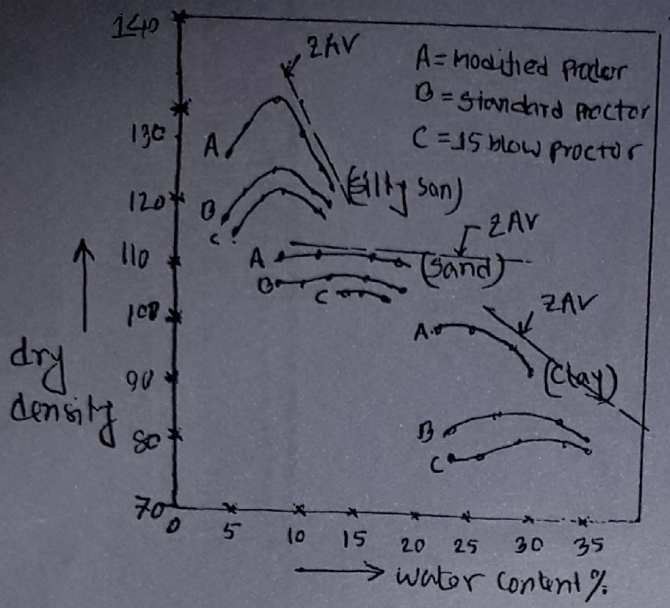
$\tau = C + \delta\tan\phi$ ---------- (i)

Where, τ = Shear Stress, C = Cohesion, δ = Total compressive stress and ϕ = Angel of internal friction or angel of shear resistance.



Q. Sketch the typical moisture - density relation for a cohesive soil under two different levels of compaction effort and show the related features (OMC, MDD, zero air void line)

Ans:



	MDD			OMC		
	A	B	C	A	B	C
Silty sand	132	125	123	8	10	10
Sand	113	110	108	ind	ind	ind
Clay	102	88	83	20	28	31

Line showing relationship between moisture content and dry density of a soil having zero air voids (ZAV) all the voids are filled with water. otherwise 100% saturation line -

$$\gamma_d = \frac{(1-n_a)G\gamma_w}{1+wG} \rightarrow ZAV,\ n_a = 0$$

$$\Rightarrow \gamma_d = G\gamma_w / 1+wG \rightarrow \text{equation of ZAV line.}$$

Q. What is standard proctor test and Modified proctor test?

Ans:

Standard Proctor test	Modified proctor test
1. Standard AASHTO T99	1. AASHTO T180
2. Material pass #4	2. Material pass #4
3. Mold dia 4"	3. Mold dia 4"
4. Compaction 3 Layers	4. Compaction 5 layers
5. 5.5 lb Hammer with 2" face	5. 10 lb hammer with 2" face
6. 12" free falling distance	6. 18" free falling distance
7. 25 blows/Layer or 56	7. 25 blows/layer or 56

Q.18. Define angel of internal friction?
Ans: The shearing reistance of soil to sliding along a plane is known as Angel of internal friction (ϕ). ϕ for loose sand is 25 to 30 and ϕ for dense sand is 32 to 37.

Q.19. For cohesionless or granular soil C =0 then $\tau = \delta\tan\phi$
For fully saturated / undrained cohesive soil (Sand) $\phi = 0$ then $\tau = C = q_u/2$ where, q_u = Unconfined compressive strength.

Q.20. Define Shear strength parameter of soil?
Ans: The fundamental shear strength equation proposed by the French engineer coulomb is
$\tau = C + \delta\tan\phi$ ---------- (i)
Where, τ = Shear Stress, C = Cohesion, δ = Total compressive stress and ϕ = Angel of internal friction or angel of shear resistance, Here C and ϕ are called Shear strength parameter of soil.

Q.21) During the direct shear test it was found that the normal stress is 96 KN/m^2 and shear stress 65 KN/m^2 causes the failure of the specimen. Determine the angle of friction?
Sol":

We know that, $\tau = C + \delta\tan\phi$ $\Rightarrow 65 = 0 + 96 \times \tan\phi$ $\Rightarrow \phi = \tan^{-1}(65/96) = 34^0$ (Ans)	Given data, Due to causes of failure specimen as used as sand so here C = 0 Normal stress, δ = 96 KN/m^2 Shear stress, τ = 65 KN/m^2 Φ =?

Q.22 Write down the methods of soil exploration?
Ans: The method of soil exploration are-
1) Trial pit method
2) Boring method
   i) Hand Auger method
   ii) Mechanical Auger boring
   iii) Wash boring
   iv) Rotary drilling method
   v) Percussion drilling method

Q.23. What do you meant by 'Disturbed' and 'Undisturbed' Sample?
Ans:

Disturbed Sample	Undisturbed Sample
1. The sample in which the natural property of soil gets disturbed during sampling is known as Disturbed sample.	1. The sample in which the natural property of soil doesn't change or disturbed during sampling is known as Undisturbed sample.
2. This sample used for determination of Index properties like liquid limit, plastic limit, grain size distribution and specific gravity etc.	2. This sample used for determination of compressibility, permeability and shear stress etc.

Q.24) Sensitivity of clay : Sensitivity is the property of clay which is measured in terms of loss of shear strength due to remolding. It is measured as,

$$St = \frac{q_u(\text{undisturbed})}{q_u(\text{remolded/disturbed})}$$ where, q_u = Unconfined Compressive Strength

Sensitivity of Normal clay - 2 to 4

(Q.) Formula of earth pressure ?

Active pressure, $P_a = K_a \gamma h - 2c\sqrt{K_a}$ KN/m^2

Total Active pressure, $P_a = \frac{1}{2} K_a \gamma h^2 - 2c\sqrt{K_a} H$

Passive pressure $P_p = K_p \gamma h + 2c\sqrt{K_p} = K_p \sigma_v + 2c\sqrt{K_p}$

Total Passive pressure, $P_p = \frac{1}{2} K_p \gamma h^2 + 2ch\sqrt{K_p}$

(Q.) A retaining wall that has a soft saturated clay backfill is shown in figure. for the undrained condition ($\phi = 0$) of the backfill determine. a) Maximum depth of tensile crack

b) Pa before the tensile crack occurs

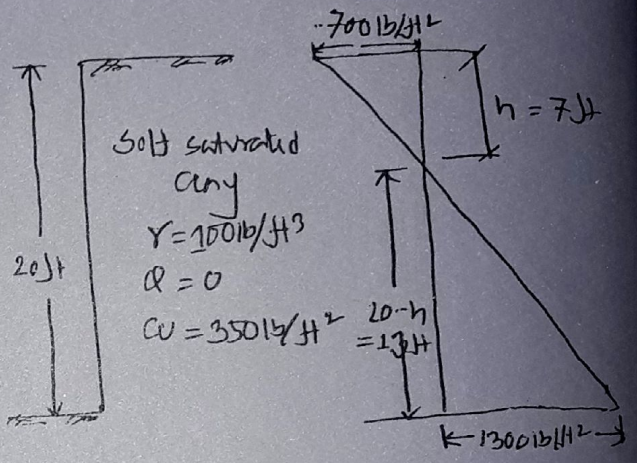
c) Pa after the tensile crack occurs

Soln:

$$K_a = \frac{1-\sin\phi}{1+\sin\phi} = \tan^2(45-\phi/2) = 1$$

At $h = 0$, $P_a = K_a \gamma h - 2c\sqrt{K_a}$
$= 1 \times 0 \times 0 - 2 \times 350\sqrt{1}$
$= -700$ lb/ft²

At $h = 20$, $P_a = K_a \gamma h - 2c\sqrt{K_a}$
$= 1 \times 100 \times 20 - 2 \times 350\sqrt{1}$
$= 1300$ lb/ft²



a) When $\phi = 0$, Maximum depth of tensile crack, $h = \frac{2C_u}{\gamma} = \frac{2 \times 350}{100} = 7$ ft (Ans)

b) Before tensile crack, $P_a = \frac{1}{2}\gamma h^2 - 2C_u H = 6000$ lb/ft (Ans)

c) After tensile crack, $P_a = \frac{1}{2} \times 1300 \times 13 = 8450$ lb/ft (Ans)

(Q.) A frictionless retaining wall is shown in figure. Determine the active force, Pa, after the tensile crack occurs? $\gamma = 15 KN/m^2$

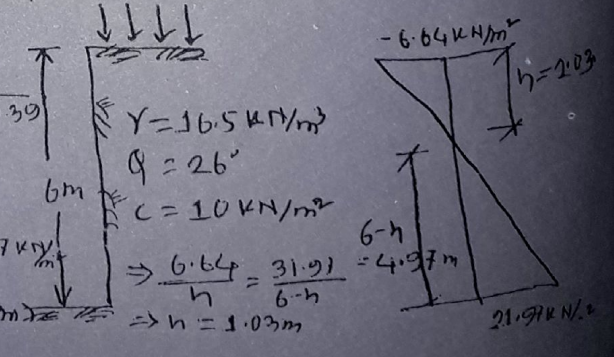
Soln:

$$K_a = \tan^2(45 - \phi/2) = 0.39$$

At $h = 0$, $P_a = K_a \gamma h - 2c\sqrt{K_a} = 0.39 \times 15 - 2 \times 10 \times \sqrt{0.39}$
$= -6.64 KN/m^2$

At $h = 6m$, $P_a = K_a \gamma h - 2c\sqrt{K_a} = 0.39 \times [15 + 6 \times 16.5] - 2 \times 10 \times \sqrt{0.39} = 31.97 KN/m^2$

After tensile crack, $P_a = \frac{1}{2} \times 31.97 \times 4.97 = 79.45 KN/m$ (Ans)



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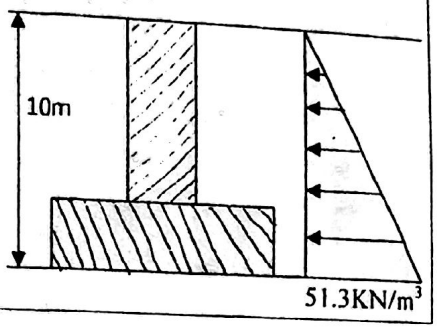
Q.25. Coefficient of active earth pressure Ka = $(1-\sin\varphi)/(1+\sin\varphi)$
Coefficient of passive pressure, Kp = $(1+\sin\varphi)/(1-\sin\varphi)$
Active earth pressure, Pa = $K_a\gamma h = \tan^2(45-\varphi/2)\gamma h$. (Passive pressure, $K_p = \tan^2(45+\varphi/2)$)

Q.26. Using Rankin theory, determine the total active trust on a vertical retaining wall 10m height if the soil retaining has following properties, $\varphi = 35^0$ and $\gamma = 19KN/m^3$?
Sol":

We know that,
Coefficient of active earth pressure Ka = $(1-\sin\varphi)/(1+\sin\varphi)$
=> Ka = $(1-\sin35^0)/(1+\sin35^0) = 0.27$
Active pressure at h = 0, Pa = $K_a\gamma h = 0$
Active pressure at h = 10, Pa = $K_a\gamma h = 0.27 \times 19 \times 10 = 51.3\ KN/m^2$
Assume, b = 1m
Total thrust = ½ x 51.3 x 10 x 1 = 257KN/m –width (Ans)
If b = 10m
Total thrust = ½ x 51.3 x 10 x 10 = 2570KN (Ans)

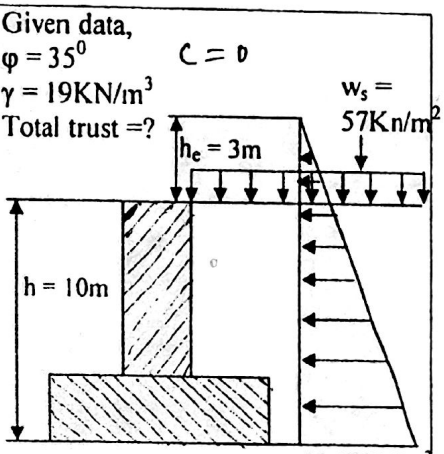
Given data,
$\varphi = 35^0$ $C = 0$
$\gamma = 19KN/m^3$
Total trust =?



Q.27. Using Rankin theory, determine the total active trust on a vertical retaining wall 10m height, which is subjected to uniform surcharge $57KN/m^2$ on horizontal surface of soil and if the soil retaining has following properties, $\varphi = 35^0$ and $\gamma = 19KN/m^3$?
Sol":

We know that,
Equivalent surcharged height, $h_e = w_s/\gamma = 57/19 = 3m$
Coefficient of active earth pressure Ka = $(1-\sin\varphi)/(1+\sin\varphi)$
=> Ka = $(1-\sin35^0)/(1+\sin35^0) = 0.27$
Active pressure at h = 0, Pa = $K_a\gamma(h+h_e) = 0.27 \times 19 \times (0+3) = 15.39KN/m^2$
Active pressure at h = 10, Pa = $K_a\gamma(h+h_e) = 0.27 \times 19 \times (10+3) = 66.69\ KN/m^2$
Assume, b = 1m
Total thrust = ½ x (66.69+15.39) x 10 x 1 = 410.30KN/m –width (Ans)
If b = 10m
Total thrust = ½ x (66.69+15.39) x 10 x 10 = 4103KN (Ans)

Given data,
$\varphi = 35^0$ $C = 0$
$\gamma = 19KN/m^3$
Total trust =?

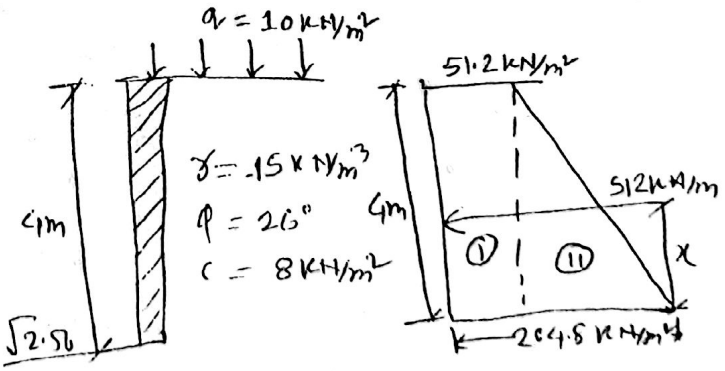


(Q.) A frictionless retaining wall in shown in figure. Find the passive resistance P_p on the backfill and the location of the resultant passive force?

Sol", $K_p = \tan^2(45+\varphi/2) = 2.56$

At h=0, $P_p = K_p\gamma h + 2C\sqrt{K_p}$
$= 2.56 \times 10 + 2 \times 8 \times \sqrt{2.56}$
$= 51.2\ KN/m^2$

At h=4, $P_p = K_p\gamma h + 2C\sqrt{K_p}$
$= 2.56[10+4\times15] + 2\times8\sqrt{2.56}$
$= 204.8\ KN/m^2$



Total passive, $P_p = \frac{1}{2} \times (51.2 + 204.8) \times 4 = 512\ KN/m$ (Ans)

Now,
$\Rightarrow 51.2 \times 4 \times 2 + \frac{1}{2} \times (204.8 - 51.2) \times 4 \times \frac{1}{3} \times 4 = 512 \times 2$
$\Rightarrow x = 1.6m$ (Ans)

Q. Explain the concepts of active and passive pressure?

Ans: There are three categories of lateral earth pressure -

i) At rest earth pressure
ii) Active pressure
iii) Passive pressure

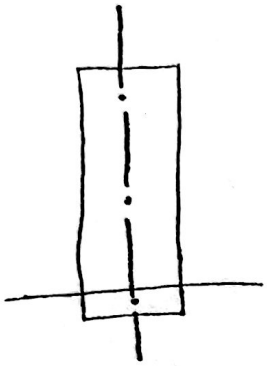


Fig. At rest case
(No movement)

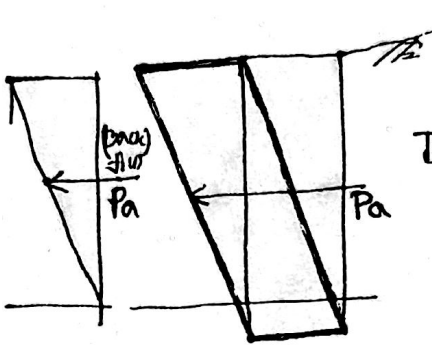


Fig. Active case
(Wall moves away from Back fill soil)

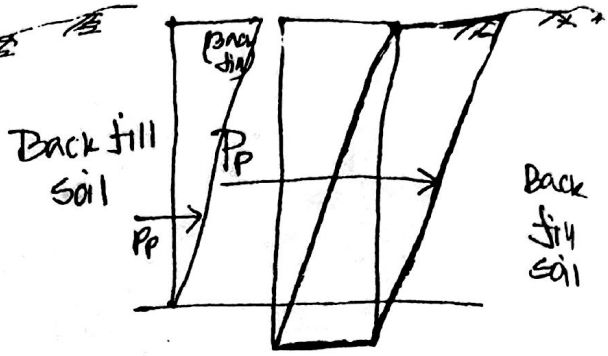


Fig. Passive case
(Wall moves into Back fill soil.)

∴ A cutting of 15m deep is made in clay having $\phi = 10°$ and $\gamma = 1.8\ t/m^3$. The angle of slope is 40° and factory of safety (F.S) 2. Find out the value of cohesion if stability Number N=0.10?

Solb:

We know that,

$$\text{Stability Number } N = \frac{C}{\gamma H (F.S)}$$

$$\Rightarrow 0.1 = \frac{C}{1.8\ t/m^3 \times 15m \times 2}$$

$$\Rightarrow C = 5.4\ t/m^2 = 5400\ kg/m^2 \text{ (Ans)}$$

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Q.29. Compute the total trust and point of action on a retaining wall of 10m height long considering two layer of soil shown in figure?

Sol":

We know that,

For upper layer

Coefficient of active earth pressure Ka = $(1-\sin\varphi)/(1+\sin\varphi)$

=> Ka = $(1-\sin30^0)/(1+\sin30^0) = 0.33$

Active pressure at h = 0 , $P_0 = K_a\gamma h = 0 KN/m^2$

Active pressure at h = 4 , $P_4 = K_a\gamma h = 0.33 \times 16 \times 4 = 21.33 KN/m^2$

For bottom layer

Coefficient of active earth pressure Ka = $(1-\sin\varphi)/(1+\sin\varphi)$

=> Ka = $(1-\sin35^0)/(1+\sin35^0) = 0.27$

Equivalent surcharged height, $h_e = w_s/\gamma = (4 \times 16)/20 = 3.2m$

Active pressure at h = 0 , $P_0 = K_a\gamma(h+h_e) = 0.27 \times 20 \times (0+3.2) = 17.28 KN/m^2$

Active pressure at h = 6 , $P_6 = K_a\gamma(h+h_e) = 0.27 \times 20 \times (6+3.2) = 49.68 KN/m^2$

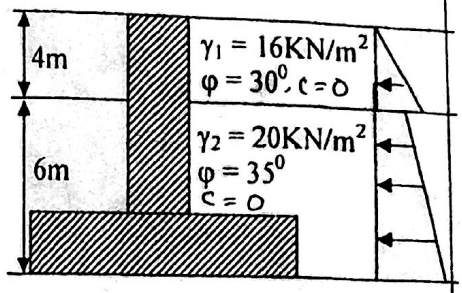
Total thrust = ½ x 21.33 x 4 + ½ x (17.28+49.68) x 6 = 243.60KN/m (Ans)

Point of Action

=> ½ x 21.33 x 4 x (6+4/3) + (17.28 x 3) + ½ x (49.68 – 17.28) x 6 x 6/3 = 243.60 x X (×6)

=> X = 3.36ft from bottom (Ans)

Given data,



Q.30. Find the total active trust per feet of wall and its action of point from shown in figure in below?

Sol":

We know that,

Coefficient of active earth pressure, Ka = $[\cos\beta \times (\cos\beta - \sqrt{(\cos^2\beta - \cos^2\varphi)}] / [\cos\beta + \sqrt{(\cos^2\beta - \cos^2\varphi)}]$

=> Ka = $[\cos15 \times (\cos15 - \sqrt{(\cos^215 - \cos^230)}] / [\cos15 + \sqrt{(\cos^215 - \cos^230)}] = 0.373$

Active pressure at h = 0, Pa = Kaγh = 0

Active pressure at h = 9.1 , Pa = Kaγh = 0.373 x 17.3 x 9.1 = 58.25 KN/m²

Total thrust = ½ x 58.25 x 9.1 = 267KN/m (Ans)

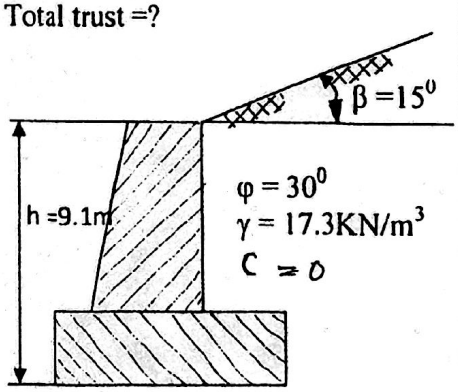
Point of Action

=> ½ x 58.25 x 9.1 x 9.1/3 = 267 x X

=> X = 3.01ft from bottom (Ans)

Given data,

Total trust =?



DUET

Q.31. Find the maximum shear stress subjected to vertical shear force 48kips where specimen size 6in x 12in?

Sol":

We know that, $S_s = \frac{VQ}{Ib}$

$\Rightarrow S_s = \frac{48 \times 432}{864 \times 6}$

$= 4 kip/in^2$ (Ans)

Given data,

V = shear force (Max^n) = 48 kips

$Q = A \times \bar{y}$

$= 6 \times 12 \times 12/2 = 432 in^3$

$I = \frac{6 \times 12^3}{12} = 864 in^4$

b = 6in

(Q) Permeability & seepage?

Ans: Darcy law: The discharge velocity of water through saturated soil is proportional to the hydraulic gradient

i.e. $v \propto i$

$\Rightarrow v = ki$ where k is co-efficient of permeability

Q. Write down the factor of co-efficient of permeability (K)?

Ans: The factors are -

i) viscosity (ii) Temperature (iii) Grain size distribution

iv) void ratio v) Degree of saturation.

Q. Write down the formula of "K"?

Ans:

<table>
<tr><th>Laboratory procedure</th><th>Field procedure</th></tr>
<tr>
<td>1) Constant head → high permeability

$K = \frac{QL}{Aht}$ (m/sec)

It is suitable for coarse grained soils

2) Falling head → Fine grained soil
↳ Low permeability

$K = \frac{2.303\, aL}{At} \log_{10}\left(\frac{h_1}{h_2}\right)$ (cm/sec)
(a: mm², L: cm, A: mm², t: sec, h: cm)

Where,
Q = Volume of water collected
A = Cross sectional area of soil
t = Time of collection of water
h = constant head difference
h_1, h_2 = constant head difference at time 't'
a = Cross sectional area of stand pipe</td>
<td>1) for confined aquifer

$K = \frac{q \log_{10}(r_1/r_2)}{2.727 H (h_1 - h_2)}$ → (ধ্রুবক ভিন্ন RRI MUT)

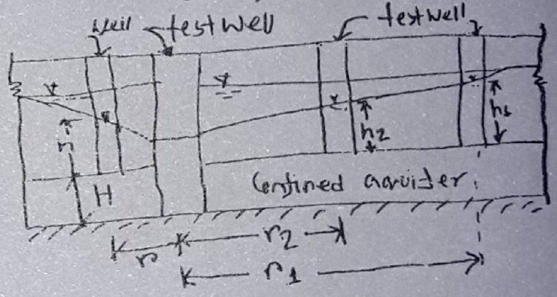
 

Fig: Confined aquifer

2) for unconfined aquifer

$K = \frac{2.303\, q \log_{10}(r_1/r_2)}{\pi (h_1^2 - h_2^2)}$

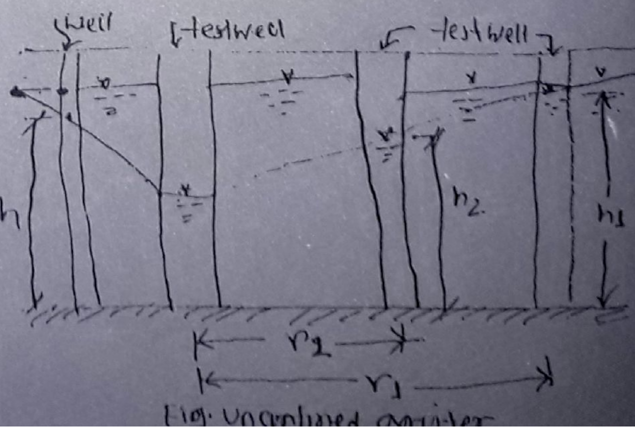
 

Fig: Unconfined aquifer</td>
</tr>
</table>

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Q. Determine permeability of soil, which effective size of the particles of 0.008mm and Co-efficient of curvature 3.5?

Sol": We know that

$K = C D_{10}^2$

$\Rightarrow K = 100 \times (0.0008\ cm)^2$

$= 6.4 \times 10^{-5}$ cm/sec

Where,
C = Allen-Hazen constant = 100

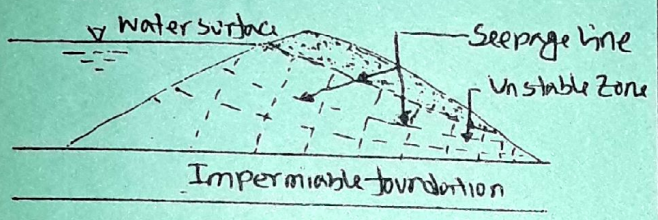
Given,
$D_{10} = 0.008mm$
$= 0.0008\ cm$
$C = 100$ (fixed value)
K = Permeability = ?

(Q.33) Write down the definition of Seepage and Flow net with sketch?

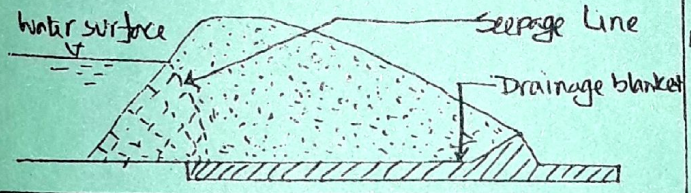
Ans:

Seepage: Seepage the process by which a liquid leake through a porous substance

Homogeneous dam:



Dam with a drainage blanket:



Flow net: Flownet is the graphical construction are to calculate ground water flow through soil. Flow net criteria-
i) Flow line are perpendicular to EL
ii) Flow net elements are almost square

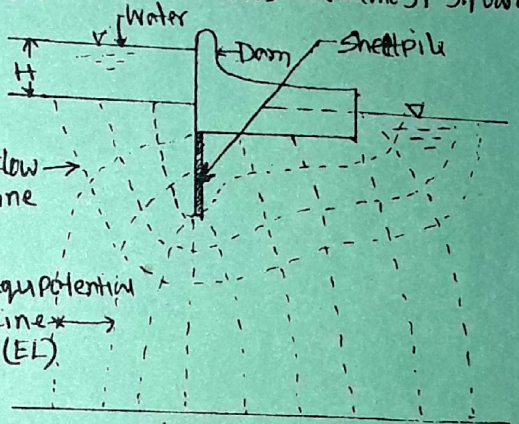


Fig. Flow net

Q.34. A flow net for flow around a single row of sheet piles in a permeable soil layer is shown in figure. Given $K_x = K_z = K = 5 \times 10^{-3}$ m/sec. Determine the total rate of seepage through the permeable layer per unit width?

Sol":

We know that,
Discharge calculation from flow Net

$$q = \frac{K H N_f}{N_d} \quad \text{---} (1)$$

$\Rightarrow q = 5 \times 10^{-3} \times \frac{H}{N_d} \times N_f$

$= 5 \times 10^{-3} \times \frac{3.05}{8} \times N_f$

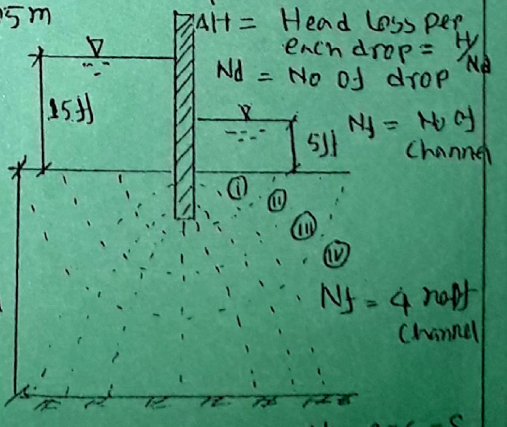
$= 5 \times 10^{-3} \times 0.381 \times 4$

$= 7.6 \times 10^{-3}\ m^3/sec/m$ (Ans)

Given Data,

$H = 15 - 5 = 10ft$
$= 3.05\ m$

Where,
q = Discharge
K =
ΔH = Head loss per each drop = H/N_d
N_d = No of drop
N_f = No of Channel



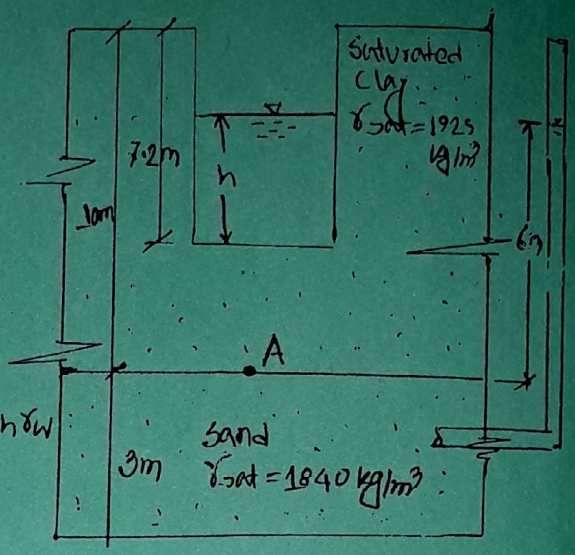
$N_f = 2 \times 4 = 8$

Q. What would be the maximum height of water 'h' in the cut so, that the stability of the saturated clay is not lost?

Soln:

For clay, $\gamma_{sat} = 1925 \text{ kg/m}^3$
$= 1925 \times 9.81 \text{ N/m}^3$
$= 18.88 \text{ kN/m}^3$

For sand, $\gamma_{sat} = 1840 \text{ kg/m}^3$
$= 1840 \times 9.81 \text{ N/m}^3$
$= 18 \text{ kN/m}^3$



Total stress at A, $\sigma_A = (10-7.2) \times 18.88 + h\gamma_w$
Pore water pressure at A, $u_A = 6\gamma_w$

For, Maximum cut, Effective stress $\sigma'_A = 0$

$\Rightarrow \sigma_A - u_A = 0$
$\Rightarrow (10-7.2) \times 18.88 + h\gamma_w - 6\gamma_w = 0$
$\Rightarrow 52.864 + h \times 9.81 - 6 \times 9.81 = 0$
$\Rightarrow h = 0.61 \text{ m}$ (Ans)

Q. The result of a constant head permeability test for a fine sand sample having a dia of 150mm & a length of 300mm are follows.

i) Constant head difference = 500mm
ii) Time of collection of water = 5 min
iii) volume of water collected = 350 cc
iv) temperature of water = 24°c

Soln: We know that,

Constant head, $K = \frac{QL}{hAt}$

$\Rightarrow K = \frac{350 \times 30}{50 \times 176.63 \times 300}$
$= 3.96 \times 10^{-3} \text{ cm/sec}$ (Ans)

Given data,
$Q = 350 \text{ cc}$
$L = 300\text{mm} = 30 \text{ cm}$
$A = \frac{\pi}{4} \times 15^2 = 176.63 \text{ m}^2$
$t = 5\text{min} = 300 \text{ sec}$
$h = 500\text{mm} = 30 \text{ cm}$

(Q.35.) A soil profile is shown in figure. Calculate the total stress, pore water pressure and effective stress at A, B & C?

We know that,

At point - A

Total stress, $\sigma_A = 0$

Pore water pressure, $u_A = 0$

Effective stress, $\sigma'_A = 0$

At point - B

Total stress, $\sigma_B = \gamma_d H$

$= \frac{G_1 \gamma_w}{1+e} H$

$= \frac{2.66 \times 9.8}{1+0.61} \times 4$

$= 64.76 \text{ KN/m}^2$

Pore water pressure, $u_B = 0$

Total stress, $\sigma'_B = 64.76 \text{ KN/m}^2$

At point C

Total stress $\sigma = \gamma_d H + \gamma_{sat} H_1$

$= 64.76 + \frac{(G+e)\gamma_w}{1+e} \times 5$

$= 64.76 + \frac{(2.62+0.48)\times 9.81}{1+0.48} \times 5$

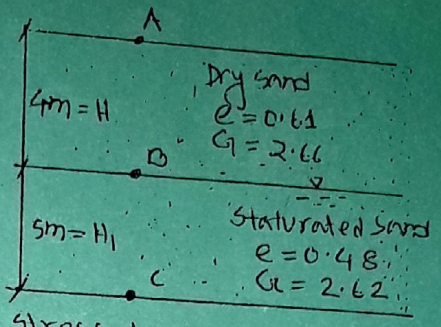
$= 169.16 \text{ KN/m}^2$

Pore water pressure, $u_c = H_1 \gamma_w = 5 \times 9.81$

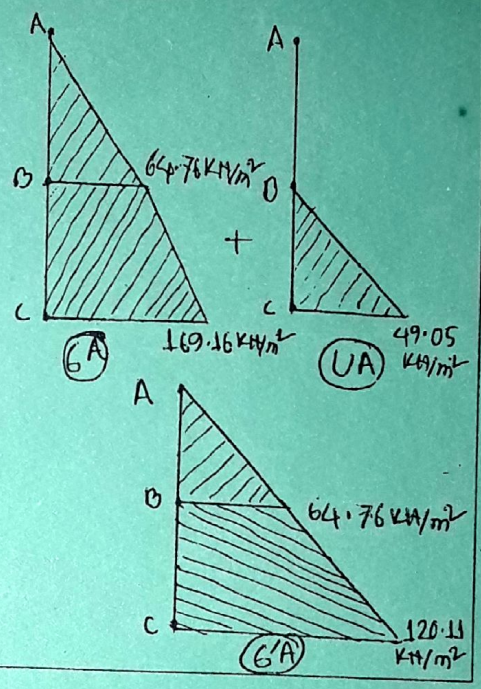
$= 49.05 \text{ KN/m}^2$

Effective stress, $\sigma'_c = \sigma_c - u_c = 120.11 \text{ KN/m}^2$

Given Data,



Stress diagram



(Q) A soil profile have 1m below of ground water table. Calculate total vertical stress, water pressure and effective vertical stress at the depth of 8m below the ground surface. Assume the unit weight of water $\gamma_w = 9.81 \text{ KN/m}^3$?

Soln:

Total vertical stress, $\sigma = 18 \times 1 + 20 \times 4 + 16 \times 3$

$\Rightarrow \sigma = 146 \text{ KN/m}^2$ (Ans)

Water pressure, $u = 0 + 4 \times 9.81 + 3 \times 9.81$

$= 68.67 \text{ KN/m}^2$ (Ans)

Effective vertical stress, $\sigma' = \sigma - u$

$= 146 - 68.67$

$= 77.33 \text{ KN/m}^2$ (Ans)

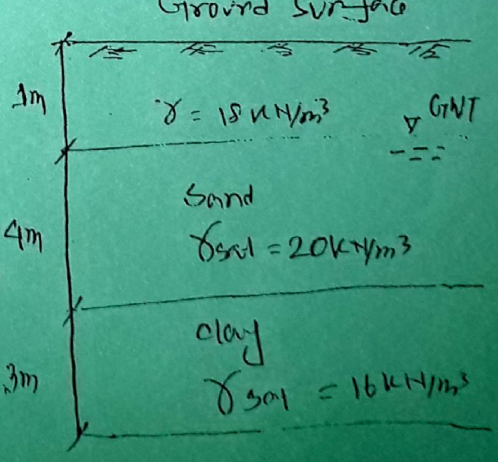


Fig. Soil Profile

Q. For a variable head permeability test, the following are given, Length of specimen 15 in, area of specimen $3in^2$ and $k = 0.0688$ in/min. What should be area of the standpipe for head to drop from 25 to 12 in in 8 min ?

Soln: we know that

$$k = \frac{2.303aL}{At} \log_{10}\left(\frac{h_1}{h_2}\right)$$

$$\Rightarrow 0.0688 = \frac{2.303 \times a \times 15}{3 \times 8} \times \log_{10}\left(\frac{25}{12}\right)$$

↑ (simple cal' log)

$$\Rightarrow 0.0688 = 0.4588\, a$$

$$\Rightarrow a = 0.15\ in^2$$

Given data,

$k = 0.0688$ in/min

$a = ?$

$L = 15$ inch

$A = 3in\,cn^2$

$t = 8$ min

$h_1 = 25$ in

$h_2 = 12$ in

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Q.36. Unified Soil Classification System?

Ans: The Unified Soil Classification System (USCS) is a soil classification system used in engineering and geology to describe the texture and grain size of a soil. The classification system can be applied to most unconsolidated materials, and is represented by a two-letter symbol. Each letter is described below (with the exception of Pt):

First and/or second letters

Letter	Definition
G	gravel
S	sand
M	silt
C	clay
O	organic

Second letter

Letter	Definition
P	poorly graded (uniform particle sizes)
W	well-graded (diversified particle sizes)
H	high plasticity
L	low plasticity

If the soil has 5–12% by weight of fines passing a #200 sieve ($5\% < P_{\#200} < 12\%$), both grain size distribution and plasticity have a significant effect on the engineering properties of the soil, and dual notation may be used for the group symbol. For example, GW-GM corresponds to "well-graded gravel *with silt*."

If the soil has more than 15% by weight retained on a #4 sieve ($R_{\#4} > 15\%$), there is a significant amount of gravel, and the suffix "with gravel" may be added to the group name, but the group symbol does not change. For example, SP-SM could refer to "poorly graded SAND with silt" or "poorly graded SAND with silt and gravel."

Symbol chart

Major divisions			Group symbol	Group name
Coarse grained soils more than 50% retained on or above No.200 (0.075 mm) sieve	gravel > 50% of coarse fraction retained on No. 4 (4.75 mm) sieve	clean gravel <5% smaller than #200 Sieve	GW	well-graded gravel, fine to coarse gravel
			GP	poorly graded gravel
		gravel with >12% fines	GM	silty gravel
			GC	clayey gravel
	sand ≥ 50% of coarse fraction passes No.4 sieve	clean sand	SW	well-graded sand, fine to coarse sand
			SP	poorly graded sand
		sand with >12% fines	SM	silty sand
			SC	clayey sand
Fine grained soils 50% or more passing the No.200 sieve	silt and clay liquid limit < 50	inorganic	ML	Silt
			CL	clay of low plasticity, lean clay
		organic	OL	organic silt, organic clay
	silt and clay liquid limit ≥ 50	inorganic	MH	silt of high plasticity, elastic silt
			CH	clay of high plasticity, fat clay
		organic	OH	organic clay, organic silt
Highly organic soils			Pt	peat

Q. A Layered of soil shown in figure where $H_1 = 3\,H$, $k_1 = 10^{-4}$ cm/s, $H_2 = 4\,H$, $k_2 = 3.2\times10^{-2}$ cm/sec and $H_3 = 6\,H$, $k_3 = 4.1\times10^{-5}$ cm/sec. Determine the ratio of equivalent permeability ?

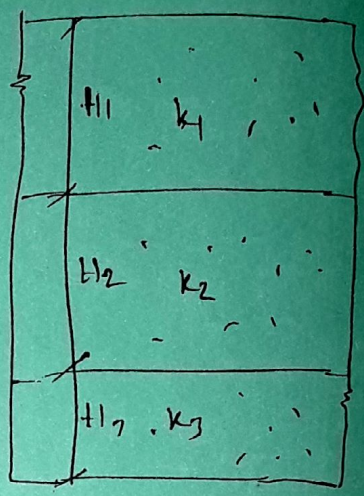
Soln

i) Equivalent hydraulic conductivity in horizontal direction

$$k_{H(eq)} = \frac{1}{H}(k_1 H_1 + k_2 H_2 + k_3 H_3)$$

$$= \frac{1}{3+4+6}(10^{-4}\times 3 + 3.2\times10^{-4}\times 4 + 4.1\times10^{-5}\times 6)$$

$$= 98.88\times10^{-4}\ \text{cm/sec}$$



ii) Equivalent hydraulic conductivity in vertical direction

$$k_{v(eq)} = \frac{H}{\frac{H_1}{k_1} + \frac{H_2}{k_2} + \frac{H_3}{k_3}} = \frac{3+4+6}{\frac{3}{10^{-4}} + \frac{4}{3.2\times10^{-4}} + \frac{6}{4.1\times10^{-5}}}$$

$$\Rightarrow k_{v(eq)} = 0.737\times10^{-4}\ \text{cm/sec}$$

Now, Ratio of equivalent Permeability $= \frac{k_{H(eq)}}{k_{v(eq)}} = 134.17$ (Ans)

Q. A soil layer having 100mm × 100mm cross section. water is supplied to maintain a constant head difference 300mm across the sample. The hydraulic conductivities of soil in the direction of flow through them are $h_1 = 150$mm, $k_1 = 10^{-2}$ cm/sec, $h_2 = 150$mm, $k_2 = 3\times10^{-3}$ cm/sec & $h_3 = 150$mm & $k_3 = 4.9\times10^{-4}$ cm/sec. Find the rate of water supply in cm^3/hr ? [Water flow 90° in sample so $k_{eq(v)}$ 2°] [If water flow same as sample 0° $k_{H(eq)}$ 2°]

Soln We know,

$$k_{v(eq)} = \frac{H}{\frac{h_1}{k_1} + \frac{h_2}{k_2} + \frac{h_3}{k_3}} = \frac{450}{\frac{150}{10^{-2}} + \frac{150}{3\times10^{-3}} + \frac{150}{4.9\times10^{-4}}} = 0.001213\ \text{cm/sec}$$

Now, $Q = k_{eq} i A = 0.001213 \times \frac{300}{450} \times \left(\frac{100}{10}\times\frac{100}{10}\right) = 0.0809\ cm^3/s$

$= 291.24\ cm^3/hr$ (Ans)

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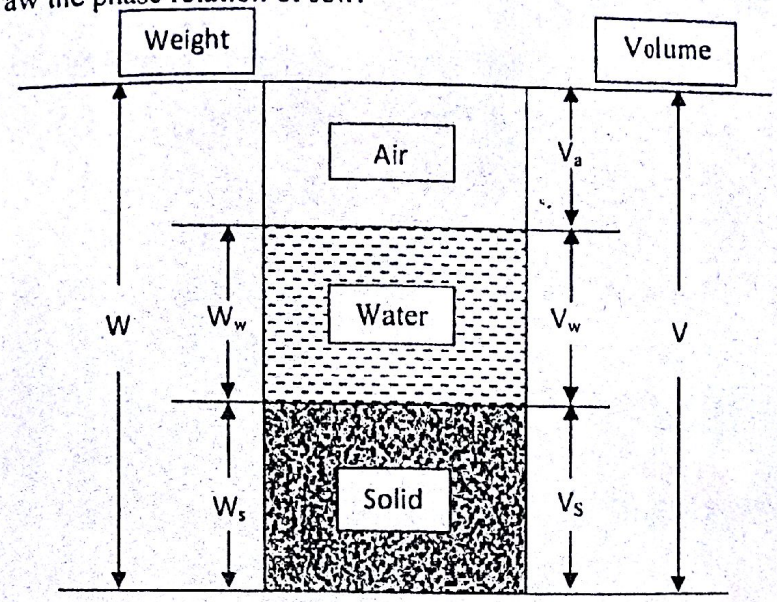
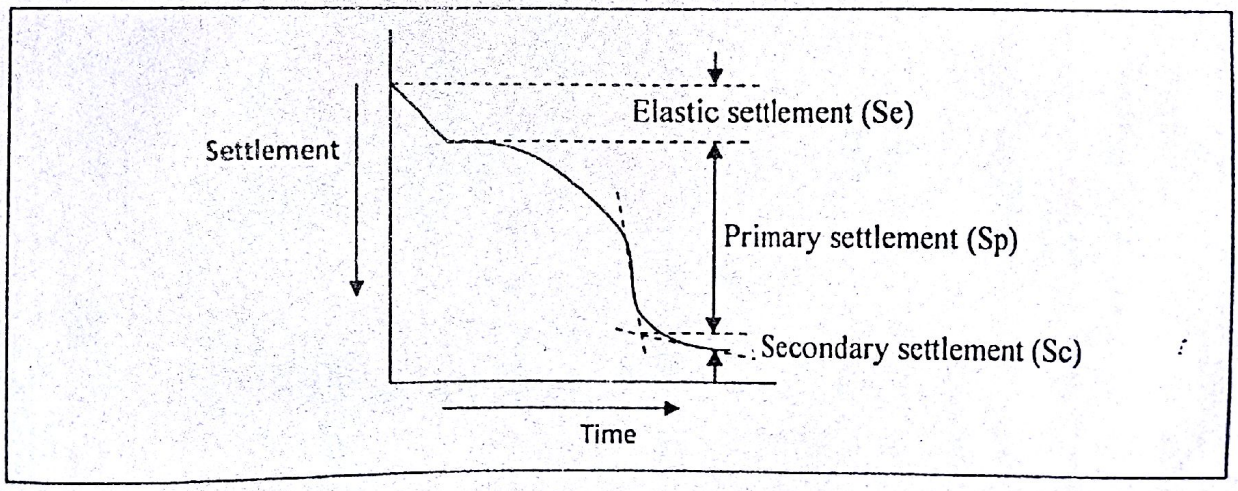
Q.37. What are the type of shear test of soil?
Ans: There are three (03) types of shear test-
(1) UU- Unconsolidated - Undraine shear test or Quick shear test or Φ test.
(2) CU- Consolidated - Undraine shear test or Consolidated Quick shear test or ΦC test.
(3) CD- Consolidated - Drained shear test or drain test or slow test.

Q.38. Draw the phase relation of soil?
Ans:



Q.39. Write down the types of settlement with sketch?
Ans: There are three types of settlement as below-
1. Elastic settlement or immediate settlement
2. Primary consolidation settlement
3. Secondary consolidation settlement



Total settlement, St = Se + Sp + Sc

DPD
MJ Q.39(a). Different between compaction and consolidation?
Ans:

Compaction	Consolidation
1. It is artificial process	1.It is natural process
2. Volume reduction due to expulsion of air	2. Volume reduction due to expulsion of water
3. Suddenly occur	3. Gradually occur
4. Dry density increases water content does not change	4. Dry density increases water content decreases
5. Application for unsaturated soil	5. Application for saturated soil

Q. In a labratory, soil sample 50% consolidates in 3 min, Which thickness is 2.5cm, what is time required is 6m soil sample in same rate of consolidation?

Soln: We know that,

$$t = \frac{T_v d^2}{c_v}$$

$$\Rightarrow t = \frac{\pi/4 \left(\frac{U\%}{100}\right)^2 \times 300^2}{c_v} \quad \text{--- (1)}$$

Given data,
Degree of consolidation, $U\% = 50$
Time factor, $T_v = \pi/4 \left(\frac{U\%}{100}\right)^2$
$= \pi/4 \left(\frac{50}{100}\right)^2 = 0.196$
$d = 6m/2 = 3m = 300cm$
$d_1 = 2.5cm/2 = 1.25cm = 1.25 cm$
$t = 3 min = 3 \times 60 = 180 sec$

Now, $c_v = \frac{T_v d_1^2}{t}$

$= \frac{0.196 \times 1.25^2}{180} = 1.7 \times 10^{-3} cm/sec$

(1) $\Rightarrow t = \frac{0.196 \times 300^2}{1.7 \times 10^{-3}} = 10.376 \times 10^6 sec = 120 days$ (Ans)

[P.T.U]

Q. Draw the phase diagram of saturated soil, Partially saturated soil & dry soil?

Ans:

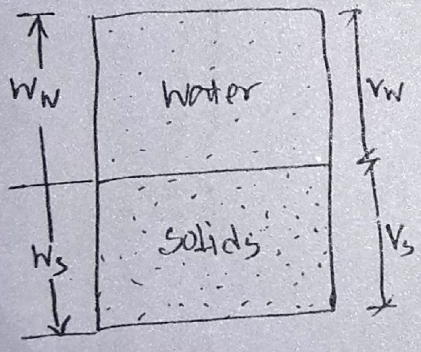


Fig: Fully saturated soil

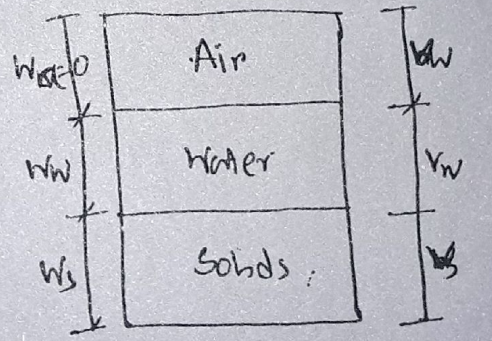


Fig: Partially saturated soil

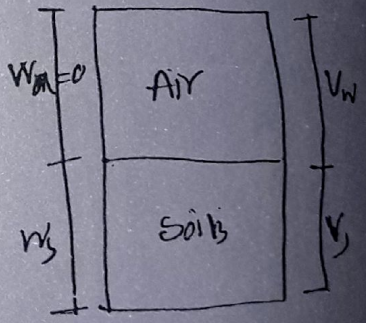


Fig: Dry soil

Q.

$C_c = 0.009(LL - 10)$ → for undisturbed clay

$C_c = 0.007(LL - 10)$ → for remolded clay

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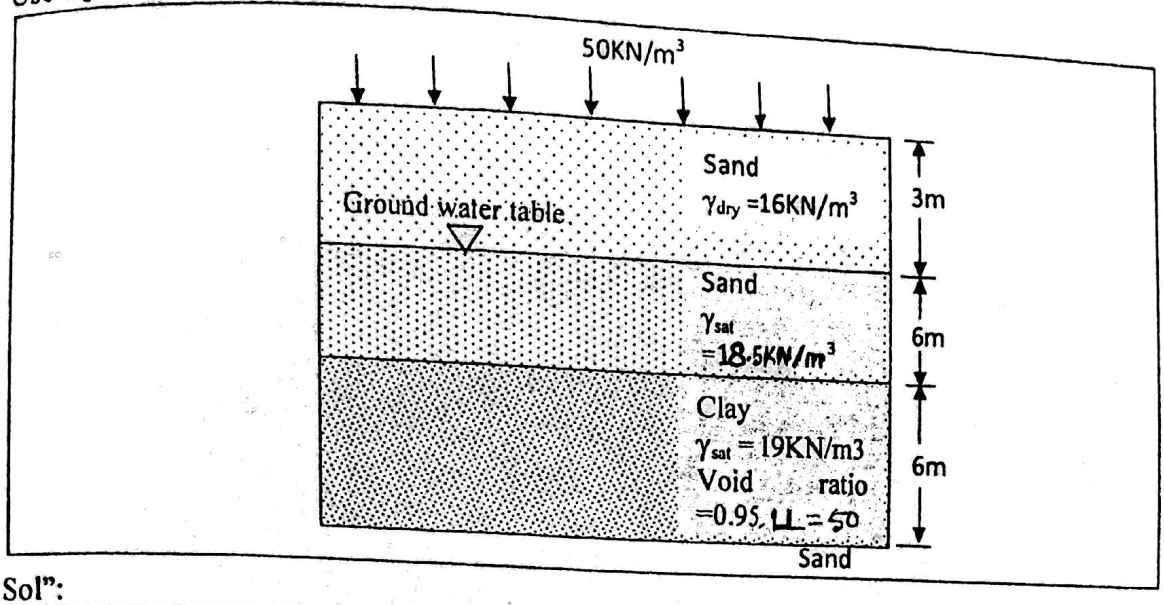
(Q.40.) A soil profile shown in figure. If a uniformly distributed load is applied at the ground surface, what is the settlement of the clay layer caused by primary consolidation if
i) The clay is normally consolidated.
ii) The preconsolidation pressure is 190 KN/m^2
iii) The preconsolidation pressure is 170 KN/m^2
Use C_S = 1/5 C_C to 1/10 Cc



Sol":

i) For normally consolidated clays

The average **effective stress** at the middle of the clay layer is

$P_0 = H_1\gamma_{dry(sand)} + H_2(\gamma_{sat(sand)} - \gamma_w) + \frac{1}{2} H_3 (\gamma_{sat(Clay)} - \gamma_w)$

$\Rightarrow P_0 = 3 \times 16 + 6 \times (18.5 - 9.81) + \frac{1}{2} \times 6 \times (19 - 9.81)$

$\Rightarrow$ Initial effective overburden pressure, P_0=127.71 KN/m^2

We know that,

For normally consolidated clays $S = C_cH/(1+e) \log (P_0 + \Delta p)/P_0$

$\Rightarrow S = ((0.36 \times 6)/(1+0.95)) \times \log((127.71 + 50)/127.71)$ = 0.159m = 159mm (Ans)

ii) if $P_0 + \Delta p \leqq P_C$

For over consolidated clays, $S = C_SH/(1+e) \log (P_0 + \Delta p)/P_0$

$\Rightarrow S = ((0.072 \times 6)/(1+0.95)) \times \log((127.71+50)/127.71)$ = 0.032m = 32mm (Ans)

iii) if $P_0 + \Delta p \geqq P_C$

For over consolidated clays, $S = C_SH/(1+e) \times \log(P_C/P_0) + C_cH/(1+e) \log (P_0 + \Delta p)/P_c$

$\Rightarrow S = ((0.072 \times 6)/(1+0.95)) \times \log(170/127.71) + ((0.36 \times 6)/(1+0.95)) \times \log((127.71 + 50)/170) = 0.049m = 49mm (Ans)$

Given data,
H_1 = 3m
H_2 = 6m
H_3 = 6m
Liquid limit, LL =50
Compressive index, $C_C = (e_1 - e_2)/(\log(P_0/P_1)) = 0.009(LL - 10) = 0.009 \times (50-10) = 0.36$
Increase of vertical pressure or applied distribution load, Δp = 50 KN/m^2
ii) if $P_0 + \Delta p \leqq P_C$
$\Rightarrow$127.27 + 50 = 177.71KN/m^2 $\leqq P_C$ =190KN/m^3
Swelling index, C_S = 1/5 x C_C =1/5 x 0.36 = 0.072
iii) if $P_0 + \Delta p \geqq P_C$
$\Rightarrow$127.27 + 50 = 177.71KN/m^2 $\geqq P_C$ =170KN/m^3

i) Settlement, $S = \frac{C_cH}{1+e} \log_{10} \left(\frac{P_0 + \Delta P}{P_0}\right)$

ii) Settlement, $S = \left(\frac{\Delta e}{1+e}\right) H$

iii) Settlement, $S = \left(\frac{a_v}{1+e}\right) \Delta P H$ Here, $a_v = \frac{\Delta e}{\Delta P}$

$S = m_v \Delta P H$

iv) $OCR = \frac{P_c}{P_0} = \frac{\text{Pre consolidated ratio}}{\text{over consolidated ratio}}$

v) If OCR > 1 or $P_0 < P_c$ soil is OC clay

vi) If OCR < 1 or $P_0 \geqslant P_c$ soil is NC clay

Q.42. Calculate the settlement of a 2.5m deep clay layer due to increase of 30KN/m^2 pressure at mid height of clay layer. Given effective vertical stress at mid height of layer 130KN/m^2 , e =0.80 and Cc = 0.28?

Sol":

We know that, For normally consolidated clays ,S = $C_cH/(1+e) \log (P_0 + \Delta P)/P_0$ => S =((0.28 x 2.5)/(1+0.80)) x log((130 + 30)/130) = m (Ans)	Given Data, e = 0.80 Cc = 0.28 P_0 = 130Kn/m^2 ΔP = 30KN/m^2 H = 2.5m

Q.43. The average natural water content of the normal clay deposit is 40%, unit weight is 2.8gm/cc and compressive index is 0.36. If C_v = 6 x 10-5 sft/min and clay deposits 20ft thick. Find settlement if drained top and bottom the existing effective overburden pressure at the centre of clay layer is 2.0 ton/sft and the increase of pressure causing the expected settlement is 0.289 ton/sft?

Sol":

We know that, $\gamma_s = G_s/V_s$ => $G_s = \gamma_s$ x V_s = 2.8 x 1 = 2.8 Again, e = wG = 0.40 x 2.8 = 1.12 For normally consolidated clays ,S = $C_cH/(1+e) \log (P_0 + \Delta P)/P_0$ => S =((0.36 x 20)/(1+1.12)) x log((2.0 + 0.289)/2.0) = 0.199ft = 2.4inch (Ans)	Given Data, Cv = 6 x 10-5 sft/min V_s = 1 cc γ_s = 2.8gm/cc w = 40% = 0.04 Cc = 0.36 P_0 = 2.0 ton/sft ΔP = 0.289 ton/sft H = 20ft

Q.44. The laboratory consolidation data on undisturbed clay sample are as follow e_0 =1.1, P_0 = 95kpa, e_1 = 0.90 and P_1 = 475kpa. Calculate the coefficient of volume compressibility, (m_v) and what will be the void ratio for a pressure of 600kpa and effective pressure in 95kpa?

Sol":

We know that, Volume compressibility, $m_v = 1/(1+e_0)$ x $(e_0 - e_1)$ /($P_1 - P_0$) => m_v = 1/(1+1.1) X (1.1 – 0.9) /(475 – 95) = 2.5 x 10^{-4} m^2/KN (Ans) Again ,We know that, Cc = $(e_0 - e_1)$ /(log(P_0/ P_1)) => Cc = (1.1 – 0.9) /(log(475/95)) => Cc = 0.286 Now, Again, Cc = $(e_0 - e_1)$ /(log(P_0/ P_1)) => 0.286 = (1.1 – e_1) /(log(600/95)) => e_1 = 0.871 (Ans)	Given data, e_0 = 1.1 e_1 = 0.9 P_0 = 95kpa P_2 = 475kpa m_v = ? Again, e_0 = 1.1 e_1 = ? P_0 = 95kpa P_2 = 600kpa

Q. Calculate the total settlement of compressible soil stratum 2m depth and co-efficient of compressibility 0.2cm^2/kg under a pressure increment of 2 kg/cm^2 ?

Soln: we know that Total Settlement, $S_L = \Delta p m_v H$ $\Rightarrow S_L$ = 2 kg/cm^2 x 0.2 cm^2/kg x 2m = 0.8 m = 80 cm (Ans)	Given data, Compressibility Co efficient, m_v = 0.2 cm^2/kg Soil stratum depth, H = 2m Pressure increment, ΔP = 2 kg/cm^2 Total Settlement, S_L = ?

DPPS)

Q Determine Ultimate pile capacity of clay soil when pile length 20ft and dia 15". $\alpha = 0.52$ with un confined compressive strength 30 kip/in^2 ?

Soln

Skin friction $= \alpha_2 c$ Asurface

$= 0.52 \times 30/2 \times \pi DL$

$= 0.52 \times 30/2 \times \pi \times 15 \text{ inch} \times (20 \times 12)$

$= 88216$ kips

End Bearing $= c\, N_c A_{tip}$

$= 30/2 \times 9 \times \frac{\pi \times 15^2}{4}$ ($N_c = 9$ for single action and Group action)

$= 23856$ kips

Total pile capacity $= 88216 + 23856 = 112072$ kip (Ans)

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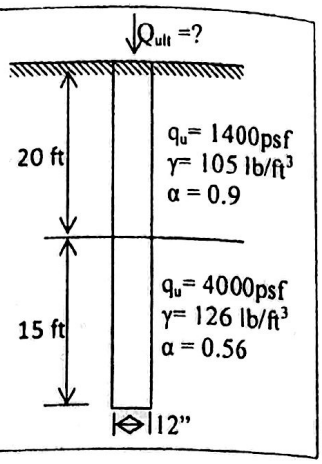
Q.46. Determine pile capacity in clay for following data?
Sol":

We know that,
$Q_{ult} = \alpha C.\Pi DL + CN_c.\Pi d^2/4$
$\Rightarrow Q_{ult} = (0.9 \times 1400/2 \times 3.14 \times 1 \times 20 + 0.56 \times 4000/2 \times 3.14 \times 1 \times 15) + 4000/2 \times 9 \times 3.14 \times 1^2/4$
$\Rightarrow Q_{ult} = 106446$ Pound
$\Rightarrow Q_{ult} = 106.44$kips (Ans)
Again, $Q_{design} = Q_{ult}/F.S$
$\Rightarrow Q_{design} = 106.44/2 =$ 53.22kips (Ans)

Given data,
Q_{ult} = Pile capacity in clay=?
Q_{design} =Design capacity of clay =?
α = Adhesion factor = (generally used 0.4 to 0.95)
C = Cohesion for clay (fully saturated condition) = $q_u/2$
N_c = Bearing capacity factor of soil = Usually this value is 9
D = Dia of Pile =12 inch= 1ft
F.S = Factor of Safety =2 for single pile.



Q.47. Determine group pile capacity in clay for following data?
Sol":

We know that,
Case :1 If S ≧3d
$Q_{(design)Group\ pile} = N.E_g.Q_{(design)single\ pile}$

Where,
N = Number of Pile
E_g = 1- θ/90 x[((n-1)m +(m-1)n)/mn]→ Normally this value 0.7 to 1
θ = $\tan^{-1}$(d/s)
d = dia of pile
S = Centre of centre spacing of pile (Usually 3d to 8d)
n = No of row in a group
m = No of column in a group

Case :2 If S ≦3d
$Q_{(ult)Group\ pile} = 2D_h\,(W + L)\,\alpha C + 1.3C.NcWL$

Where,
W = Width of pile group
L = Length of pile group
C = Cohesion
N_c = usually used 9
D_h = Depth of Pile group
Now, $Q_{(design)Group\ pile} = Q_{(ult)Group\ pile}/F.S$

Given data,
Q_{ult} = Pile capacity in clay= $Q_{ult} = \alpha C.\Pi DL + CN_c.\Pi d^2/4$
$Q_{(design)single\ pile} = Q_{ult}/F.S$
α = Adhesion factor = (generally used 0.4 to 0.95)
C = Cohesion for clay (fully saturated condition) = $q_u/2$
Nc = Bearing capacity factor of soil = Usually this value is 9
D = Dia of Pile =12 inch= 1ft
F.S = Factor of Safety =3 for group pile.

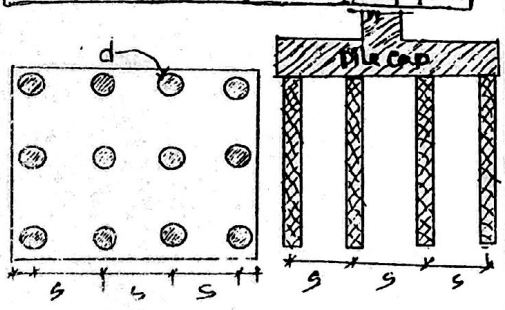


Fig: Pile

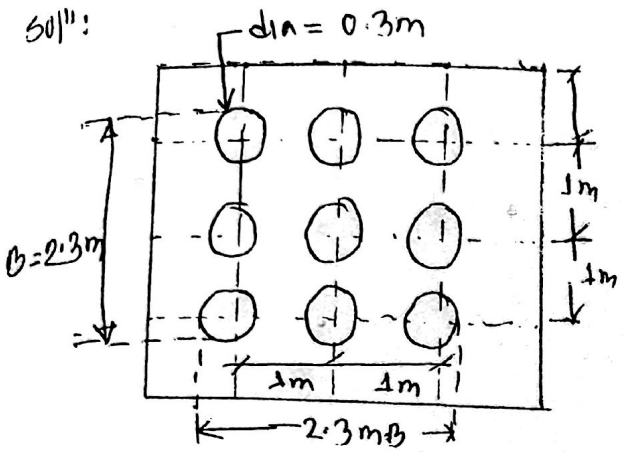
Q.48. Define foundation?
Ans: Define as foundation-
1. A foundation is that part of a structure which transmits the weight of the structure to ground.
2. A foundation distributes the load of the super structure on a large area.

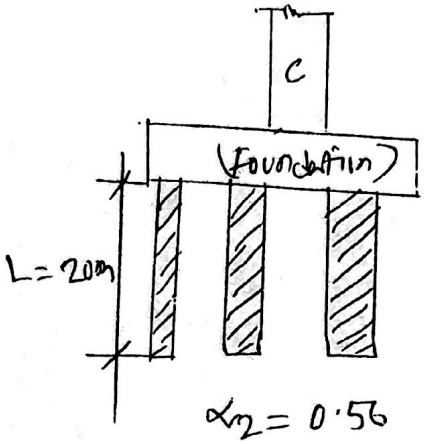
(Q.) Depth of foundation, $D = \frac{P}{W_s}\left(\frac{1-\sin\phi}{1+\sin\phi}\right)^2$ ϕ = Angel of repose

Where, P = Safe bearing capacity of soil
W_s = Unit weight of soil = 1600 Kg/m^3

Q. A pile group consists of a 9 friction pile in cohesive soil (clay) as shown in figure the dia of each pile is 0.3m & centre to centre distance of two piles 1m. Compute the ultimate design capacity of the group of pile?

Soln:





$\alpha_2 = 0.56$

$\sigma_v = 60\ kN/m^2$

$C = \sigma_v/2$

① Individual action

Skin friction $= \alpha_2 C A_{surface}$ [Always $N_c = 9$]

$= 0.56 \times 60/2 \times \pi DL$

$= 0.56 \times 30 \times \pi \times 0.3 \times 20$ [Single pile, FS = 2]

$= 316.67\ kN$

End Bearing $= C N_c A_{tip}$

$= 60/2 \times 9 \times \frac{\pi D^2}{4}$

$= 9 \times 30 \times \frac{\pi \times 0.3^2}{4}$

$= 19.1$

Total capacity of pile $= (316.67 + 19.1) \times 9 = 3021.93\ kN$ ----①

② Group action

Skin friction $= \alpha_2 C A_{surface}$

$= 1 \times 60/2 \times (4BL)$

$= 1 \times 30 \times 4 \times 2.3 \times 20 = 5520\ kN$

End Bearing $= 9 C A_{tip}$

$= 9 \times 60/2 \times (2.3 \times 2.3)^2 = 1428.3\ kN$

[Group pile; $\alpha_2 = 1$ (always); $A_{tip} = B \times B$; FS = 3 (always)]

Total capacity $= 6948.3\ kN$ ----②

Now Ultimate capacity of group pile is $= 3021.93\ kN$

$\therefore$ Allowable capacity $= \frac{3021.93}{3} = 1007.31\ kN$. (Ans)

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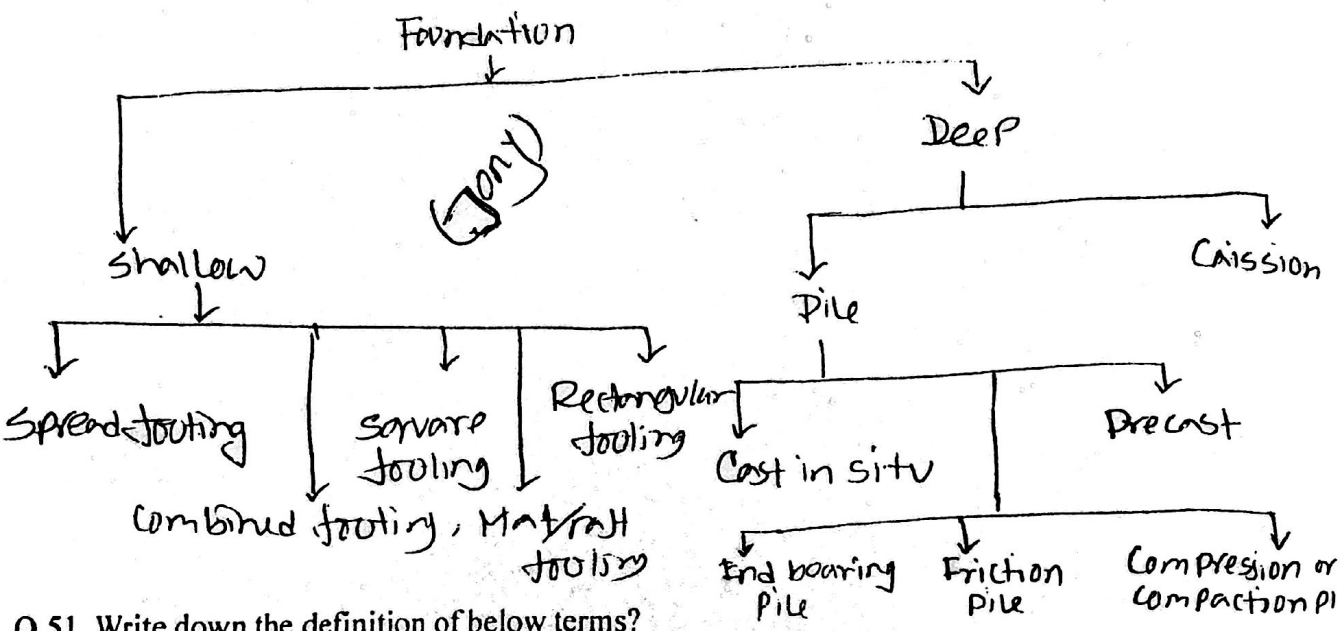
Q.49. Write down the design criteria of foundation?
Ans: The design criteria of foundation –
1. The soil below foundation does not fail in shear
2. The settlement is within safe limit.

Q.50. Write down the types of foundation?
Ans:

Foundations are structural components used to support column and transfe
loads to the underlying soil.



Q.51. Write down the definition of below terms?
Ans: **Bearing capacity of soil:** It may be defined as the capacity of soil held to bear the loads of super structure without shear failure and without excess settlement of soil. It is denoted by q
Ultimate Bearing capacity: It is the gross pressure at the base of the foundation at which soil fails in shear. It is denoted by q_u
Net ultimate Bearing capacity: It is the net increases in pressure at the base of foundation that causes shear failure of the soil. It is equal to the gross pressure minus overburden pressure.
Thus $q_{nu} = q_u - \gamma D_f$
Net safe bearing capacity: It is the net soil pressure which can be safely applied to the soil considering shear failure. Thus, $q_{ns} = q_{nu}/FS$, Where FS = Factor of safety which is generally taken 3.0
Gross Safety bearing capacity: It is the maximum gross pressure which the soil can cary safety without shear failure. Thus $q_s = q_{ns} + \gamma D_f$
Net safe settlement pressure: It is the net pressure which the soil can carry without exceeding the allowable settlement. This is also known as unit soil pressure or safe bearing pressure.
Note: For individual footing the maximum allowable settlement generally varies 25mm to 40mm

Q.52. Write down the shear failure of foundation?
Ans: The shear failures of foundation are –
1. General shear failure
2. Local shear failure
3. Punching shear failure

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Q.53. Write down the effect of shear failure on bearing capacity for cohesive soil/ C-soil and C-φ soil?

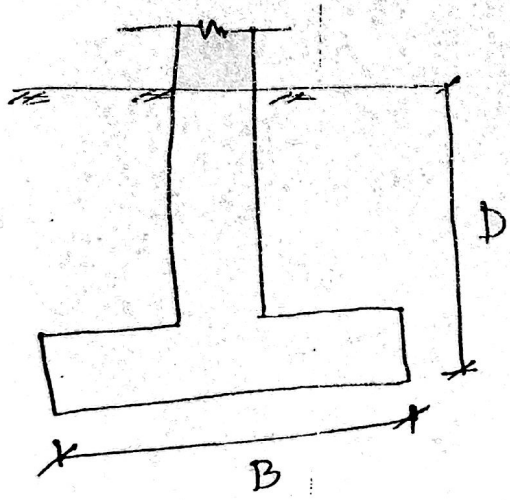
Ans: The effect of shear failure of foundation are-

C-soil	C-φ soil
1. General shear failure – No effect on C 2. Local shear failure – Mobilized cohesion, $C_d = 2/3\ C$ 3. Punching shear failure – No effect on C	1. General shear failure – No effect on C 2. Local shear failure – Mobilized cohesion, $C_d = 2/3\ C$ and $\varphi_d = \tan^{-1}[2/3 \times \tan\varphi]$ 3. Punching shear failure – No effect on C

Q.54. What is thixotropy?

Ans: Thixotropy defined as an isothermal, reversible, time dependent process occuring under conditions of constant composition and volume whereby a material stiffness when at rest and softens or liquifie upon remolding.

Q. Define shallow and Deep foundation?



$D/B \leq 1$ = shallow foundation

$D/B > 1$ but < 15 = Moderate deep "

$D/B > 15$ = Deep foundation

Practically $L > 5B$ = Strip foundation.

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Q.56. Write down the assumption of Tarzaghis soil bearing capacity theory?
Ans: The assumptions are –
1. Footing base rough
2. Footing lay at shallow depth, $D_f \leq B$
3. Shear strength neglect above footing level and consider surcharged weight γD_f
4. Footing load is vertical and UDL.
5. Footing is long (L/B ratio is infinite)
6. Water table far from foundation level
7. Shear strength of soil is governed by the mohr-columb equation

General Bearing capacity equation

$q_{ult} = CN_c f_{cs} f_{cd} f_{ci} + qN_q f_{qs} f_{qd} f_{qi} + 0.5\gamma B N_\gamma f_{\gamma s} f_{\gamma d} f_{\gamma i}$

Gross allowable bearing capacity with respect to shear failure,

$q_{all(shear)\ gross} = C_d N_c f_{cs} f_{cd} f_{ci} + qN_q f_{qs} f_{qd} f_{qi} + 0.5\gamma B N_\gamma f_{\gamma s} f_{\gamma d} f_{\gamma i}$

Where,
N_c, N_q, N_γ = Bearing capacity factor
$f_{cs} f_{cd} f_{ci}$ = Shape factor
$f_{qs} f_{qd} f_{qi}$ = Depth factor
$f_{\gamma s} f_{\gamma d} f_{\gamma i}$ = Load inclination factor
$q = \gamma D_f$

Ultimate Bearing capacity of soil

$q_{ult} = CN_c + qN_q + 0.5\gamma B N_\gamma$ --------->For strip footing

$q_{ult} = 1.3CN_c + qN_q + 0.4\gamma B N_\gamma$ --------> For Square footing.

$q_{ult} = 1.3\ CN_c + qN_q + 0.3\gamma B N_\gamma$ --------->For circular footing

Where,
N_c, N_q, N_γ = Bearing capacity factor
$q = \gamma D_f$

Effect of water table:

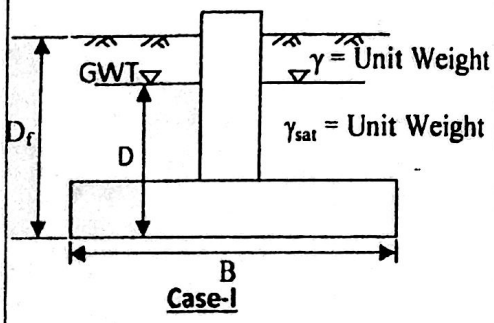
Case-I

It the groundwater table is located at a distance D above the bottom of the foundation, the magnitude of q in the **second term** of the bearing capacity equation should be calculated as,

$q = \gamma' D + (D_f - D)\gamma$

Where, $\gamma' = \gamma_{sat} - \gamma_w$ = effective unit weight of soil.

And **third term** of the bearing capacity equations should be replaced by γ'

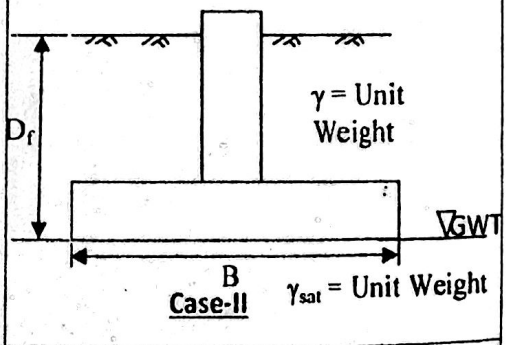


Case-II

It the groundwater table coincides with the bottom of the foundation, the magnitude of q in the **second term** of the bearing capacity equation should be calculated as,

$q = \gamma D_f$

And **third term** of the bearing capacity equations should be replaced by γ', Where, $\gamma' = \gamma_{sat} - \gamma_w$ = effective unit weight of soil.



Case-III

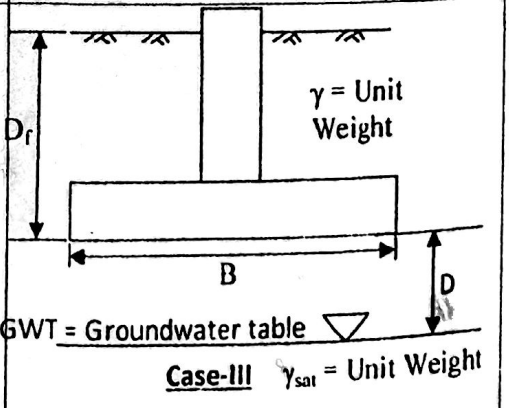
It the groundwater table is at a depth D below the bottom of the foundation, the magnitude of q in the **second term** of the bearing capacity equation should be calculated as,

$q = \gamma D_f$

And **third term** of the bearing capacity equations should be replaced by γ_{av},

$\gamma_{av} = 1/B[\gamma D + \gamma'(B - D)]$----------> for $D \leq B$

$\gamma_{av} = \gamma$----------> for $D > B$



(Q.57.) Determine the ultimate bearing capacity of a strip footing 1.2m wide and having the depth of foundation is 1m, if take for C-φ soil , C = 18KN/m^2, γ = 18KN/m^3, φ = 35^0 , Nc = 57.7, Nq = 14.4, Nγ = 42.4] and take for C-soil C = 30KN/m^2, γ = 20KN/m^3, φ = 0 then [Nc = 5.14 and Nq = 1.0 and Nγ = 2.4] i) General shear failure and ii) Local shear failure.?

Sol":

For C-φ soil **i) General shear failure** Ultimate Bearing capacity of soil for strip footing, $q_{ult} = CN_c + qN_q + 0.5\gamma BN_\gamma$ $\Rightarrow q_{ult}$ = 18 x 57.7 + 18 x 14.4 + 0.5 x 18 x 1.2 x 42.4 = 1755.7KN/m^2 (Ans) **ii) Local shear failure** Ultimate Bearing capacity of soil for strip footing, $q_{ult} = CN_c + qN_q + 0.5\gamma BN_\gamma$ $\Rightarrow q_{ult}$ = 12 x 25.1 + 18 x 12.7 + 0.5 x 18 x 1.2 x 9.7 = 634.6KN/m^2 (Ans)	Given data, **i) General shear failure** B = 1.2m , D_f = 1m , q = γD_f = 18 x 1 =18KN/m^2 C = 18KN/m^2, γ = 18KN/m^3, φ = 35^0 , Nc = 57.7, Nq = 14.4, Nγ = 42.4 **ii) Local shear failure** B = 1.2m , D_f = 1m , q = γD_f = 18 x 1 =18KN/m^2 C = 2/3 x 18KN/m^2 = 12 KN/m^2, γ = 18KN/m^3, φ = $\tan^{-1}$[2/3 x tan35^0] = 25^0, Nc = 25.10, Nq = 12.7, Nγ = 9.7[Given that this value of Nc, Nq & Nγ]
For C-soil **i) General shear failure** Ultimate Bearing capacity of soil for strip footing, $q_{ult} = CN_c + qN_q + 0.5\gamma BN_\gamma$ $\Rightarrow q_{ult}$ = 30 x 5.14 + 20 x 1.0 + 0 = 174.1KN/m^2 (Ans) **ii) Local shear failure** Ultimate Bearing capacity of soil for strip footing, $q_{ult} = CN_c + qN_q + 0.5\gamma BN_\gamma$ $\Rightarrow q_{ult}$ = 20 x 5.14 + 20 x 1 + 0 = 122.8KN/m^2 (Ans)	Given data, **i) General shear failure** B = 1.2m , D_f = 1m , q= γD_f = 20 x 1 =20KN/m^2 C = 30KN/m^2, γ = 20KN/m^3, φ = 0^0 , Nc =5.14, Nq = 1.0, Nγ = 2.4 [Last value =0 because this value are depends on inclination, φ =0] **ii) Local shear failure** B = 1.2m , D_f = 1m , q= γD_f = 20 x 1 =20KN/m^2 C = 2/3 x 30KN/m^2 =20KN/m^2, γ = 20KN/m^3, φ = $\tan^{-1}$[2/3 x tan0^0] = 0^0 , Nc = 5.14, Nq = 1.0, Nγ = 2.4[Last value =0 because this value are depends on inclination, φ =0 and bearing factor fixed because φ =0]

IMP

Q.58. Write down the factors affecting the bearing capacity of shallow foundation resting on sand

Ans: The factors are -

1. Nature of soil/its physical & Engineering properties
2. Nature of the foundation
3. Site, shape, depth of the foundation.
4. Rigidity of structure
5. Total & differential settlements of that structure
6. Location of ground water table
7. Initial stresses, if any.

(Q.59) A 2m x 2m footing is laid at a depth of 1.3m below the ground surface. Determine the ultimate bearing capacity if i) water table rises to the level of the base, ii) water table rise the ground surface, iii) water table is 1m below the base, iv) water table is 0.5m below the ground surface, given data $\gamma = 20KN/m^3$, $C = 24KN/m^2$, $\varphi = 30^0$ Nc = 37.2, Nq = 22.5 and $N\gamma = 19.7$?

Sol":

<u>i) water table rises to the level of the base</u> For square footing, $q_{ult} = 1.3CN_c + qN_q + 0.4\gamma' BN_\gamma$ $\Rightarrow q_{ult} = 1.3 \times 24 \times 37.2 + 20 \times 1.3 \times 22.5 + 0.4 \times 10.2 \times 2 \times 19.7 = 1906.39KN/m^2$ (Ans)	Given data,(case-II) B= 2m and D_f= 1.3m Ultimate Bearing capacity, q_{ult} = ? $\gamma' = 20\text{-}9.8 = 10.2KN/m^3$, $C = 24KN/m^2$, $\varphi = 30^0$ Nc = 37.2, Nq = 22.5 and $N\gamma$ = 19.7
<u>ii) water table rise the ground surface</u> For square footing, $q_{ult} = 1.3CN_c + qN_q + 0.4\gamma' BN_\gamma$ $\Rightarrow q_{ult} = 1.3 \times 24 \times 37.2 + 13.26 \times 22.5 + 0.4 \times 10.2 \times 2 \times 19.7 = 1619.74KN/m^2$ (Ans)	Given data,(case-I) B= 2m, D_f= 1.3m , D =1.3m $q = \gamma' D + (D_f - D)\gamma$ $\Rightarrow q = 10.2 \times 1.3 + (1.3\text{-}1.3) \times 20 = 13.26 KN/m^2$ Ultimate Bearing capacity, q_{ult} = ? $\gamma = KN/m^3$, $\gamma' = 20 - 9.8 = 10.2KN/m^3$, $C = 24KN/m^2$, $\varphi = 30^0$ Nc = 37.2, Nq = 22.5 and $N\gamma$ = 19.7
<u>iii) water table is 1m below the base</u> For square footing, $q_{ult} = 1.3CN_c + qN_q + 0.4\gamma_{av} BN_\gamma$ $\Rightarrow q_{ult} = 1.3 \times 24 \times 37.2 + 26 \times 22.5 + 0.4 \times 15.1 \times 2 \times 19.7 = 1983.62KN/m^2$ (Ans)	Given data,(case-III) B= 2m and D_f= 1.3m, D =1m Ultimate Bearing capacity, q_{ult} =? $\gamma = 20KN/m^3$, $\gamma' = 20\text{-}9.8 = 10.2KN/m^3$, $C = 24KN/m^2$, $\varphi = 30^0$ Nc = 37.2, Nq = 22.5 and $N\gamma$ = 19.7 **Second term** ,$q = \gamma D_f = 20 \times 1.3 = 26 KN/m^2$ **third term** γ should be replaced by γ_{av}, $\gamma_{av} = 1/B[\gamma D + \gamma'(B - D)]$----------> for $D \leq B$ $\Rightarrow \gamma_{av} = ½ \times [20 \times 1 + 10.2(2\text{-}1)] = 15.1 KN/m^3$
<u>iv) water table is 0.5m below the ground surface</u> For square footing, $q_{ult} = 1.3CN_c + qN_q + 0.4\gamma' BN_\gamma$ $\Rightarrow q_{ult} = 1.3 \times 24 \times 37.2 + 18.16 \times 22.5 + 0.4 \times 10.2 \times 2 \times 19.7 = 1730KN/m^2$ (Ans)	Given data,(case-I) B= 2m, D_f= 1.3m , D =1.3 – 0.5 = 0.8m $q = \gamma' D + (D_f - D)\gamma$ $\Rightarrow q = 10.2 \times 0.8 + (1.3\text{-}0.8) \times 20 = 18.16KN/m^2$ Ultimate Bearing capacity, q_{ult} = ? $\gamma = KN/m^3$, $\gamma' = 20 - 9.8 = 10.2KN/m^3$, $C = 24KN/m^2$, $\varphi = 30^0$ Nc = 37.2, Nq = 22.5 and $N\gamma$ = 19.7

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Q. Name 5 different procedures for site soil exploration?

Ans: The procedures are..

i) Test pits ii) Probing iii) Sub-surface sounding

iii) Boring v) Gun-physical method.

Q. Define Retaining wall and also write down their classification?

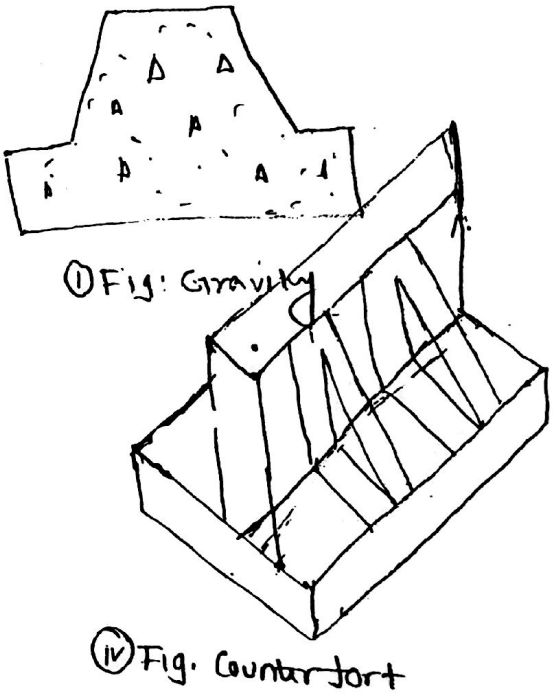
Ans: Retaining ~~wall~~ are structures designed

i) to retain soil to unnatural slopes

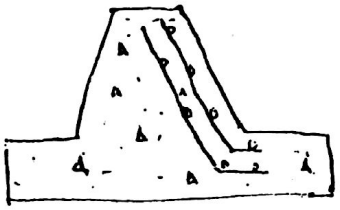
ii) to bound two difference level of soil

There are four types

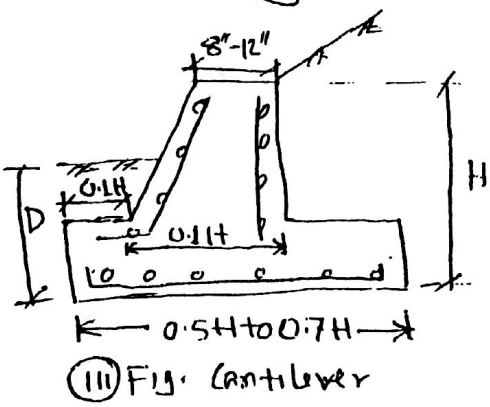
i) Gravity type retaining wall
ii) Semigravity retaining wall
iii) Cantilever retaining wall
iv) Counterfort retaining wall



① Fig: Gravity



⑪ Fig. semi gravity



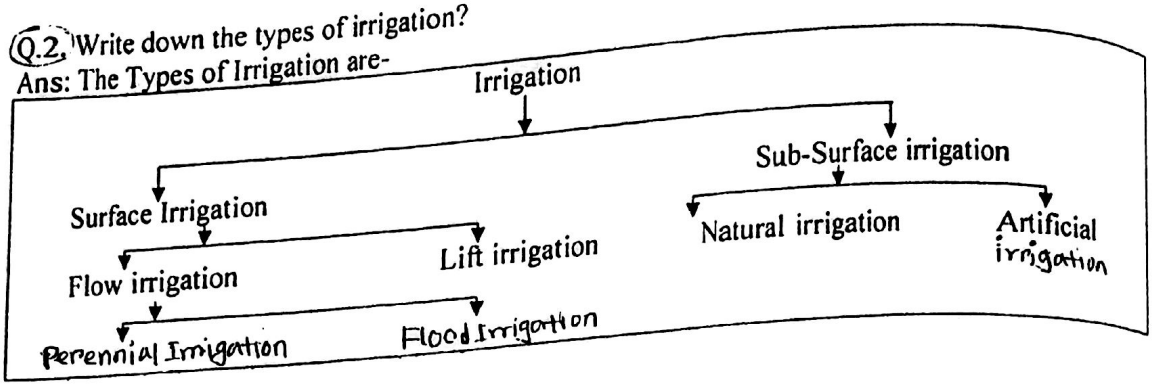
⑪ Fig. Cantilever

⑪ Fig. Counterfort

IRRIGATION ENGINEERING

Q.1. Define is irrigation water?
Ans: Irrigation may be defined as the science of artificial application of water in accordance with the crop requirement throughout the crop period for full nourishment.

Q.2. Write down the types of irrigation?
Ans: The Types of Irrigation are-



Q.3. Define Perennial irrigation?
Ans: Perennial irrigation was practiced in the Mesopotamian plain whereby crops were regularly watered throughout the growing season.

Q.4. Write down the method of irrigation?
Ans: The methods are-
1. Free flooding
2. Border flooding
3. Check flooding
4. Basin flooding
5. Furrow irrigation
6. Sprinkler irrigation
7. Drip irrigation

Q.5. Define Kor watering and Crop ratio?
Ans: **Kor watering:** The first watering given to the crop when it has grown a few centimeters is called kor watering. The optimum depth of kor watering 19cm for rice ,13.5cm for wheat and 16.5cm for sugarcane.
Crop Ratio: The ratio of the areas of the two main crop seasons, i.e, Kharif and Rabi, is called crop ratio. Where as Rabi seasons – 1st October to 31th March and Kharif seasons – 1st April to 30th September.

Q.6. Define crop period and base period?
Ans: **Crop period:** The time period from the instant of its sowing to the instant of its harvesting is called the crop period.
Base period: The time between the first watering of a crop at the time of sowing to its last watering before harvesting is known as base period.

Q.7. Define duty and delta of crop?
Ans: **Delta:** The total amount of water required by a crop to come to maturity is known as delta.
Duty: The number of hectors of land irrigated for full growth of a given crop by supply $1 m^3$/sec continuously during the base periods of that crop is known as duty of water.

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Q.8. Find the delta for a crop when its duty is 864 hac/m^3/sec of base period of 120 days?
Sol":

We know that, Delta , $\Delta = 864B/D$ Delta, $\Delta = 864 \times 120 / 864 = 120$ cm (Ans)	Given data, Base period, B = 120days Duty, D= 864 Hac/m^3/sec Delta, Δ =? cm

Q.9. The kor depth for rice 19cm and kor period is 14 days. The outlet factor for the crop in hectares per cumec will be?
Sol":

We know that, Delta , $\Delta = 864B/D$ Delta, $19 = 864 \times 14 / D$ $\Rightarrow D = 637$ Hac/m^3/sec (Ans)	Given data, Kor Period = Base period, B = 14days Outlet Factor = Duty, D= ? Hac/m^3/sec Kor Depth = Delta, Δ =19 cm

Q.10 Write down the definition of Paleo?
Ans: The first watering before sowing the crop is called Paleo

Q.11. Define rainfall?
Ans: The precipitation falling during the growing period of a crop that is available to meet the evapo-transpiration needs the crop is known as effective rain fall.

Q.12. Determine the time required to irrigation a land of 0.04Hac from a tube well with a discharge of 0.02 cumec infiltration capacity of soil is 5cm/hr with an average depth on the field is 10cm also determine the maximum land that can be irrigated?
Sol":

We know that, Required time to irrigated land, $t = 2.3 (y/f) \log_{10} (Q/(Q-fA))$ $\Rightarrow t = 2.3x (0.1/0.05) \times \log_{10}(72/(72-0.05 \times 400))$ $\Rightarrow t = 0.65$ hr (Ans) Max" land area for irrigate, $A_f = Q/f = 72/0.05$	Given data, Discharge, Q = 0.02 cumec = 0.02m^3/sec $=0.02 \times 60 \times 60 = 72m^3$/hr Average water depth, y = 10cm = 0.1m Infiltration capacity, f = 5cm/hr= 0.05m/hr Land area, A = 0.04 Hac = $0.04 \times 10000 = 400m^2$

Q.13. Write down the impurities of irrigated water?
Ans: The impurities of irrigated water are-
1. Sediment concentration in water
2. Total concentration of soluble in water
3. Proportion of sodium ions to the other cations

Q.14. How to indentify types of irrigated water?
Ans: Water identifications are two types which are-

A) By Sodium Absorption ratio (SAR) (i) If SAR = 0 to 10 = Low sodium water (ii) If SAR = 11 to 18 = Medium sodium water (iii) If SAR = 19 to 26 = High sodium water (iv) If SAR > 26 = Very high sodium water	B) By electrical conductivity (EC) (i) If EC < 250 micro mhos/cm = Low conductivity (ii) If EC = 250 to 750 = Medium conductivity (iii) If EC = 750 to 2250 = High conductivity (iv) If EC > 2250 = Very high conductivity

Q.15. Classify the irrigated water from the following data concentration of Na^+, Ca^{++} and Mg^{++} is 22, 3 and 1.5 multi- equivalent/litters and electrical conductivity in 200 micro-mhos/cm at 25°C?

Sol":

We know that,

Sodium Absorption Ratio, $SAR = Na^+ / (\sqrt{((Ca^{++} + Mg^{++})/2)}$

$\Rightarrow SAR = 22/ (\sqrt{((3+1.5)/2)}) = 14.67$

The SAR is 14.67 which between 10 to 18, So its Medium Sodium water (Ans)

Again,

Electrical conductivity is 200 micro-mhos/cm which between < 250, So it's Low Conductivity Water (Ans)

Given data,
$Na^+ = 22$
$Ca^{++} = 3$
$Mg^{++} = 1.5$
Water classification according to SAR and EC=?

Q.16. Define Precipitation, Vapour Pressure?

Ans: **Precipitation:** The water which comes back to the earth surface in various forms like rain, snow, hail etc is known as precipitation.

Vapour Pressure: The pressure exerted by the vapour present in the air is known as vapour pressure, If is the air is fully saturated with these vapour is called saturation vapour pressure or saturation pressure

Q.17. Define Humidity?

Ans: **Humidity:** The term humidity is used in order to obtain an idea of the amount of moisture.

Q.18 What do you mean by C_2-S_2 water?

Ans: C_2-S_2 means water of medium conductivity as well as it is a medium sodium water, From C_2-S_2 – i) SAR = 10 to 18 and ii) EC = 250mmhos/cm to 750mmhos/cm.

Q.19 Write down the losses of water in irrigation canal?

Ans: The losses of water in irrigation are –

(1) Evaporation: The water lost by evaporation. It's very small generally about 2% -3% of total loss

(2) Seepage: Two types of seepage

(i) Percolation (ii) Absorption

Q.20. Define Run-off and Catchment area?

Ans: Run-off: The amount of water which flow over the surface of the earth after all the losses have taken place is called Run-Off.

Catchment area: A tract of land which contributes the run-off into a stream or reservoir is called catchment and its area is known as catchment area.

Q.21. Define Root Zone depth?

Ans: The maximum depth in soil strata in which the crop spreads its root system and deriver's water from the soil.

Q.22. What do you mean by Sodium Hazards in Irrigation Water (SHIW)?

Ans: The percentage of sodium ions in irrigation water is generally less than 5% of total exchangeable cations. If the percentage exceeds 10%, there grows a tendency to replace in calcium and magnesium ions from the soil. This exchange converts the insoluble calcium silicate and magnesium silicate to soluble sodium silicate; this is the sodium hazards in irrigation water.

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Q.23. Define Rabi and Kharif season?
Ans: Rabi season: Rabi season start from 1st October to 31th March. Rabi crops are Barley, Linseed, Mustard, Potatoes etc. (Winter)
Kharif season: Kharif season start from 1st April to 30th September. Kharif crops are Rice, Cotton, Tobacco, Ground Nut, Bayar, Maize etc. (Summer)

Q.24. Define canal lining?
Ans: Canal Lining is a process which the earthen surface of the channel is lined with a stable lining surface such as concretc, tiles, asphalt etc in order to minimize the losses of irrigation canal.

Q.25. Write down the requirement of good lining?
Ans: The requirements is – (i) Economy, (ii) Structural Stability, (iii) Durability, (iii) Repairability

Q.26. Define water logging?
Ans: A land is said to be water logged when its productivity gets affected and when the root zone of the plants gets flooded with water by the high water table.

Q.27. Draw the cross section of a irrigation canal?
Ans:

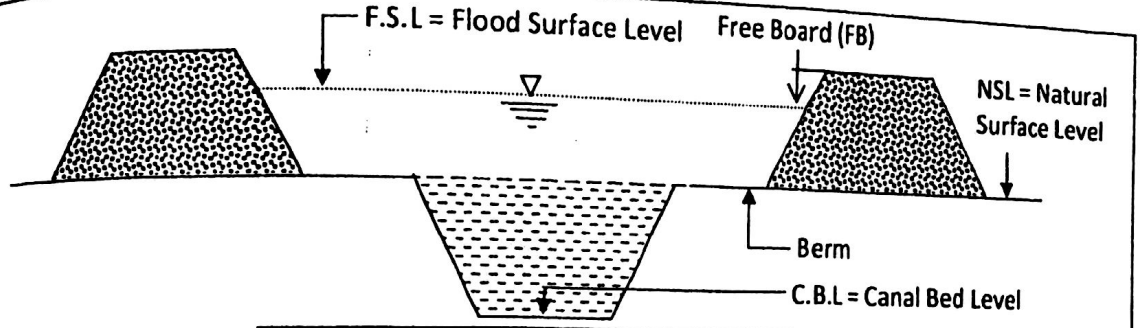


Fig. Cross section of a irrigation canal

Q.28. Write of cause of water logging?
Ans: The causes of water logging are –
(i) Irregular or Flat Topography
(ii) Over and Intensive Irrigation
(iii) Seepage of water
(iv) Inadequate natural drainage
(v) Inadequate surface drainage
(vi) Excess rainfall

Q.29. What is Leaching Requirement?
Ans:

Leaching Requirement LR = (Depth of water drained out per unit area / Depth of irrigation water applied per unit area) x 100
$\Rightarrow LR = D_d / D_i = D_i - C_u / D_i = C_i / C_d = EC_{(i)} / EC_{(d)} = EC_{(i)} / 2EC_{(e)}$ ----------(i)

Where, D_d = Depth of water drained out per unit area D_i = Depth of irrigation water applied per unit area C_u = Consumption used of water C_i = Salt content in irrigation water	C_d = Salt content in drainage water $EC_{(i)}$ = Electrical conductivity in Irrigation water $EC_{(d)}$ = Electrical conductivity in drainage water $EC_{(e)}$ = Electrical conductivity in saturated soil extract

(Q.30.) Estimate the leaching requirement when electrical [illegible] extract of soil is 10mhos/cm at 25% reduction in the yield of a crop. The EC of irrigation water is 1.2mhos/cm. What will be the required depth of water to be applied to the field if the consumptive use requirement of the crop is 80mm?

Sol":

We know that, Leaching Requirement LR = $EC_{(i)}$ / $2EC_{(e)}$ => LR = (1.2 / 2 x10) x 100 = 6% (Ans) Again, Leaching Requirement LR = D_i- C_u /D_i => 6% = D_i-80 / D_i x 100 => 0.06 = D_i-80 / D_i => 0.06 D_i = D_i-80 => D_i = 85.10mm (Ans)	Given data, $EC_{(e)}$= Electrical conductivity in saturated soil extract = 10mhos/cm $EC_{(i)}$= Electrical conductivity in Irrigation water = 1.2mhos/cm C_u = Consumption used of water = 80mm Leaching Requirement LR =? D_i = Depth of irrigation water applied per unit area =?

Q.31. Define Efflorescence?

Ans: When water table rises the soluble alkali salt also move up with water and get deposited in the soil within the plant root, This phenomenon of salt coming up in solution and forming a thin layer after the evaporation of water is known a Efflorescence.

Q.32. Define Flood and cause of flood?

Ans: A flood is any relatively high flow that overtops the natural and artificial banks in any reach of a stream.

The causes of flood are –

i) Excessive rainfall
ii) Tidal water
iii) Melting of ice and glacises
iv) Reduction of river capacity

Q. 33. Write down the definition of Weir and Barrage?

Ans: **Weir:** If the major part or the entire ponding of water is achieved by a raised crest and a smaller part or nil part of it achieved by the shutters, then this barrier is known as a weir.

Barrage

If most of the ponding is done by gates and a smaller or nil part of it is done by the raised crest, then the barrier is known as a barrage or a river regulator.

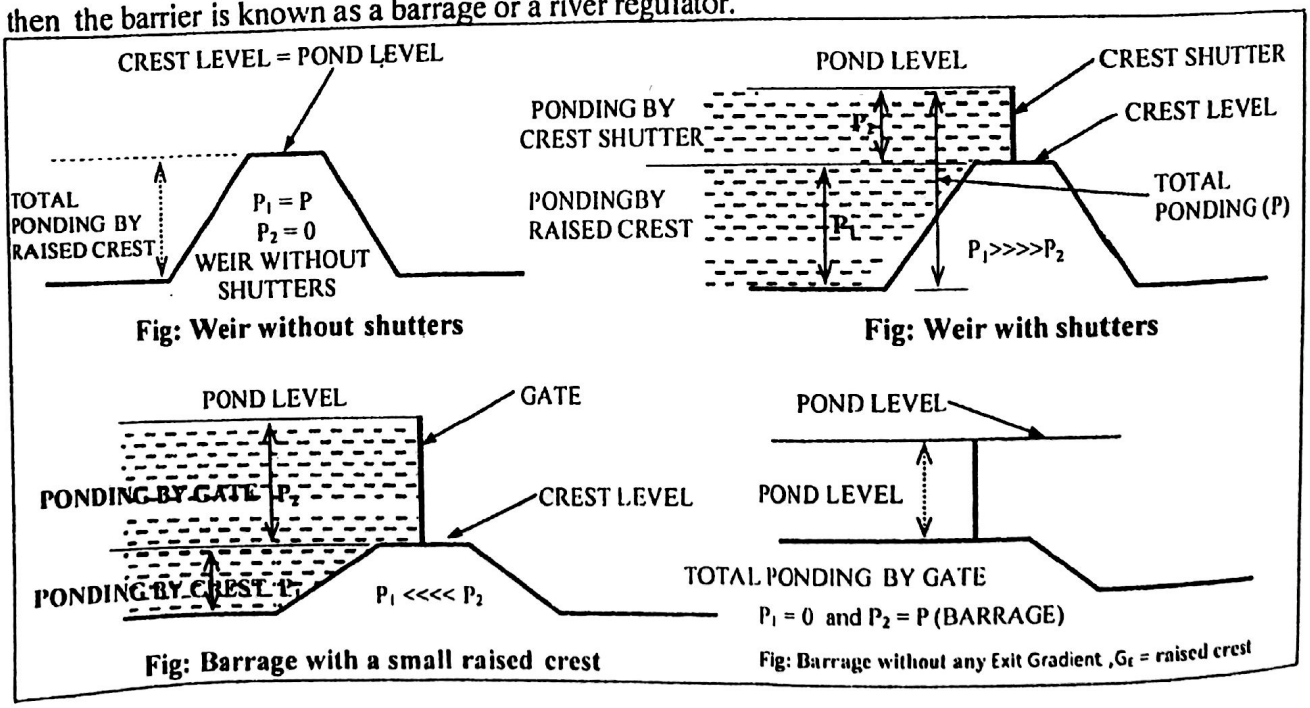


Fig: Weir without shutters

Fig: Weir with shutters

Fig: Barrage with a small raised crest

Fig: Barrage without any Exit Gradient ,G_t = raised crest

Q.35. Write down the types of weirs?
Ans: The types of wire are-

i) Masonry weirs with vertical drop
ii) Rock-fill weirs with sloping aprons
iii) Concrete weirs with sloping glacis

Q.36 What type method used in Bangladesh at Flood control
Ans: Levees and flood wall method is commonly adopted in our country due to low cost of construction and possibility of using local materials.

Q.37. Write down the Concrete weir?
Ans: Now-a-days, the weir is constructed with reinforced cement concrete. The impervious floor and the weir are made monolithic. The cut off walls are provided at the upstream and downstream end of the floor and at the toe of the weir. Sheet piles are provided below the cut-off walls. The crest Shutters are also provided which have dropped down during the flood.

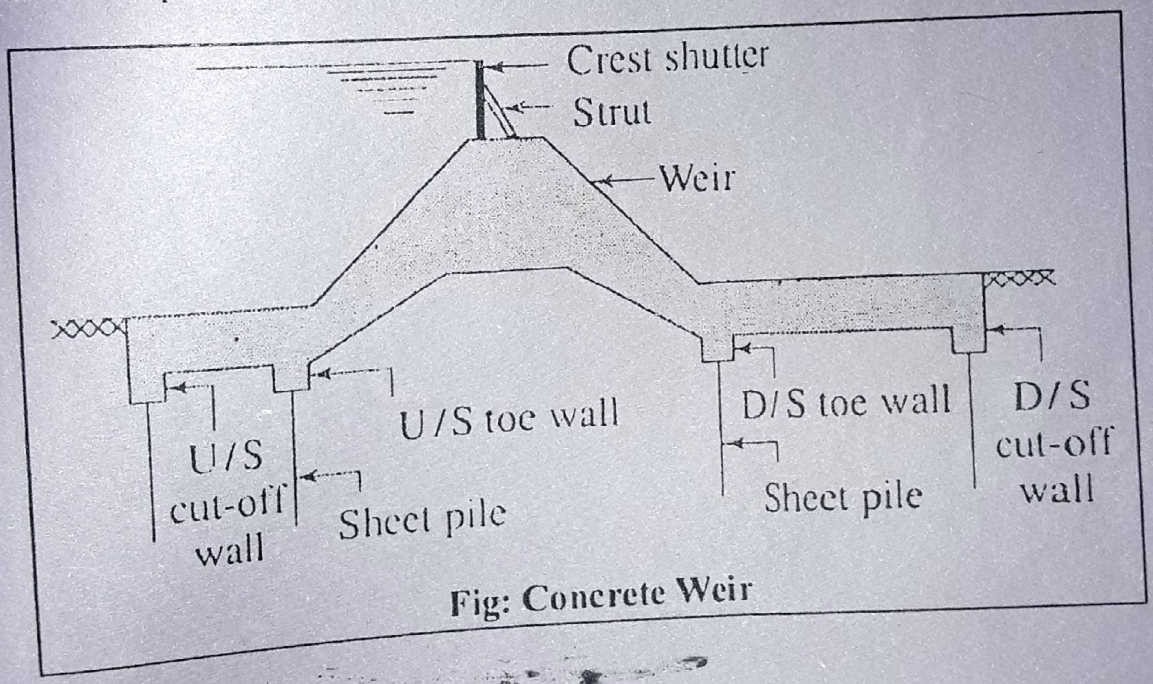


Fig: Concrete Weir

Q.39. Draw A typical cross-section of a barrage?

Ans:

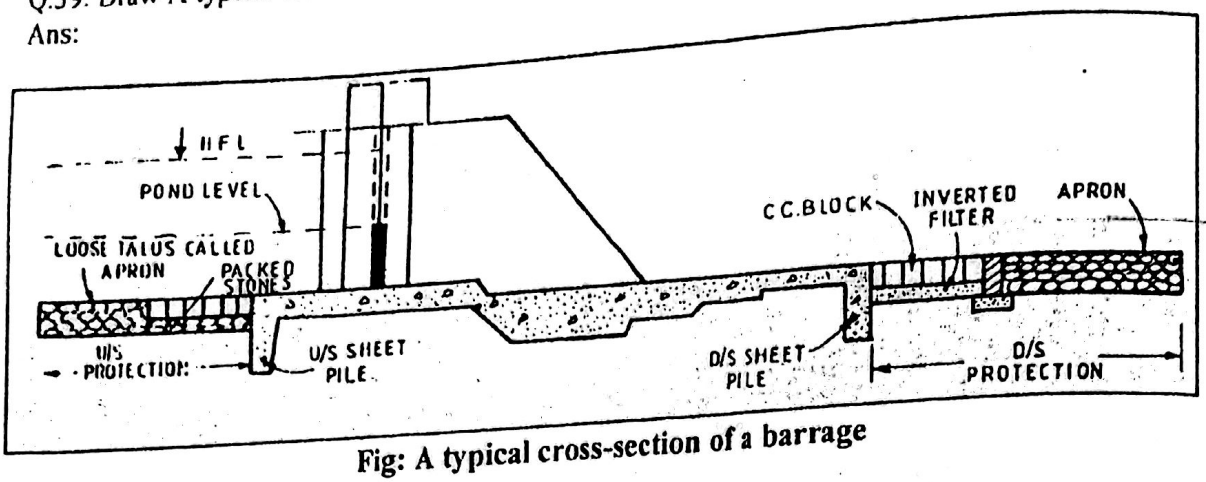


Fig: A typical cross-section of a barrage

Q.40. What do you mean by Afflux?

Ans:

i)The rise in the highest flood level (HFL) upstream of the weir due to construction of the weir across the river is called. Afflux.

ii) In case of weir, the afflux caused during high floods is quite high. But in case of a barrage, the gates can be opened during high floods and the afflux will be nil or minimum.

Q.41. Choice between a weir and a barrage?

Ans: The choice between a weir and a barrage is largely governed by cost and convenience in working.

i)A shuttered weir will be relatively cheaper but will lack the effective control possible in the case of a barrage.

ii) A barrage type construction can be easily supplemented with a roadway across the river at a small additional cost. Barrages are almost invariably constructed now-a-days on all important rivers.

DUE!

Q.42. Difference between Barrage and Weir?

Ans:

SL	Barrage	Weir
(a)	Low set crest	High set crest
(b)	Ponding is done by means of gates	Ponding is done against the raised crest or partly against crest and partly by shutters
(c)	Gated over entire length	Shutters in part length
(d)	Gates are of greater height	Shutters are of smaller height, 2 m
(e)	Gates are raised clear off the high floods to pass floods	Shutters are dropped to pass floods
(f)	Perfect control on river flow	No control of river in low floods
(g)	Gates convenient to operate	Operation of shutters is slow, involve labour and time
(h)	High floods can be passed with minimum afflux	Excessive afflux in high floods
(i)	Less silting upstream due to low set crest	Raised crest causes silting upstream
(j)	Longer construction period	Shorter construction period
(k)	Silt removal is done through under sluices	No means for silt disposal
(l)	Road and/or rail bridge can be constructed at low cost	Not possible to provide road-rail bridge
(m)	Costly structure	Relatively cheaper structure

Q.44. Write down the definition of Diversion Head Works?
Ans: The works, which are constructed at the head of the canal, in order to divert the river water towards the canal, so as to ensure a regulated continuous supply of silt-free water with a certain minimum head into the canal, are known as diversion heads works.

Q.45. Write down the objective of Diversion Head Works?
Ans: The objectives are-
i) To rise the water level at the head of the canal.
ii) To form storage by constructing dykes (embankments) on both the banks of the river so that water is available throughout the year
iii) To control the entry of silt into the canal and to control the deposition of silt at the head of the canal
iv) To control the fluctuation of water level in the river during different seasons

Q.46. Write down the Selection of Site for Diversion Head Works?
Ans: At the site, the river should be straight and narrow
i) The river banks should be well defined.
ii) The valuable land should not be submerged when the weir or barrage is constructed.
iii) The elevation of the site should be much higher than the area to be irrigated.
iv) The site should be easily accessible by roads or railways.
v) The materials of construction should be available in vicinity of the site.
vi) The site should not be far away from the command area of the project, to avoid transmission loss.

Q.47. Layout of a Diversion Head Works and its components?
Ans: A typical layout of a canal head-works is shown in figure below. Such a head-works consists of
i) Weir or Barrage
ii) Under-sluices Divide wall
iii) River Training works Fish Ladder
iv) Canal Head Regulator
v) River Training Works e.g. Guide bank, Marginal bunds, spur and groyne etc. Shutters and Gates
vi) Silt Regulation Work

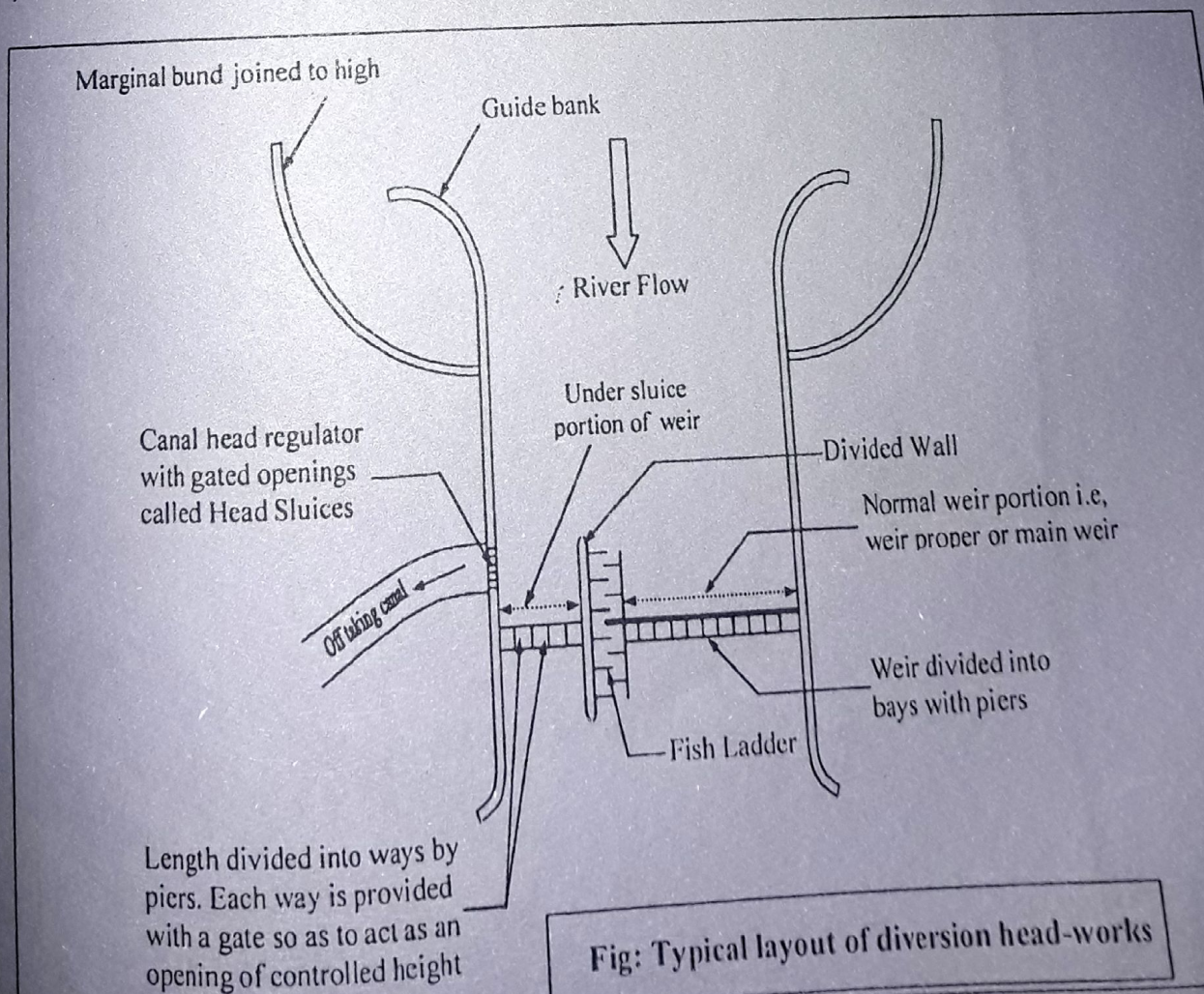


Fig: Typical layout of diversion head-works

Q.49. Write down the main functions of under-sluices?
Ans: The the main functions of under-sluices are-
i)To; maintain a well defined deep channel approaching the canal head regulator.
ii) To ensure easy diversion of water into the canal through the canal head regulator even during low flow.
iii) To control the entry of silt into the canal
iv) To help scouring and of the silt deposited over the under-sluice floor and removing towards the downstream side.
v) To help passing the low floods without dropping the shutters of the weir.

Q.50. Write down the main functions of the divide walls?
Ans: The main functions of the divide walls are-
i)It separates the 'under-sluices' with lower crest level from the 'weir proper' with higher crest level.
ii) It helps in providing a comparatively less turbulent pocket near the canal head regulator, resulting in deposition of silt in this pocket and, thus, to help in the entry of silt-free water into the cana
fi) It helps to keep cross-current, if any, away from the weir.

Q .51. Write down the functions of Canal Head Regulator?
Ans: The functions of Canal Head Regulator are –
i) It regulates the supply of water entering the canal
ii) It controls the entry of silt in the canal
iii) It prevents the river-floods from entering the canal

Q.52. Define River Training Works
Ans: River training works are required near the weir site in order to ensure a smooth and an axial flow of water, and thus, to prevent the river from outflanking the works due to a change in its course.

Q.53. Write down the objective of river training works?
Ans: The objective are –
i) to protect the river bank form scour and erosion
ii) to ensure effective disposal of sediment load
iii) to provided a minimum depth for navigation
iv) to prevent the river from changing ite coarse

Q.55. Write down the method of River Training work?
Ans: The methods are as below-
i) Guide banks
ii) Marginal bunds
iii) Spurs or groynes
iv) Artificial cut off
v) Pitched Islands
vi) Pitching Banks

Q.56. What is Guide Bank and write down the purposes of guide bank?
Ans: When a barrage is constructed across a river which flows through the alluvial soil, the guide banks must be constructed on both the approaches to protect the structure from erosion.
Guide bank serves the following purposes:
i) It protects the barrage from the effect of scouring and erosion.
ii) It provides a straight approach towards the barrage.
iii) It controls the tendency of changing the course of the river.
iv) It controls the velocity of flow near the structure

Q.57. Write down the definition and purposes of Marginal Bunds or Marginal Embankment or Leevees or Dyke?
Ans: The marginal bunds are earthen embankments which are constructed parallel to the river bank on one or both the banks according to the condition. The top width is generally 3 m to 4 m. The side slope on the river side is generally 1.5: 1 and that on the country side is 2:1.
The marginal bunds serve the following purposes:
i) It prevents the flood water or storage water from entering the surrounding area which may be submerged or may be water logged.
ii) It retains the flood water or storage water within a specified section.
iii) It protects the towns and villages from devastation during the heavy flood.
iv) It protects valuable agricultural lands.

Q.58. What do you mean by Spurs?
Ans: These are temporary structures permeable in nature provided on the curve of a river to protect the river bank from erosion. These are projected from the river bank towards the bed making angles 60^{o} to 75^{o} with the bank of the river.

Q.59. What do you mean by Groynes?
Ans: The function of groynes is similar to that of spur. But these are impervious permanent structures constructed on the curve of a river to protect the river bank from erosion. They extend from the bank towards the bed by making an angle of 60^{o} to 75^{o} with the bank. The angle may be towards the upstream or downstream. Sometimes, it is made perpendicular to the river bank. These are constructed with rubble masonry in trapezoidal section and the surface is finished with stone pitching or concrete blocks.

The stone pitching or the concrete blocks are set with rich cement mortar.

i) The length of the groyne depends on the width and nature of the river.
ii) The top width varies from 3 m to 4 m. The side slope may be 1½: 1 or 2:1.
iii) The groynes are provided in series throughout the affected length of the river bank.
iv) The spacing between the adjacent groynes is generally kept as 2L, where L is the length of the groyne.
v) These are recommended for the river where the permanent solution of erosion control is extremely necessary.

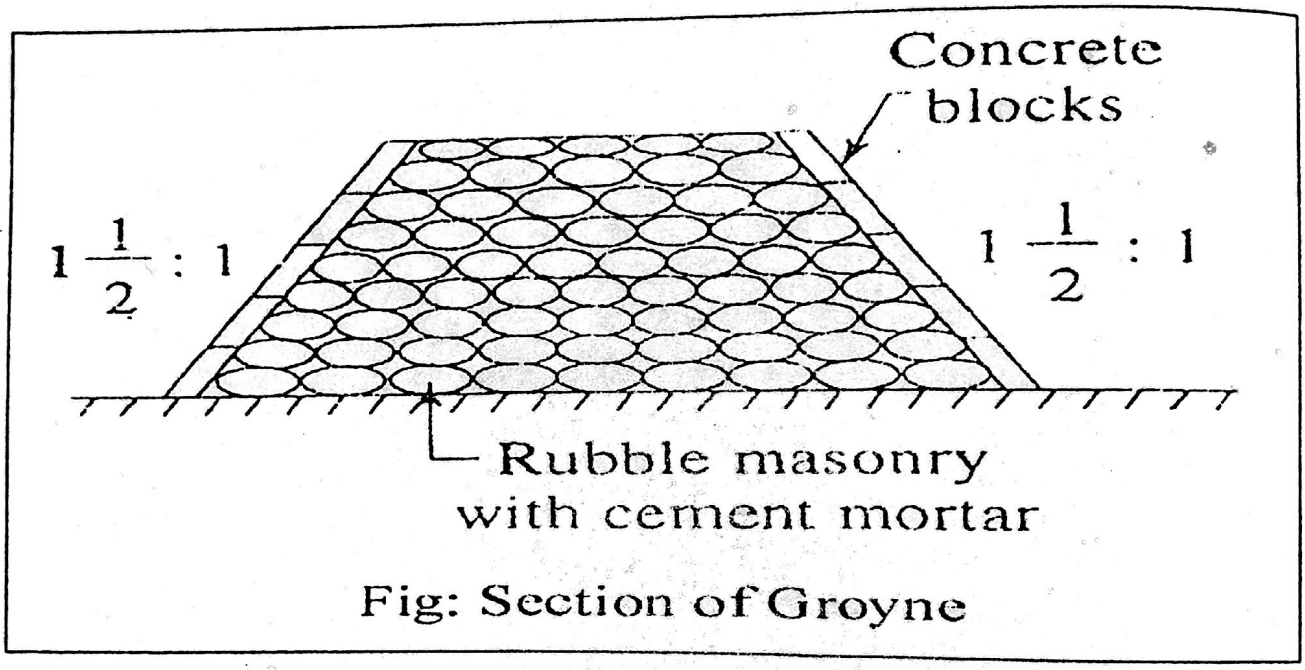


Fig: Section of Groyne

Q.60. Write down the Comparison between spur and groyne?
Ans:

Spur	Groyne
1) It is a temporary structure.	1) It is a permanent structure.
2) It is permeable.	2) It is impermeable.
3)It is constructed with bamboo pile, timber pile, sand bag, boulders etc.	3) It is constructed with rubble masonry with cement mortar.
4) It requires repair works.	4) It does not require any repair work.
5) It is recommended for small rivers.	5) It is recommended for large rivers.
6) It is useful for low or medium velocity of flow	6) It is suitable for high velocity of flow.

Q.61. Write down the function of Shutters and Gates?
Ans: The functions of shutters and gates are-
i) They maintain pond level.
ii) They raise water level during low flow.

Q.62. What do you mean by Pond Level?
Ans: The water level required in the under-sluice pocket upstream of the Canal Head Regulator, so as to feed the canal with its full supply, is known as Pond Level.

The FSL of the canal at the head depends upon the level of the irrigated areas and the slope of the canal.
Pond Level = Canal FSL + 1.0 to 1.2 m

Q. 63. What do you meant by Silt Regulation works with classification?
Ans: The entry of silt into a canal, which takes off from a head works, can be reduced by constructed certain special works, called silt control works.

These works may be classified into the following two types-
i) Silt Excluders
ii) Silt Ejectors

Q. 64. What do you meant by Silt Excluders?

Ans: Silt excluders are those works which are constructed on the bed of the river, upstream of the head regulator. The clearer water enters the head regulator and silted water enters the silt excluder. In this type of works, the silt is, therefore,, removed from the water before in enters the canal.

Q. 65. What do you meant by Silt Ejectors?

Ans: Silt ejectors, also called silt extractors, are those devices which extract the silt from the canal water after the silted water has traveled a certain distance in the off-take canal. These works are, therefore, constructed on the bed of the canal, and little distance downstream from the head regulator.

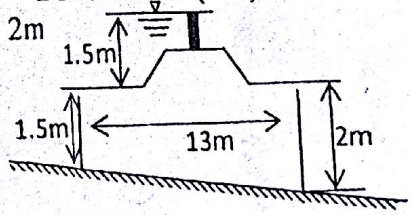
Q.66. What do you mean by Exit gradient?
Ans: The gradient of water pressure at the exit end is known as exit gradient.

Exit Gradient ,$G_E = \frac{H}{d}\frac{1}{\Pi\sqrt{\lambda}}$	Where, $\lambda = [1+\sqrt{(1+\alpha^2)}]/2$ $\alpha = b/d$ H = Height or Depth of water d = Down steam (D/S) cut-off depth	Type of soil	Safe Exit Gradient
		Shingle	0.25 to 0.2
		Coarse Sand	0.2 to 0.17
		Fine Sand	0.17 to 0.14

Q.67. Calculate the exit gradient for following figure?
Sol":

We know that,
Exit Gradient ,$G_E = H/d\ (1/\Pi\sqrt{\lambda})$----------(i)
We know,
$\alpha = b/d = 13/2 = 6.5$
Again,
$\lambda = [1+\sqrt{(1+\alpha^2)}]/2 = [1+\sqrt{(1+6.5^2)}]/2 = 3.79$
From (i)
$G_E = H/d\ (1/\Pi\sqrt{\lambda})$
$\Rightarrow G_E = (1.5/2) \times (1/\Pi\sqrt{(3.79)}) = 0.123 < 0.18$ for coarse sand (Ans)

Given data,
H = Height or Depth of water = 1.5
b = Width of weir = 13m
d = Down steam (D/S) cut-off depth = 2m



Q.68. Dowel or Dowla: A Dowel is a formation which is provided on the site of a service road or inspection road between the road and the channel

Q.69. Define Cross Drainage work?
Ans: A cross drainage work is a structure which is constructed at the crossing of a canal and a natural drain to dispose of drainage water without interrupting the canal supplies.

Q.70. Find the field capacity of soil for following data ,i) Depth of root zone 2m , ii) Existing water content 7% , iii) Dry density of soil 1400kg/m^3 , iv) Water applied to soil 600m^3, v) Water lost by evaporation and deep percolation 10% ,vi) Area of irrigated land 800m^2?
Sol":

We know that, Volume of Retained water irrigated land = 600 x 0.90 = 540m^3 So, Weight of Retained water in irrigated land = 540 x 9.81 = 5297.4KN Again, Dry weight of irrigated land = Area x Depth of root zone x Dry density of soil => Dry weight of irrigated land = 800 x 2 x 1400 =2240000kg => Dry weight of irrigated land = (2240000 x 9.81) /1000 = 21974.4KN Now, % of water content in irrigated land = (5297.4KN / 21974.4KN) x 100 = 24.11% Again,we know that, Field capacity = Existing water content + Calculated % of water content => Field capacity = 7% + 24.11% = 31.11% (Ans)	Given data, i) Depth of root zone = 2m Unit weight of water = 9.81KN/m^3 v) Water lost by evaporation and deep percolation 10% So water retained in (100-10) = 90% = 0.90 iv) Total Water volume = 600m^3 iii) Dry density of soil = 1400kg/m^3 vi) Area of irrigated land = 800m^2 ii) Existing water content = 7%

Q.71. If the flow rate is 113cusec and area is 5hector than what is the time required for irrigation if dewatering in irrigated land 10.92cm?
Sol":

We know that, Volume of irrigated water, V= A d_w => V = 50000 x 0.1092 = 5460m^3 Now, We know that, Q = V/t => 0.113 = 5460 / t => t = 48318.58sec = 13.42 hr (Ans)	Given data, Flow rate , Q = 113cusec = 113 Liter/sec =0.113m^3/sec Area, A = 5hector = 50000m^2 Dewatering in irrigated land,d_w =10.92cm= 0.1092m Time required for irrigation, t =?

Q.72. Furrows 90m long and Spaced 75cm are irrigated by an stream of 2 lit/sec for 50min,size of stream was reduced to 0.5 lit/sec for 1 hours. Estimate average depth of irrigation?
Sol":

We know that, Average depth of irrigation,d = d1 + d2 => d = q_1t_1 /wl + q_2t_2/wl => d = (7.2 x 0.83)/ (90 x 0.75) + (1.8 x 1) /(90 x 0.75) => d = 0.0885 + 0.0267 => d = 0.1152 m = 11.52 cm (Ans)	Given data, q_1 = 2 lit/sec = 7.2m^3/h q_2 = 0.5 lit/sec =1.8m^3/h t_1 =50 min = 0.83 hour t_2 = 1 hour w = Furrows length =90m l = 75cm = 0.75m Average depth of irrigation,d =?

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Q.73. Write down the Important Formula in irrigation engineering?
Ans:

Formula	Notations
i) Chezy's formula, $V = C\sqrt{(RS)}$ ii) Mannings formula, $V = 1/n\ R^{2/3}S^{1/2}$ iii) Discharge, $Q = AV$ **n = Manning co-efficient** **Q = Discharge (cumec or m^3/sec) = AV** **S = Bed Slope = $f^{6/3}/(3340Q^{1/6})$** **A = Area (m^2)**	**Where,** **V = Velocity (m/sec)** **C = Chezy's co-efficient** **R = Hydraulic mean radius (m) = A/P = 5/2 (V^2/f)** **P = Wetted perimeter (m) = $4.75\sqrt{Q}$** **f = Silt Factor = $1.76\sqrt{d_{mm}}$** **d_{mm}= Particle size (mm)**
iv) Flood Estimation $R = 1-(1-1/T_R)^n$	**Where,** **R = % of risk of flooding** **T_R = Return Period** **n = Year**

Q.74. Determine the size (diameter) at the outlet of a 6 hector drainage system if the D.C **(1cm D.C means 1cm water is passing per day through 6 hector)** is 1cm/day and tile grade is 0.3% , assume manning roughness co-efficient 0.011 ?
Ans:

We know that, Mannings formula, $V = 1/n\ R^{2/3}S^{1/2}$ $\Rightarrow V = 1/0.011 \times R^{2/3} \times (0.003)^{1/2}$ $\Rightarrow V = 4.98\ (A/0.396)^{2/3}$ Again, Discharge, $Q = AV$ $\Rightarrow 0.00694 = A \times 4.98\ (A/0.396)^{2/3}$ $\Rightarrow A(A/0.396)^{2/3} = 0.0014$ $\Rightarrow A = \sqrt[5/3]{0.000755} = 0.0134$ $\Rightarrow \pi D^2/4 = 0.0134$ $\Rightarrow D = 0.13m = 13cm$ (Ans)	Given data, Q = Discharge (cumec or m^3/sec) = 1/100 x 60000/(24 x 3600) = 0.00694 m^3/sec) n = Manning co-efficient = 0.011 R = Hydraulic mean radius (m) = A/P = A/0.396 P = Wetted perimeter (m) = $4.75\sqrt{Q}$ = 0.396m S = Bed Slope = 0.3% = 0.003

Q.75. What return period a highway engineer must, assume if he allows 10% risk that flooding may occure in the next 5 year?
Sol":

We know that, % o;f risk of flooding ,$R = 1-(1-1/T_R)^n$ $\Rightarrow 0.10 = 1-(1-1/T_R)^5$ $\Rightarrow (1-1/T_R)^5 = 0.90$ $\Rightarrow T_R = 47.96$ days (Ans)	Given data, R = % of risk of flooding = 10% = 0.10 T_R = Return Period = ? n = Year = 5 years

DPDC

Q.76. Determine discharge if lit/sec when velocity 2.5 m/sec and dia of pipe 15mm of water flow through the pipe ?

Soln:
We know that.

$Q = AV$
$\Rightarrow Q = 1.76\times10^{-4} \times 2.5$
$= 4.417\times10^{-4}\ m^3/sec$
$= 0.4417\ L/sec$ (Ans)

$(1m^3 = 1000L)$

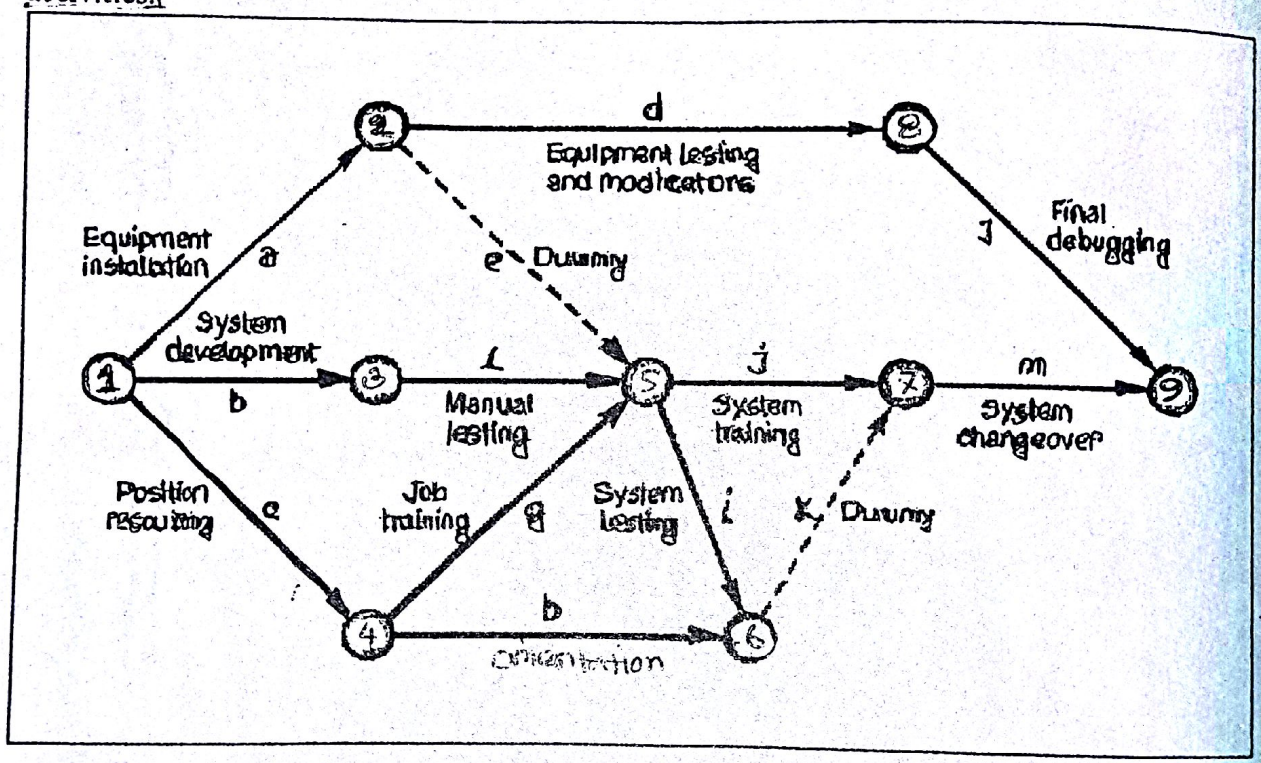
Given data,
$d = 15mm = 0.015m$
$A = \frac{\pi d^2}{4} = 1.76\times10^{-4}m^2$
$V = 2.5m/sec$
$Q = ?\ L/sec$

CONSTRUCTION MANAGEMENT

Q. 1. Why needs construction management?
Ans: Because of-
i) To check the wastage materials and labor
ii) To complete the work in the shortest possible time
iii) To have less construction cost
iv) To improved the quality of work by the modern construction equipments.

Q.2. Write down the methods of Planning and scheduling?
Ans: The methods are –
I) Bar Chart or Gantt Chart
ii) CPM ,PERT and Line of Bolana System(L.B.S)

Q.3. Write down the differences between PERT and CPM (Diagramally)?
Ans:
PERT (Program Evaluation and Review Technique) are most commonly used methods for project management. There are some similarities and differences between PERT and CPM. PERT can be applied to any field requiring planned, controlled and integrated work efforts to accomplish defined objectives. On the other hand, CPM (Critical Path Method) is the method of project planning consisting of a number of well defined and clearly recognizable activities.



Q.4. Determine the Probabilistic time (t_m) for completion of an activity when optimistic time or best time (t_o) is 6 days ,Most probable time or likely time(t_n) is 8 days and Pessimistic or worst time(t_p) is 4 days?
Sol":

We know that, Probabilistic time $(t_m) = (t_o + t_p + 4t_n)/6$ $\Rightarrow tm = (6 + 4 + 4 \times 8) / 6$ $\Rightarrow tm = 7$ days (Ans)	Given data, Optimistic time or best time $(t_o) = 6$ days Most probable time or likely time $(t_n) = 8$ days pessimistic or worst time, $t_p = 4$ days probabilistic time $(t_m) = ?$

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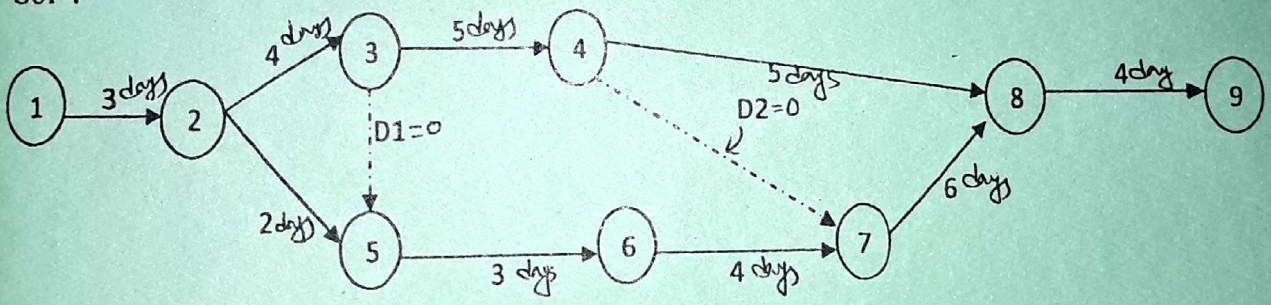
Q.5. Write down the differences between PERT and CPM?
Ans: PERT and CPM both are used for project management, there are differences between CPM and PERT. The relative table for PERT vs CPM is shown below.

CPM	PERT
1. CPM uses activity oriented network.	1. PERT uses event oriented Network.
2. Durations of activity may be estimated with a fair degree of accuracy.	2. Estimate of time for activities are not so accurate and definite.
3. It is used extensively in construction projects.	3. It is used mostly in research and development projects, particularly projects of non-repetitive nature.
4. Deterministic concept is used.	4. Probabilistic model concept is used.
5. CPM can control both time and cost when planning.	5. PERT is basically a tool for planning.
6. In CPM, cost optimization is given prime importance. The time for the completion of the project depends upon cost optimization. The cost is not directly proportioned to time. Thus, cost is the controlling factor.	6. In PERT, it is assumed that cost varies directly with time. Attention is therefore given to minimize the time so that minimum cost results. Thus in PERT, time is the controlling factor.

Q.6. Write down the golden rule for construction work?
Ans: A golden rule for the construction site is 2/3 of construction materials **stores** at work site and 1/3 under procurement.

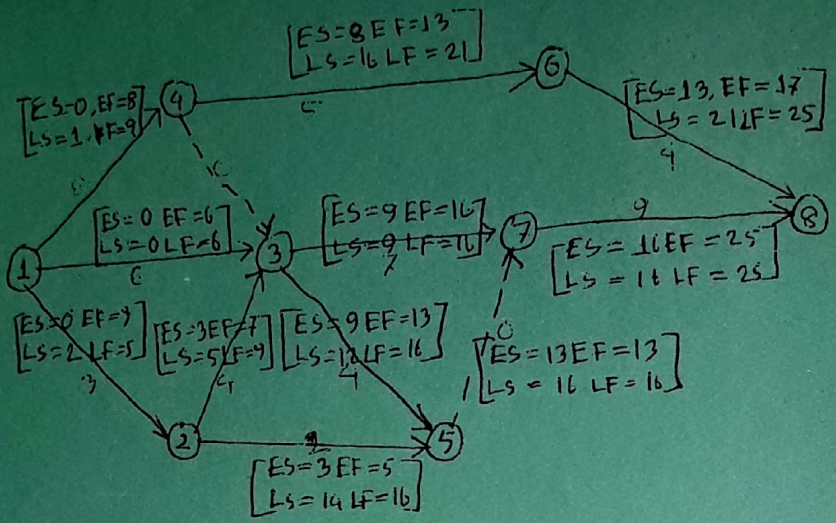
Q.7. Determine Critical Path by the method of CPM at below network diagram?
Sol":



Path i) 1-2-3-4-8- 9 ,Project completion = 21 Days
ii)1-2-5-6-7-8-9 ,Project completion = 22 Days
iii) 1-2-3-4-7-8-9,Project completion = 22 Days
iv) 1-2-3-5-6-7-8-9 ,Project completion = 24 Days
So the critical path of this project is Path (i) which is completion only 21 Days (Ans)

Q. What is meant by the term 'critical path Method'? show the critical path of the following Network diagram. each inside number the activity designate duration in days?

Ans:



Q. Write down the names of the essential components of a contract document. What is meant by the term of specification?

Ans: the essential component of a contract document -

i) Form of contract
ii) General condition
iii) Term of reference
iv) Special condition
v) Schedule of price.

Specification is an explicit set of requirement to be satisfy by a material, production or service.

(2021)

(2) Distinguish among different methods of economic analysis of engineering project?

Ans: The methods are -

i) Net present value
ii) B/C ratio
iii) Internal rate of return.
iv) Pay back period
v) First year rate of return.

(Mist)

(2) Define claim. Different between contractual and extra contractual claim?

Ans: A claim is define as any application by the contractor to the engineer pursuant to any relavent clause of the contract for any additional payment, extension of time or damages for any alleged breach of duty by the employer, the engineer or any other party in connection with the contract.

Claim are three classify i) Contractual claims ii) Extra contractual claims iii) ex-gratia claims

Difference:

Contractual claims	Extra contractual claims	Ex-gratia claims
1. arising from specific clauses in the contract 2. breaches affecting the performance of the contract by nevertheless	1. arising from common law entitlement but without any specific basis in the contract 2. breaches affecting the performance of the contract by wallace's.	1. initiated by the contractors where no entitlement exist under both contract and common law provisions.

Q.1. Modulus of resilience and toughness?

Ans: Modulus of resilience: Materials to store energy without permanent deformation is called Modulus of resilience.

$$\text{Modulus of resilience} = \frac{\sigma^2}{2E} \qquad \sigma = 30000 \text{ psi}$$

Toughness: ability to retained energy up to fracture

→ stress hardening range
→ linear hardening range.

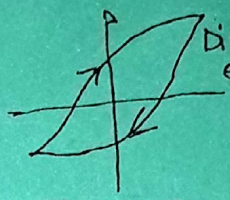


Fig: Hysteresis loop

Q.2. Write down the relation between Modules of rigidity, Poison ratio & modules of elasticity

Ans:

$$\text{Poison ratio } \gamma = \frac{\text{lateral strain}}{\text{axil strain}}$$

$$\text{Modulus of rigidity, } G = \frac{E}{2(1+\gamma)} \quad \text{(Ans)}$$

IPDC

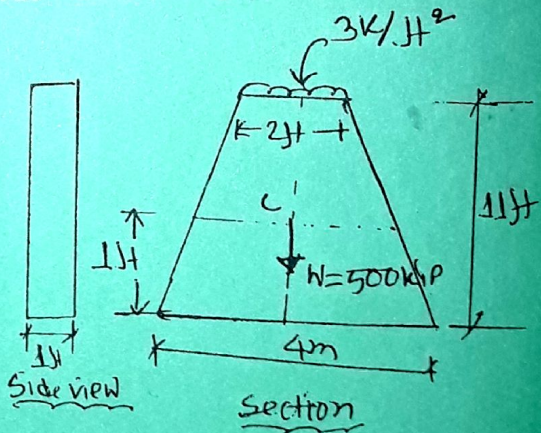
Q.3. Find out the stress at point of C which is below in below figure, or Find the stress above 1ft from base of Pile?

Solb:

Length, L (above 1') = 2×0.909 + 2
= 3.82 ft

Area at this section, A = 3.82 × 1
= 3.82 ft²

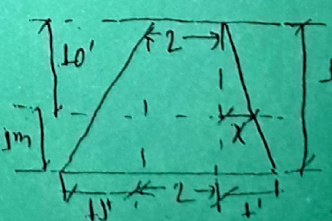
Total load act = 3 × (2×1)
= 6 kips



We know, stress, $\$ = \frac{P}{A}$

$$= \frac{500+6}{3.82}$$

$$= 132.46 \text{ kip/ft}^2 \quad \text{(Ans)}$$



$\frac{11}{1} = \frac{10}{x}$

$\Rightarrow x = 0.909$

Q.4. Find the defection for the following structure?

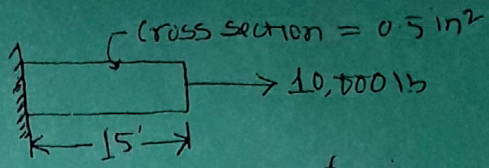
Sol":

We know,

$$\delta = \frac{PL}{AE} = \frac{10,000 \times 15}{AE}$$

$$\Rightarrow \delta = \frac{10,000 \times 15}{0.5 \times 29 \times 10^6} = 0.0103'$$

(Lengthening)



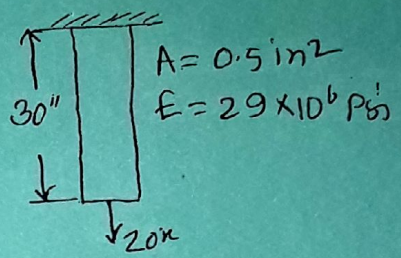
$E = E_s = 29 \times 10^6$ psi

(Ans)

Again,

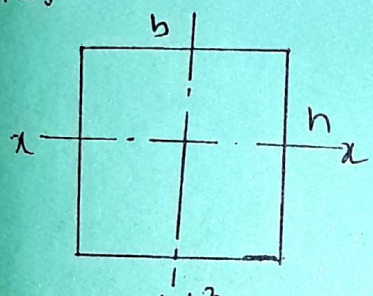
$$\delta = \frac{PL}{AE} = \frac{20 \times 1000 \times 30}{0.5 \times 29 \times 10^6}$$

$$= 0.041" \text{ (Lengthening)}$$

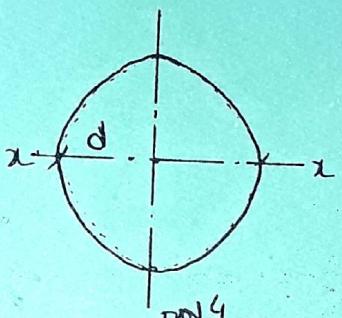


Q.5. Write down the moment of inertia of following structure at the level of 'x' axis or centroid axis?

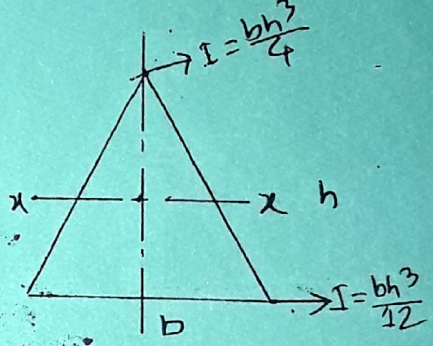
Ans:



$$I_{gx} = \frac{bh^3}{12}$$



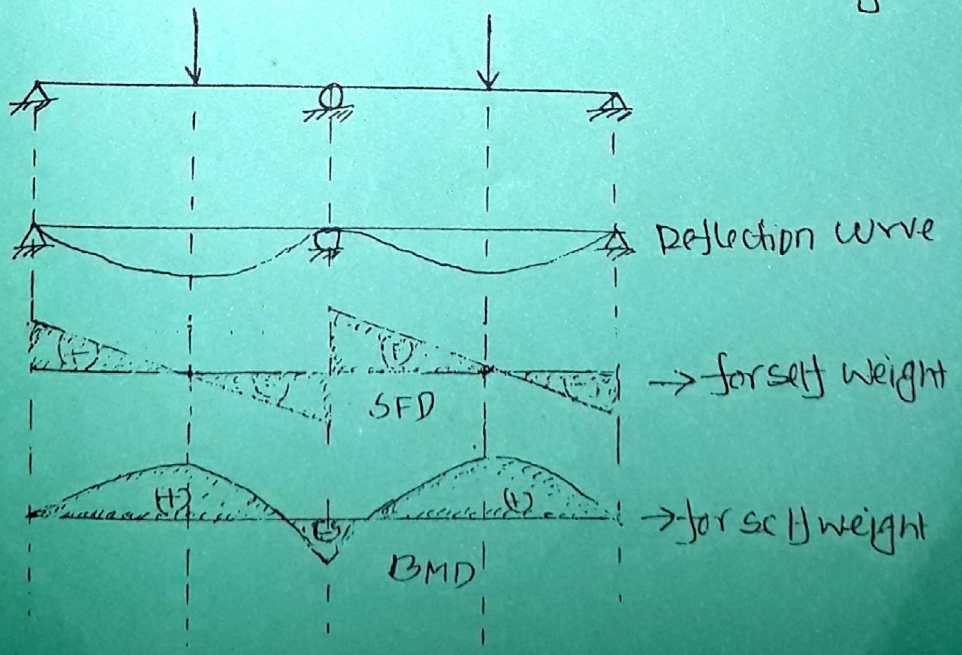
$$I_{gx} = \frac{\pi d^4}{64}$$



$$I_{gx} = \frac{bh^3}{36}$$

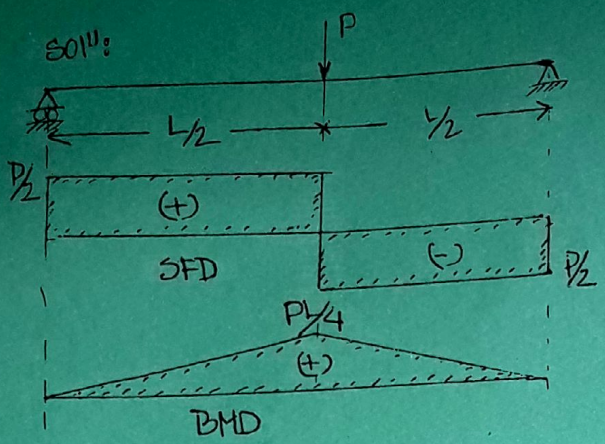
Q.6. Draw defection curve & BMD (self weight) for following structure?

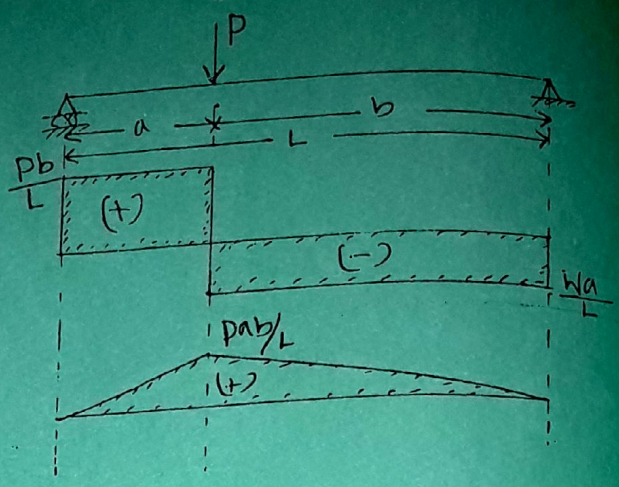
Ans:



Q.7. Draw the BMD & SFD for the following structure?

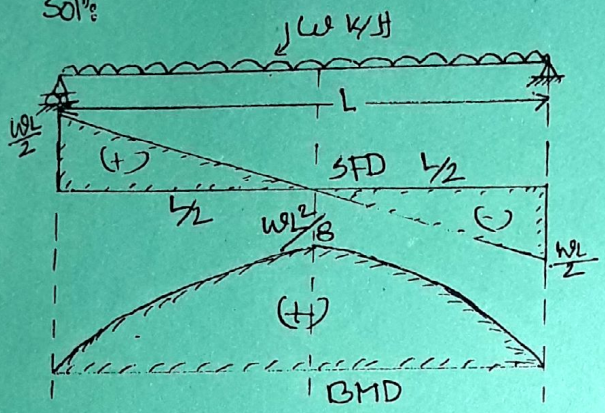
Soln:

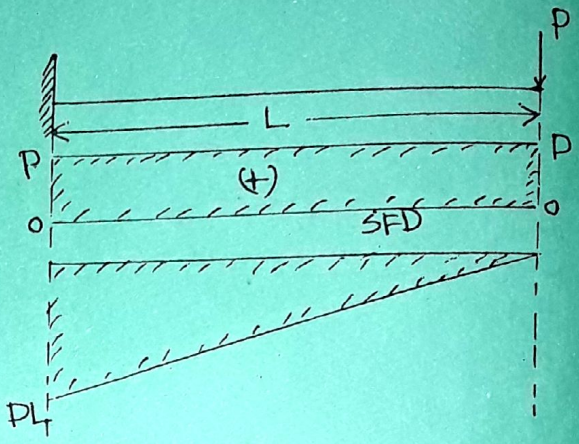




Q.8. Draw the SFD & BMD for the following structure?

Soln:

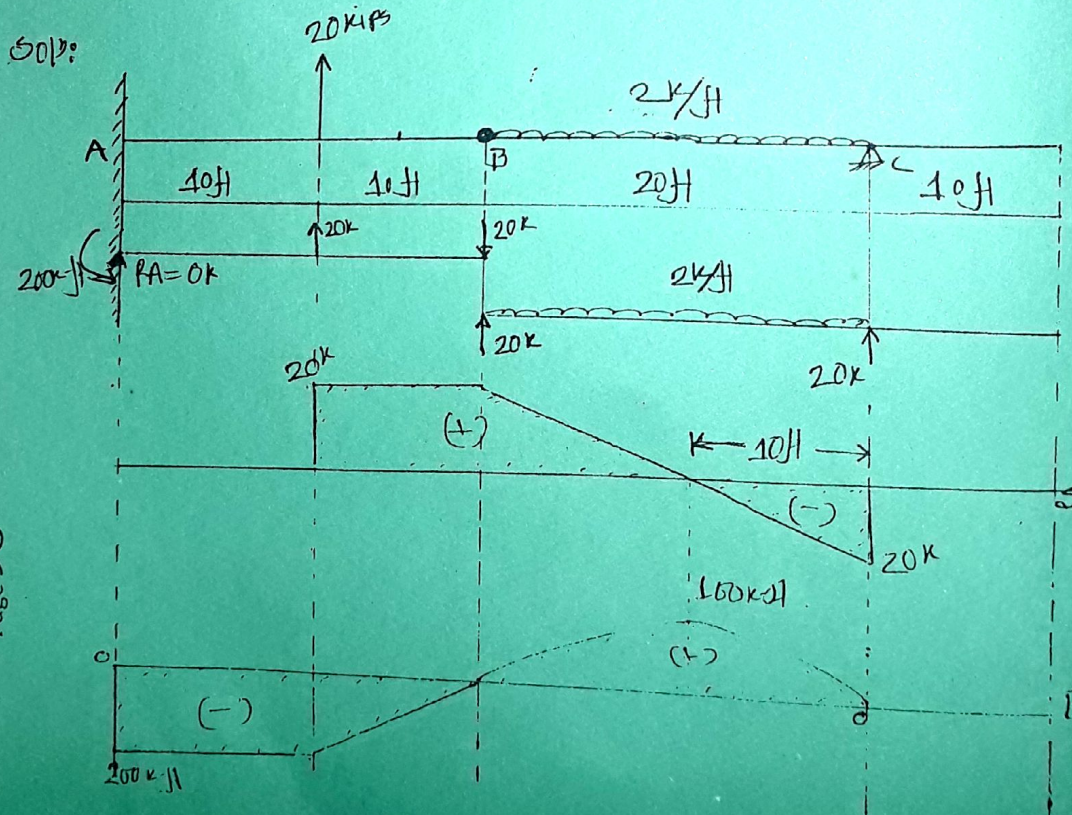




ECC

Q.9. Draw the SFD & BMD for the following structure?

Soln:



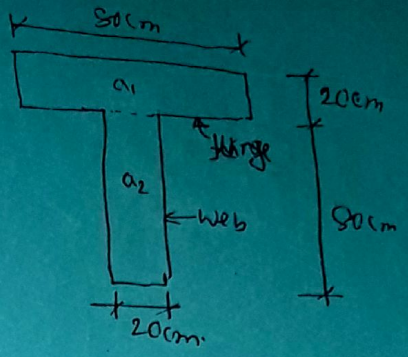
Q. Determine $\bar{y}$ & I for the following structure?

Soln:

$$\bar{y} = \frac{a_1y_1 + a_2y_2}{a_1 + a_2}$$

$$= \frac{80\times20\times(80+20/2) + 80\times20\times(80/2)}{80\times20 + 80\times20}$$

$$= 65\text{cm} \quad \text{from web} \quad (\text{Ans})$$



$$I = I_G + Ad^2$$

$$= \frac{20\times80^3}{12} + 80\times20\times(65-80/2)^2 + \frac{80\times20^3}{12} + 80\times20\times\{(80+20/2)-65\}^2$$

$$= 1.85\times10^6 + 1.05\times10^6$$

$$= 2.903\times10^6 \quad (\text{Ans})$$

Q. Determine maximum shear stress for the following structure?

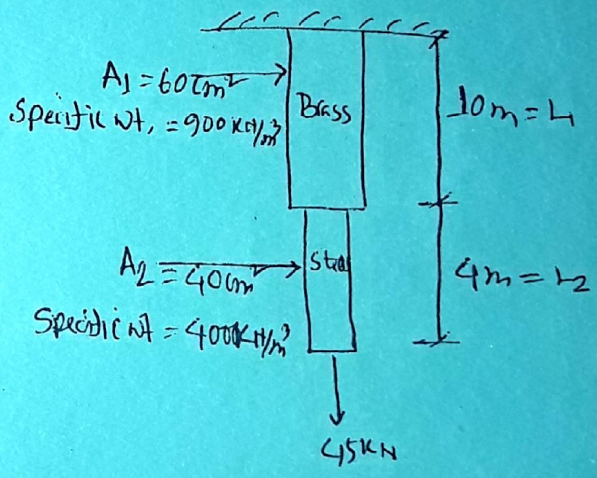
Soln:

Weight of Brass, $W_B = \rho_1 A_1 L_1$

$\Rightarrow W_B = 900\text{KN/m}^3 \times 60\text{cm}^2 \times 10\text{m}$

$= 900\text{KN/m}^3 \times 60\times10^{-4}\text{m}^2 \times 10$

$= 54\text{ KN}$



Again, Weight of steel, $W_S = \rho_2 A_2 L_2$

$= 400\times40\times10^{-4}\times4$

$= 64\text{ KN}$

Now, total force acting on a structure, $P = 45 + W_B + W_S = 45+54+64$

$\Rightarrow P = 163\text{ KN}$

Shear stress on Brass $= \frac{45+54}{60} = 1.65\text{ KN/cm}^2$

Shear stress on steel $= \frac{45+64}{40} = 2.73\text{ KN/cm}^2$

Total or Maximum Shear stress $= 1.15+2.73 = 4.38\text{ KN/cm}^2$

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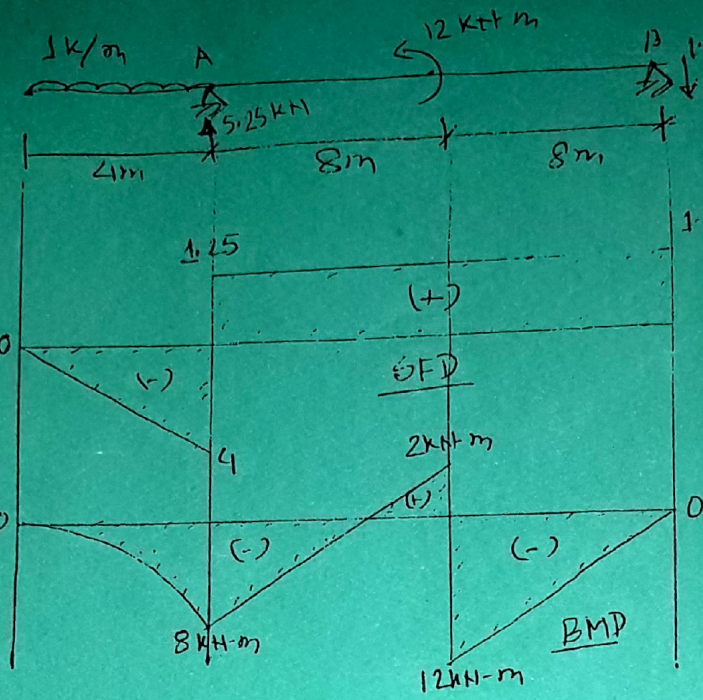
[TUTORIAL]

Q. Draw the SFD and BMD for following structure?



$(\Sigma M_A = 0 \circlearrowleft +ve)$

$-1 \times 4 \times 2 - 12 + R_B \times 16 = 0$

$\Rightarrow R_B = 1.25 KN \downarrow (+ve)$

Now, $R_A = 5.25 KN (\uparrow +ve)$

[TUTORIAL]

Q. Find the maximum bending stress / maximum shear stress for following structure?

Soln:

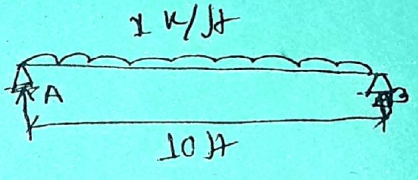
We know that

Bending stress, $S_b = \frac{MY}{I}$

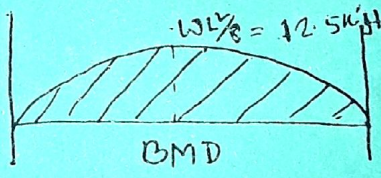
$\Rightarrow S_b = \frac{12.5 K\text{-}ft \times 10/12/2}{\frac{10 \times 10^3}{12} in^4}$

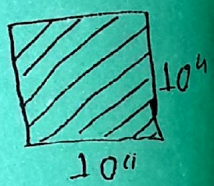
$\Rightarrow S_b = \frac{12.5 K\text{-}ft \times 0.42 ft}{0.040 ft^4}$

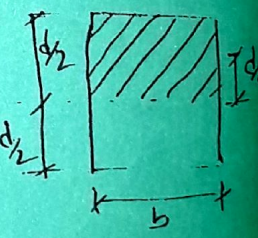
$= 131.25 K/ft^2$ (Ans)



$\Sigma M_A = 0 \circlearrowleft \quad R_B = 5K = R_A \uparrow$







Again we know that, Shear stress, $S_s = \frac{VQ}{Ib}$

Here,

$V = \frac{WL}{2} = \frac{1 \times 10}{2} = 5 kips$

$Q = A \times \bar{y}$

$= b \times d/2 \times d/4$

$= 10 \times 10/2 \times 10/4 = 125 in^3$

$I = \frac{10 \times 10^3}{12} = 833.33 in^4$

$b = 10"$

$\Rightarrow S_s = \frac{5 \times 125}{833.33 \times 10}$

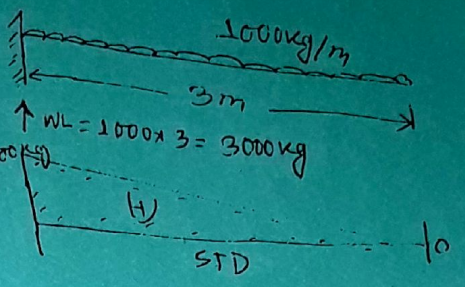
$= 0.075 K/in^2$ (Ans)

(1) Determine maximum shear stress at 25cm arm of equilateral triangle of a 3m span of cantilever beam whose are carry 1000 kg/m ?

Soln:

We know that shear stress at maximum.

$$\delta_s = \frac{VQ}{Ib} \quad ---- (1)$$



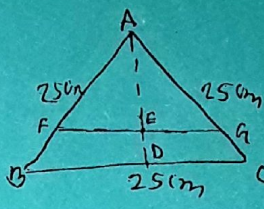
Where, $V = 3000kg$

$Q = A\bar{x}\bar{y}$

$= \text{Area of } AFG \times \frac{1}{3} \times AE$

$= \frac{1}{2} \times 16.67 \times 14.43 \times \frac{1}{3} \times 14.43$

$= 578.51\ cm^3$



$AD = \sqrt{25^2 - 12.5^2}$

$= 21.65\ cm$

$AE = \frac{2}{3} \times 21.65$

$= 14.43$

$\frac{FG}{14.43} = \frac{25}{21.65}$

$FG = 16.67\ cm$

$I = \frac{25 \times 21.65^3}{36} = 7047.11\ cm^4$

$b = 16.67\ cm$

$M_{max} = WL \times \frac{L}{2}$

$= \frac{WL^2}{2} = \frac{1000 \times 3^2}{2} = 4500\ kg\text{-}m$

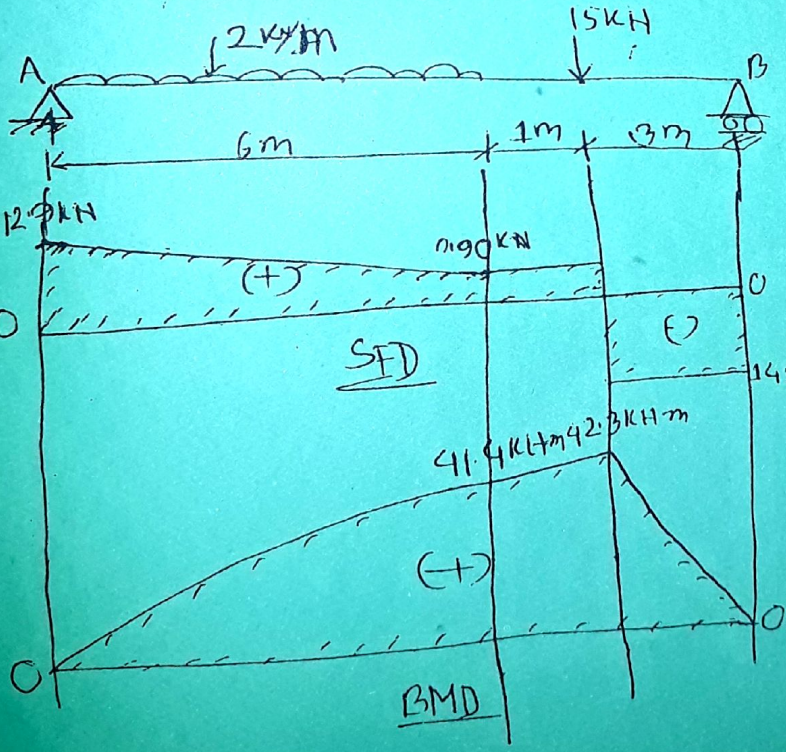
So, $\delta_{s\,max} = \frac{3000 \times 578.51}{7047.11 \times 16.67} = 14.77\ kg/cm^2$ (Ans)

Bending stress. $\delta_b = \frac{MY}{I} = \frac{4500 \times \frac{1}{3} \times 21.65}{7047.11} = 460.82\ kg/cm^2$ (Ans)

Ques

(2) Determine reaction at supports and Draw SFD & BMD ?

Soln



$\Sigma M_A = 0$ (+ve)

$2 \times 6 \times 3 + 15 \times 7 - R_B \times 10 = 0$

$\Rightarrow R_B = 14.1\ KN$ (Ans)

$\Sigma F_Y = 0$ (+ve)

$R_A = 12.9\ KN$ (Ans)

SURVEYING

Q.1. Write down the definition of Surveying?
Ans: The art of determining relative positions of objects on the surface of the earth by taking measurements in the horizontal and vertical planes is called Surveying.

Q.2. Write down the classification of surveying?
Ans: Surveying may be classified on the following basis -

1) Nature of the survey field
   a) Topographic survey
   b) Cadastal survey
   c) City survey
   d) Marine or Hydrographic survey
   e) Astronomical survey

2) Object of survey.
   a) Engineering survey
   b) Military survey
   c) Mines survey
   d) Geological survey
   e) Archeological survey

3) Instruments used
   a) Chain survey
   b) Compass survey
   c) Plane table survey
   d) Theodolite survey
   e) Tacheometric survey
   f) Modern survey using EDM or TS (total station)
   g) Photographic & Aerial survey

4) Methods employed
   a) Triangulation
   b) Traversing

Q.4. Write down the different correction of surveying?
Ans:

1. Temperature correction, $C_t = \alpha(T_m - T_o)\, L$ (±ve)	L = Measure length α = Coefficient of length T_m = Measurable temperature T_o = Standard temperature P_m = Measurable pull P_o = Standard pull A = Sectional area E = Coefficient of Elasticity h = Difference of height in between two support l = Tape length in between two support w = Weight of tape n = no of span L' = Corrected length
2. Pull correction, $C_p = [(P_m - P_o) \times L]/AE$ (±ve)	
3. Slope correction, $C_h = h^2/2l = l(1 - \cos\Theta)$	
4. Sag correction, $C_s = Lw^2/24n^2P_m^2$ (-ve)	
5. Length correction, TL = L'/L x mL	
6. Area correction, TA = $(L'/L)^2$ x mA	

Q.5. The distance between two station was 1200m when measured with a 20m chain. The distance was measured with a 30m chain was found to be 1195m. If the 20m chain was 0.05m long. What was the error of 30m chain?
Sol":

We know that, Length correction, TL = L'/L x mL => TL = 20.05/20 x 1200 = 1203m Again, Length correction, TL = L'/L x mL => 1203 = L'/30 x 1195 => L' = 30.20m So, Error = L' - L = 30.02 – 30 = 0.02m (Ans)	Given data, For 20m chain L' = 20+0.05= 20.05m L = 20m mL = 1200m TL =?	For 30m chain L' = ? L = 30m mL = 1195m TL =1203m

Q. A correct distance of 1000m was measured with a 25m chain which was actually 24.9m long. Calculate the chain distance?

Sol":

We know that,

$$\frac{D}{D'} = \frac{L'}{L}$$

$$\Rightarrow \frac{D}{1000} = \frac{24.9}{25}$$

$$\Rightarrow D = 996\ m \text{ (Ans)}$$

Given data,

$D' = 1000m$ = measured length

$L = 25m$

$L' = 24.9\ m$

$D = ?$

Q.6. A line was measured by a 20m chain which was accurate before starting the day's work chaining 900m the length of chain 20.06m. After chaining 1575m, the chain was found to be 14cm too long. Find the distance of the line?

Sol;":

We know that, Length correction, TL = L'/L x mL => TL = 20.03/20 x 900 = 901.35m Again, Length correction, TL = L'/L x mL => TL = 20.10/20 x 675 => TL = 678.375m So, True distance = 901.35 + 678.375 = 1579.73m (Ans)	Given data, For 20m chain L' = (20+20.06)/2= 20.03m L = 20m mL = 900m TL =?	For 20m chain L' = 20 +(.06+.14)/2 = 20.10m L = 20m mL = 1575 -900 = 675m TL =?

Q.7. A steel tape was exactly 30m long at 20^0c when supported at throughout its length under a pull of 10kg. A line was measured with this tape under a pull of 15kg and at a mean temperature of 32^0c and found to be 780m long. The cross sectional area of the tape 0.03cm^2 and its total weight 0.693kg, $\alpha = 11 \times 10^{-6}$ per °F, $E = 2.1 \times 10^6$ kg/cm^2. Compute the true length at every 30m?

Sol":

1. Temperature correction, $C_t = \alpha(T_m - T_o)$ L (±ve) => $C_t = 11 \times 10^{-6} \times (32 - 20) \times 780 = 0.103$m (+ve) 2. Pull correction, $C_p = [(P_m - P_o) \times L]/AE$ (±ve) => $C_p = [(15 - 10) \times 780]/[0.03 \times 2.1 \times 10^6]$ => $C_p = 0.062$m (+ve) 3. Sag correction, $C_s = Lw^2/24n^2P_m^2$ (-ve) => $C_s = 30 \times (0.693)^2/24 \times (1)^2 \times (15)^2$ (-ve) => $C_s = 0.0027$m (-ve) For 780m, $C_s = (780 \times 0.0027)/30 = 0.070$m (-ve) Now, True length = 780 + 0.103 + 0.062 - 0.070 => True length = 780.095m (Ans)	Given Data, L = Measure length = 780m $\alpha = 11 \times 10^{-6}$ per °F $T_m = 32^0$c $T_o = 20^0$c $P_m = 15$kg $P_o = 10$kg A = 0.03cm^2 E = 2.1×10^6 kg/cm^2 w = Weight of tape = 0.693kg n = no of span =1 L' = Corrected length

Q.8. Write down the method of plane table?

Ans: The method of plane table are-

i) Radiation, ii) Intersection, iii) Resection, iv) Traversing

Q.9. Define of Closing Error?

Ans: Closing error is the amount by which a closed traverse fails to satisfy the requirements of a true mathematical figure as the length of line joining the true and computed position of the same point.

Closing error = Difference betn BR & FR − Difference betn RL of the same point which BR & FR are taking.

Q.10. RL of bench mark at two points is 108.78 and 114.95 respectively in a leveling by operation. Sum of back and fore bearing is 24.88 and 18.64 respectively. Calculate Closing error?

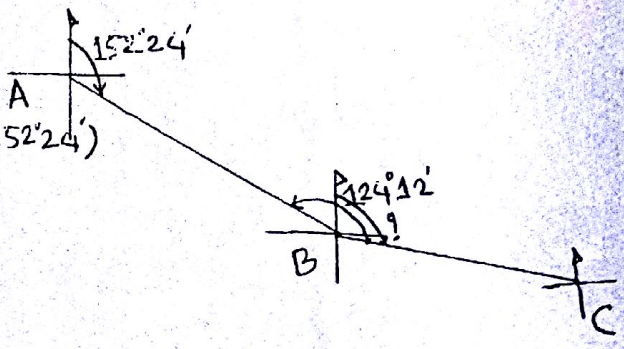
Sol":

Difference of R.L = 114.98 − 108.78 = 6.17	Difference of Reading = 24.88 − 18.64 = 6.24	Closing Error = 6.24 − 6.17 = 0.07 (Ans)

[DPDC]

Q. Bearing of a line AB is 152°24' and the internal angle of ABC is 124°12'. How Determine the Bearing of a line BC?

Soln:



Bearing of a line BC = 124°12' - (180° - 152°24')

⇒ Bearing of a line BC = 96°36' (Ans)

Q.11. In generally plane surveying taken into less than 250km^2 area of land and geodetic or trigonometrical surveying taken into more than 20km^2 of land.

Q.12. How to use in ranging rod, OFF set rod and Plumb Bob?
Ans:

Ranging rod	OFF set rod	Plumb Bob
Used to range same intermediates point in survey line	Provided with a notch or hook at one point	Used to make ranging pole vertical

Q.13. Determine the interior and exterior angel of the following closed traverse?
Ans:

i) Bearing for Left turn traverse
P+Q±180 (Interior angel)

ii) Bearing for Left turn traverse
P−Q±180 (Exterior angle)

iii) Bearing for right turn traverse
P+Q±180 (Interior angel)

iv) Bearing for right turn traverse
P+Q±180 (Exterior angle)

Here,
P+Q<180 (+)
P+Q>180 (−)
P−Q<180 (+)
P−Q>180 (−)

⊛ Angle of polygon (বহুভুজ) = $\frac{(2n \pm 4)90}{n}$
Where, n = no of arm
for interior angel = (−)
Exterior angel = (+)

Latitude (অক্ষাংশ) = LCosΘ (NS)
Longitude (দ্রাঘিমাংশ) = LSinΘ (EW)

Q.14. Write down the terms of Bearing, Whole circle bearing, Quadrantal bearing, Forward bearing,Back bearing and True bearing?
Ans: The whole circle bearing (W.C.B) of a line is the horizontal angle measured clockwise from the North limb of the meridian. It varies from 0° to 360°. In Figure 19.6, The whole circle bearing (W.C.B) of the line OA is 52° and that of line OB is 208°

The bearing of a line measured in the forwrard direction (i.e., along the progress of survey) is known as fore bearing.
In Figure -1 fore bearing of the line AB is given by ∠NOB.
Fore bearing = Back bearing ± 180
The bearing of a line measured in the backward direction (i.e., opposite to the direction of progress of survey) is known as back bearing.
In Figure-2, the back bearing of the line AB is ∠NOA (= 223°). ∠NOA is also called bearing of the line BA. Thus,
Back Bearing = Fore Bearing ± 180°

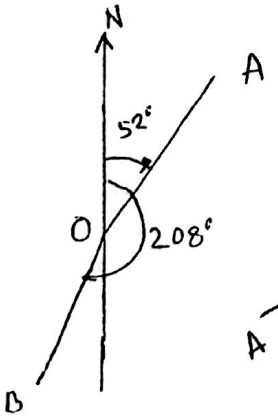


Fig:1. Fore bearing of a line AB.

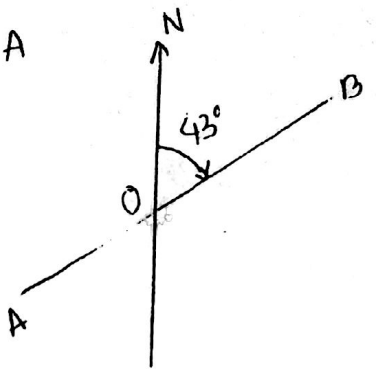
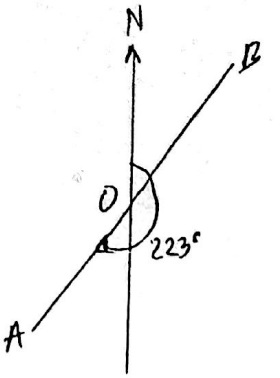


Fig: 2 Back bearing of a line AB



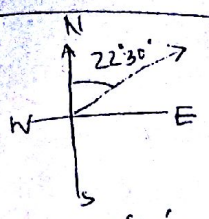
Whole circle Bearing of a line.

Q. Write down convert the following WCB to QB & RB

i) 22°30′ ii) 170°12′ iii) 211°54′ iv) 327°24′

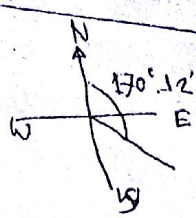
Soln:

i)



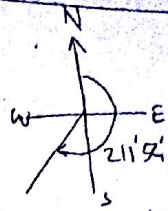
QB = N 22°30′ E

ii)



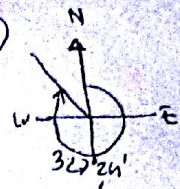
QB = 190 − 170°12′
= S 9°40′ E

iii)



QB = 211°54′ − 180
= S 31°54′ W

iv)



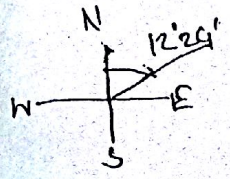
QB = 360 − 327°24′
= N 32°36′ W

Q. Convert the following QB to WCB ?

Soln

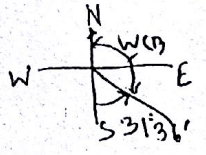
i) N 12°24′ E

WCB = RB = 12°24′



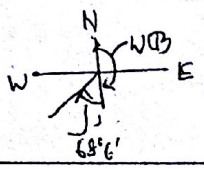
ii) S 31°36′ E

WCB = 180° − 31°36′
= 148°24′



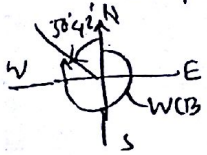
iii) S 68°6′ W

WCB = 180 + 68°6′
= 248°6′



iv) N 5°42′ W

WCB = 360 − 5°42′
= 354°28′



Q. Write down the Balancing rule of a traverse?

Ans: The Balancing rule of a traverse -

i) Bowditch's rule

Correction to Latitude (or departure) of any side = Total errors in Latitude (or departure) × $\frac{\text{length of that side}}{\text{perimeter of traverse}}$

ii) Transit rule

iii) Graphical method

iv) Axis method

Q. Write down the defination of "Line of sight" or "Collimation Line"

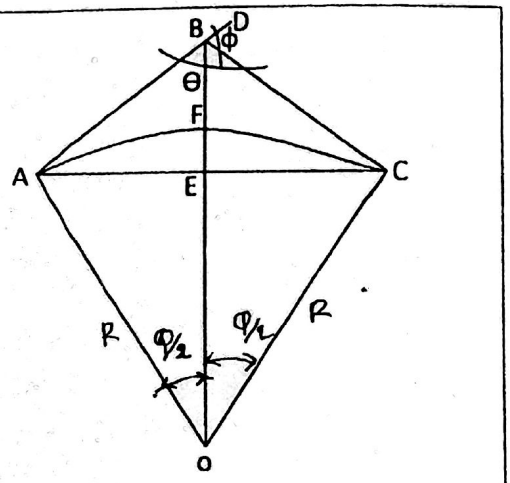
Ans: Collimation Line : It is the line passing through the intersection of the vertical & horizontal cross hair and the optical center of the object glass and its continuation

Q.15. Write down the method of plane table surveying?
Ans: The method of plane table surveying are -

i) Radiation
ii) Intersection
iii) Traversing → ① Transit-tape traversing, ② plane-table traversing
iv) Resection

Correction for curvature (-) = $0.0786 d^2$ (m) → d = km
Correction for Refraction (+) = $\frac{1}{7} C_c$ (m)
Combined correction of curvature & refraction = $0.0673 d^2$ (m)
(where d = km)

(Q.16) Write down the formula of curve with appropriate figure?
Ans:

BA=BC= Length of Tangent = Rtan(φ/2) AC= Long Chord = 2Rsin(φ/2) AFC=Length of Curve = πRφ/180 BF = Apex Distance = R[sec(φ/2) -1] EF= Versed Sine = R[1-cos(φ/2)] < DBC = φ = Deflection Angel < ABC= Θ = Central Angel **Relation bet" Degree and Radius of a Curve** R = 1719/D m(30m) R= 1146/D m(20m) R = 1753/D m(10m) R = 5730/D ft(100ft)	

(Q.17) Determine the degree of curve if given deflection angel of a simple curve is $25^0 30'$ and length of tangent 60m?
Sol":

We know that, Length of Tangent = Rtan(φ/2) => 60 = Rtan($25^0 30'$/2) => R = 265.16m => R = 1719/D = 265.16 => D = $6^0 28' 58"$ (Ans)	Given data, Length of tangent = 60m φ = Deflection Angel = $25^0 30'$ D = Degree of Curve=?

Q.18. Define Bench Mark (BM) and Mean Sea Level (MSL)?
Ans: BM = A benchmark is a point of reference by which something can be measured. In surveying, a "bench mark" (two words) is a post or other permanent mark established at a known elevation that is used as the basis for measuring the elevation of other topographical points.

a. Write down the formula of calculation of traversing area?

Ans: The formula are

1. Mid ordinate rule

Traversing Area, $A = (O_1 + O_2 + O_3 + \dots + O_n)d$

2. Average ordinate rule

Traversing Area, $A = \left(\frac{O_1 + O_2 + O_3 + \dots + O_n}{n+1}\right) \times nd$

3. Trapezoidal rule

Traving Area, $A = \left(\frac{O_1 + O_n}{2} + O_2 + O_3 + \dots O_{n-1}\right)$

4. Simpon's rule

Traversing Area, $A = \frac{d}{3}(O_1 + O_n + 4\{\text{Even number} + 2\{\text{Odd number}\})$

MSL= The zero surface to which elevations or heights are referred is called a vertical datum. Traditionally, surveyors and mapmakers have tried to simplify the task by using the average (or mean) sea level as the definition of zero elevation, because the sea surface is available worldwide

Q.19. Define Leveling?

Ans: Leveling (or leveling in US English) is a branch of surveying, the object of which is to

1. Find the elevation of a given point with respect to the given or assumed datum.
2. Establish a point at a given elevation with respect to the given or assumed datum.

Q.20. Define Reduced Level?

Ans: Reduced Level in surveying refers to equating elevations of survey points with reference to a common assumed datum. It is a vertical distance between survey point and adopted datum plane. Thus it is considered as the base elevation which is used as reference to reckon heights or depths of other important places.

Q.21. The following is the page of a level Book. Calculate missing data & apply boundary check?

Sol":

Distance	BR	IR	FR	Rise	Fall	RL	Remark
0	2.295					232.46	
100	1.65		2.265	0.02		232.48	
200		2.105			0.455	232.025	
300	1.625		1.96	0.145		232.17	
450	2.05		1.925		0.30	231.87	
500			1.71	0.34		232.21	
Total	7.61		7.86				

Check,

$\Sigma BR - \Sigma FR$ = Last RL − 1st RL

$\Rightarrow 7.61 - 7.86 = 232.21 - 232.46$

$\Rightarrow -0.25 = -0.25$ (OK)

Q.22. The following is the page of a level book. Calculate missing data & apply boundary check?

Sol":

Distance	BR	IR	FR	Rise	Fall	RL	Remark
0	4.75					100	BM-1
100		3.5		1.25		101.25	
200	5.21		7.9		4.4	96.85	
300			-0.14	5.65		102.5	BM 2
Total	9.96		7.46				

Check:

$\Sigma BR - \Sigma FR$ = Last RL − 1st RL

$\Rightarrow 2.5 = 2.5$ (OK)

Q. What do you mean by Contour?

Ans: A contour is an imaginary line on the ground joining the points of equal elevation

Contour interval: The vertical distance between any two Consecutive contour is called Contour interval

Horizontal equivalent: The horizontal distance between any two Consecutive Contour is called Horizontal equivalent.

MIST

Q Draw Pond and Hill for Contour line?

Ans:

i) If higher value are out side. it is pond/depression

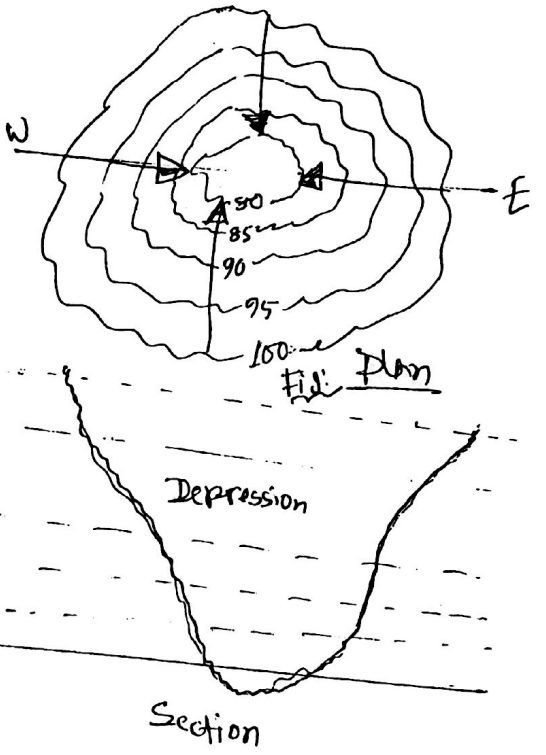
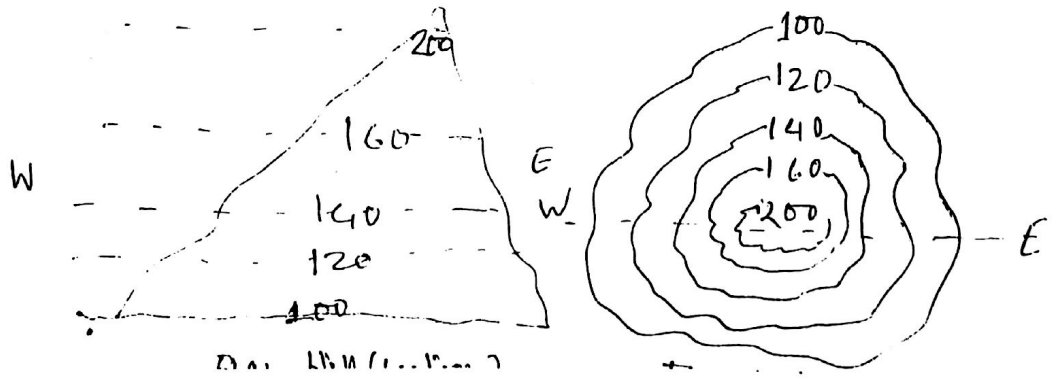


Fig: Pond

ii) If higher value are inside it is Hill.



(Q.) Write down the characteristics of contours?

Ans: The contours characteristics are -

1) All points in a contour line have the same elevation

2) When the contour lines cross one another on map, it indicates an overhanging cliff

3) When several contour coincide and the horizontal equivalent is zero, it indicates a verlical cliff

4) A series of closed contours line on the map indicates a hill (higher value inside)

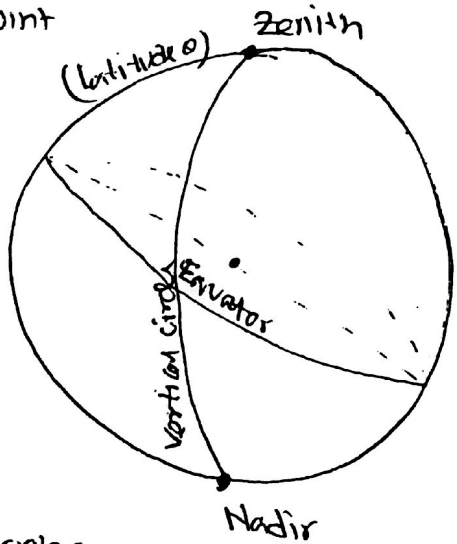
5) A series of closed contours line on the map indicates a depression if higher values are outside

6) The contours lines cross ridge or valley lines at right angle.

Q. Define astronomical terms?

Ans: Zenith: The zenith (Z) is the point on the upper portion of the celestial sphere marked by plumb line above the observe.

Nadir: The Nadir (Z') is the point on the lower portion of the celestial sphere marked by plumb line below the observe.



Celestial sphere: The imaginary sphere on which the stars appear to lie or to be studded is known as Celestial sphere.

$$\text{One Nautical mile} = \frac{\text{Circumference of the great circle}}{360 \times 60}$$

$$= \frac{2\pi R}{360 \times 60} = \frac{2\pi \times \text{radius of earth}}{360 \times 60} = \frac{2\pi \times 6370\ km}{360 \times 60}$$

$$= 1.852\ km.$$

HYDRALIC STRUCTURE

Q.1. Write down the meaning of Froude Number and Flow States?
Ans: The Froude number, Fr, is a dimensionless value that describes different flow regimes of open channel flow. The Froude number is a ratio of inertial and gravitational forces.

$$Fr = \frac{V}{\sqrt{gD}}$$	Where, V = Water velocity D = Hydraulic depth (cross sectional area of flow / top width) g = Gravity
When, Fr = 1, critical flow, Fr > 1, supercritical flow (fast rapid flow), Fr < 1, subcritical flow (slow / tranquil flow)	

Flow states: A stick placed in the water will create a V pattern of waves downstream. If flow is subcritical waves will appear in front of the stick. If flow is at critical waves will have a 45° angle. If flow is supercritical no upstream waves will appear and the wave angle will be less than 45°.

Note: Critical flow is unstable and often sets up standing waves between super and subcritical flow. When the actual water depth is below critical depth it is called **supercritical** because it is in a higher energy state. Likewise actual depth above critical depth is called **subcritical** because it is in a lower energy state.

Q.2. What is Reynolds number?
Ans: The Reynolds number is defined below for each case.

$$Re = \frac{\text{inertial forces}}{\text{viscous forces}} = \frac{\rho v L}{\mu} = \frac{v L}{\nu}$$	Where, v = the mean velocity of the object relative to the fluid (SI units: m/s) L = a characteristic linear dimension, (travelled length of the fluid; hydraulic diameter when dealing with river systems) (m) μ = the dynamic viscosity of the fluid (Pa·s or N·s/m² or kg/(m·s)) ν = the kinematic viscosity ($\nu = \mu/\rho$) (m²/s) ρ = the density of the fluid (kg/m³).
Note: R.N < 2000 it is Laminar Flow R.N > 2800 , it is Turbunent Flow (*) Neither laminar nor turbulent when RN = (2000 between 2800)	

Q.3. Write down the below terms?

Ans:

1. Reynolds number = $\frac{\text{Inertia force}}{\text{Viscous force}}$
2. Froude number = $\frac{\text{Inertia force}}{\text{Gravity force}}$
3. Weber's number = $\frac{\text{Inertia force}}{\text{Surface tension}}$
4. Euler's number = $\frac{\text{Inertia force}}{\text{Pressure force}}$
5. Mach number = $\frac{\text{Inertia force}}{\text{Elastic force}}$ → M < 1 = sub sonic flow, M = 1 = sonic flow, M = 1-6 = super sonic flow, M > 6 = Hyper sonic flow

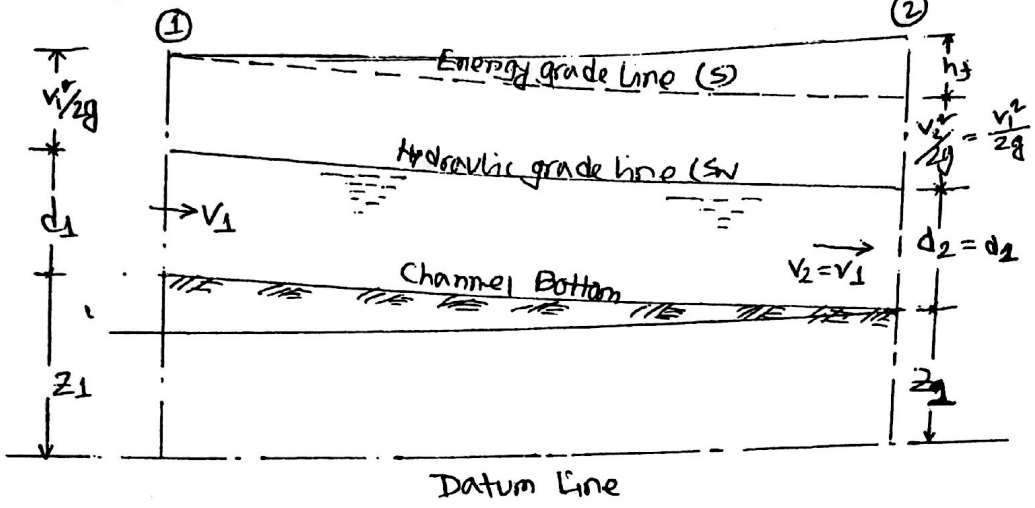
[PRACTICAL]

Q. Define with sketch of energy line & hydraulic grade line for open channel?

Ans:

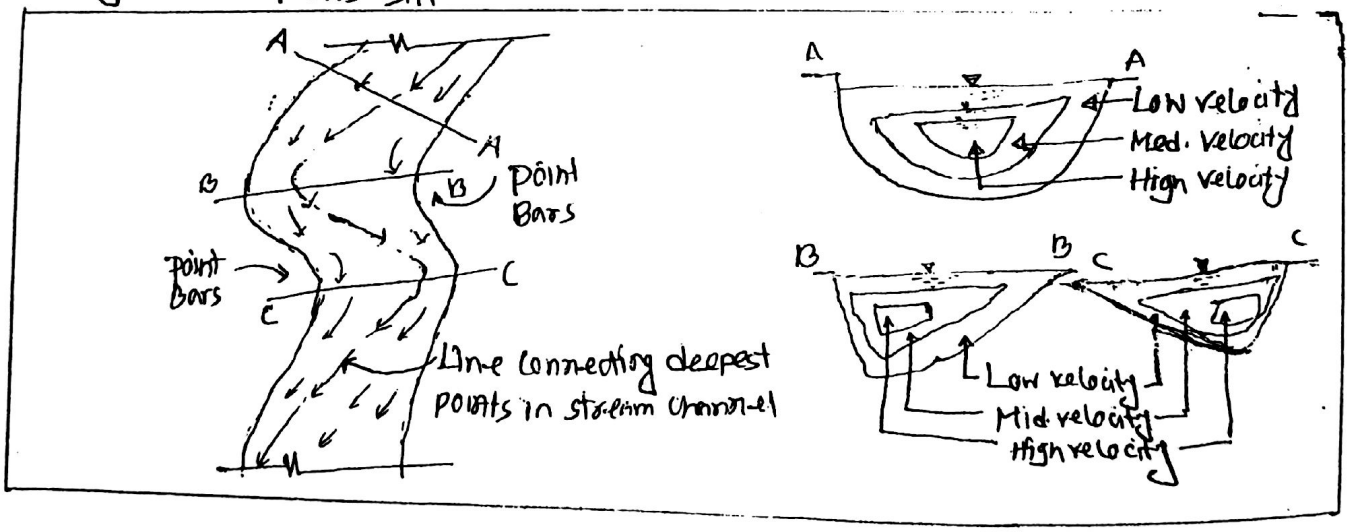
Energy line: A line that represents the elevation of energy head of water flowing in a pipe, conduit or channel is called energy line.

Hydraulic grade line: A line that represents the elevation of velocity head of water flowing a pipe, conduit or channel is called hydraulic grade line.



Q. Sketch Plan and section of Meandering river?
আঁকাবাঁকা

Ans: Meandering River: A meander, in generally is a bend in a sinuous water-course or river. A meander forms when moving water in a stream erodes the the outer banks and widens its valley and inner part of the river loses less energy and deposits silt.

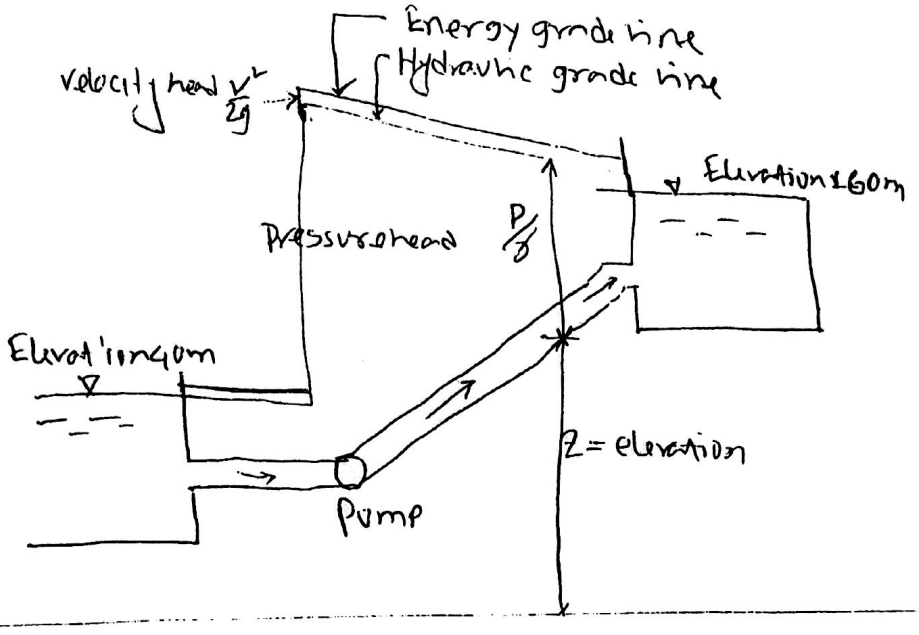


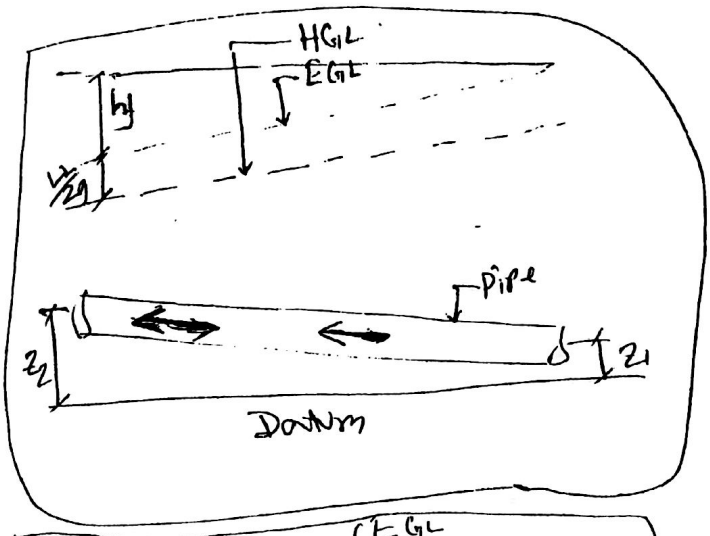
Q. Define Newtonion fluids?

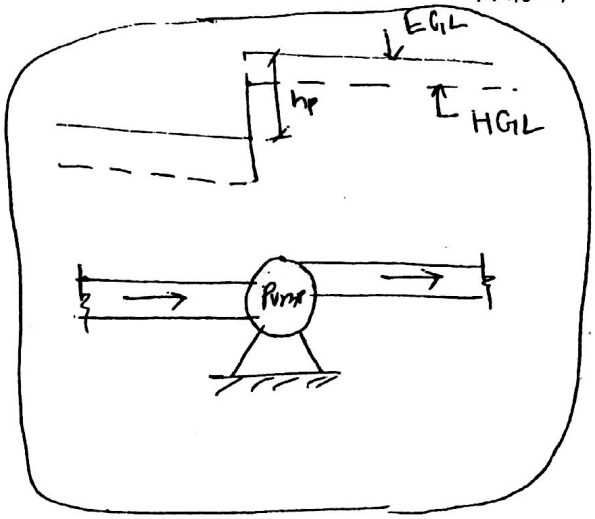
Ans: A fluids whose velocity does not change with the rate of deformation or shear stress is known as Newtonion fluids.

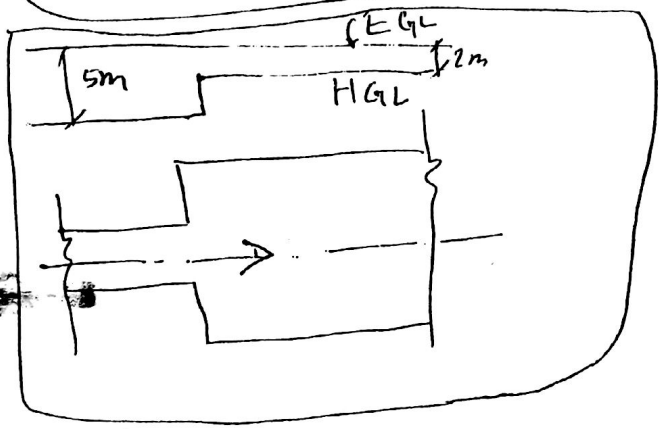
(Q. Draw the hydraulic grade line and energy grade line for following flow of pipe?

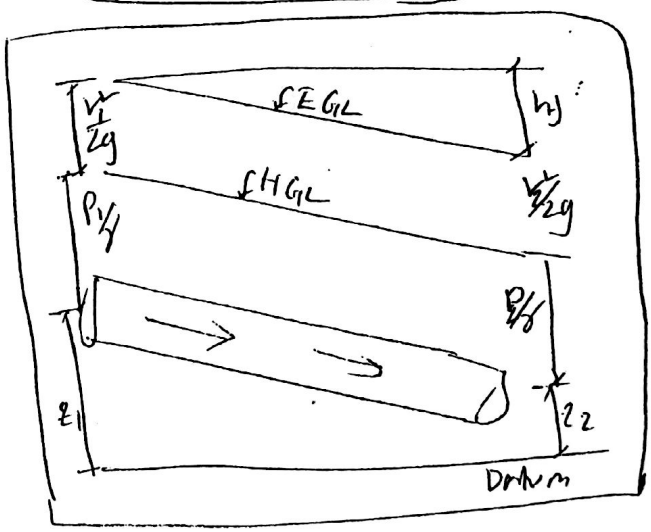
Ans:

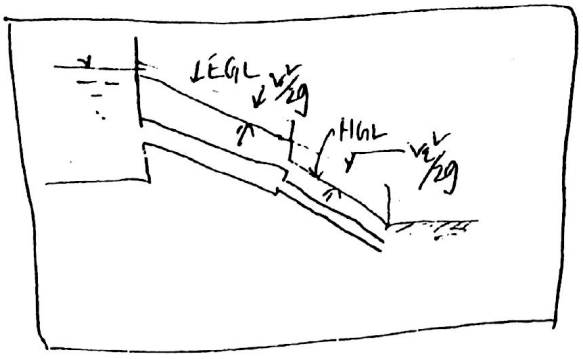


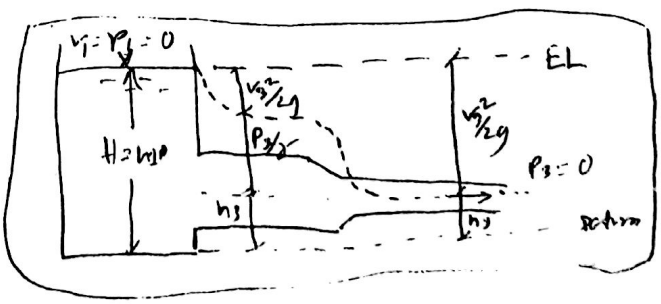












[MIST]

Q. What is water hammer ? or, fluid hammer or hydraulic shock ?

Ans: Water hammer is a pressure caused when a fluid/liquid/gas in motion is forced to stop or change direction suddenly.

Q. Write down the purposes of work for below instrument ?

i) venturimeter ii) Orifice iii) Pitot tube iv) Notch & weir v) Manometer

Ans:

i) venturimeter — Discharge (Q)
ii) Orifice meter — Discharge (Q)
iii) Pitot tube — velocity (v)
iv) Notch & weir — rate of flow (Q)
v) Manometre — pressure.

Q. Prove that froude Number, $F = 1$ for critical flow ?

or show that the state of flow specific is minimum at Critical state ?

Ans: We know that, $E = h + \frac{v^2}{2g} = h + \frac{Q^2}{2gA^2}$

$$\Rightarrow \frac{dE}{dh} = 1 + \frac{Q^2}{2g}(-2) \times A^{-3}\frac{dA}{dh}$$

$$= 1 - \frac{v^2 \times 2}{2gA} \cdot \frac{dA}{dh}$$

$$= 1 - \frac{v^2}{gA} \cdot \frac{dA}{dh}$$

$$= 1 - \frac{v^2}{gA} \cdot B = 1 - \frac{v^2}{gA/B} = 1 - \frac{v^2}{gD}$$

For minimum energy, $\frac{dE}{dh} = 0$

$$\Rightarrow 1 - \frac{v^2}{gD} = 0$$

$$\Rightarrow 1 - Fr^2 = 0$$

$$\Rightarrow Fr = 1 \text{ (proved).}$$

Hence specific energy is minimum at critical state

Q. Write down the difference between open channel flow and pipe flow?

Ans:

Open channel flow	Pipe flow
1. Flow occurs due to gravity	1. Flow occurs due to different in pressure
2. Cross section of open channel can be rectangular, trapezoidal triangular, Parabola & circular	2. Cross section of pipe generally round
3. In the open channel flow HGL coincide with water surface line	3. In the pipe flow HGL do not coincide top surface of the water.
4. $(z + p/\gamma)$ = Piezometric head, where p is the pressure in pipe	4. Piezometric head = $z + h$, where h is depth of channel.

TRANSPORTATION ENGINEERING

Q.1. Write down the definition of skid and slip?

Ans: Skid:

i) It is occurs when the slide of wheel without revolving

ii) The distance travelled by wheel on road is greater than the circumference movement of wheel.

Slip:

i) It is occurs when wheel revolves more than corresponding longitudinal movement along the roads.

ii) The distance travelled by wheel on road is less than the circumference movement of wheel.

Q.2. Define Pavement?

Ans: Pavement is a structure which is constructed on the compacted earth surface.

Q.3. Define Flexible and Rigid Pavement?

Ans:

Flexible Pavement: A pavement which is consists of asphalt or bituminous materials mixing with aggregate which have a very low flexural strength and is flexible in structural behavior is known as flexible pavement.

Rigid Pavement: The pavement which is consists of cement concretc slab which have capable of considerable flexural strength is known as rigid pavement.

Q.4. Difference between Flexible and Rigid pavement?

Ans:

Flexible Pavement	Rigid Pavement
i) It has low flexural strength	i) It has capable of consideration flexural strength
ii) Initial cost is low	ii) High initial cost
iii) High maintenance cost	iii) Low maintenance cost
iv) High deflection	iv) Low deflection
v) Lower life time	v) Longer life time
vi) It distributes the load in small area	vi) It distributes the load in larger area

Q.5. Define Prime coat, Tack coat and Seal coat?

Ans:

Prime Coat	Tack Coat	Seal Coat
1. Definition: The application of binder or bituminous materials having a low viscosity provided on surface of the WBM.	1. Definition: The application of binder or bituminous materials provided on the existing surface.	1. Definition: It is the final coat over the bituminous pavement of very thin layer usally less than ½" thickness.
2. Purposes: i) Prevent the capillary rise of water ii) Good bond between WBM and bituminous materials.	2. Purposes: i) Better bond between existing surface and new bituminous layer.	2. Purposes: i) To provided water proofing surface. ii) To provided non skid road surface. iii) to rejuvement of old surface
3. Materials: Tar and Asphalt (MC-30, MC-70) are used	3. Materials: Liquid Asphalt (RC-70, RC-250) are used	3. Materials:Asphalt Emulsion and Tar Emulsion are used

1st

(1) Write down the design factor of flexible pavement?

Ans: The design factor of flexible pavements are -

1. Design wheel load
2. Subgrade soil
3. Climatic factors
4. Pavement component materials
5. Environmental factor
6. Special factors in the design of different types of pavement.

MID

(2) Write down the distress of flexible pavement? and maintenance?

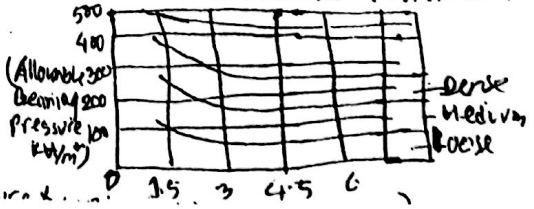
Ans: The distress & solution as below -

Distress	Solution
1. Bleeding	reduce the asphalt binder film
2. Block Cracking	1) Crack seal with HMA 2) Remove & replace the crack pavement
3. Stripping	remove & replace sub-surface drainage
4. Rutting	sufficient compaction,
5. Potholes	In accordance with patching techniques
6. Roller marks	Proper compaction. Properly roller operation
7. Fat spots	i) Moisture content should be low when aggregate & asphalt are mixing ii) Carefully use of petroleum or diesel contamination of paving situ

FINAL

(3) What is SPT 'N' value/ How to collect SPT 'N' value/ What do you meant by SPT 'N' value/ Define Standard Penetration Resistance?

Ans: The SPT test uses a thick walled sample tube with an outside diameter of 50.8mm and an inside diameter of 35mm, and a length of around 650 mm. This is driven into the ground at the bottom of a borehole by blows from a slide hammer with a mass of 63.5kg falling through a dis" of 760mm. The sample tube is driven 150mm into the ground and the number of blows needed for the tube to penetrate each 150mm upto a depth of 450mm is recorded. The sum of the number of blows required for the second and third 6" of penetration is termed the "Standard Penetration resistance" or the "N-value"



Overburded correction, ; where,

$$N' = N_f \left(\frac{50}{P+10}\right)$$

N' = Corrected N value

N_f = Field N "

DPDC (Full)

Q.6 Sketch the cross section for Flexible Pavement Road and show different components?

Ans:

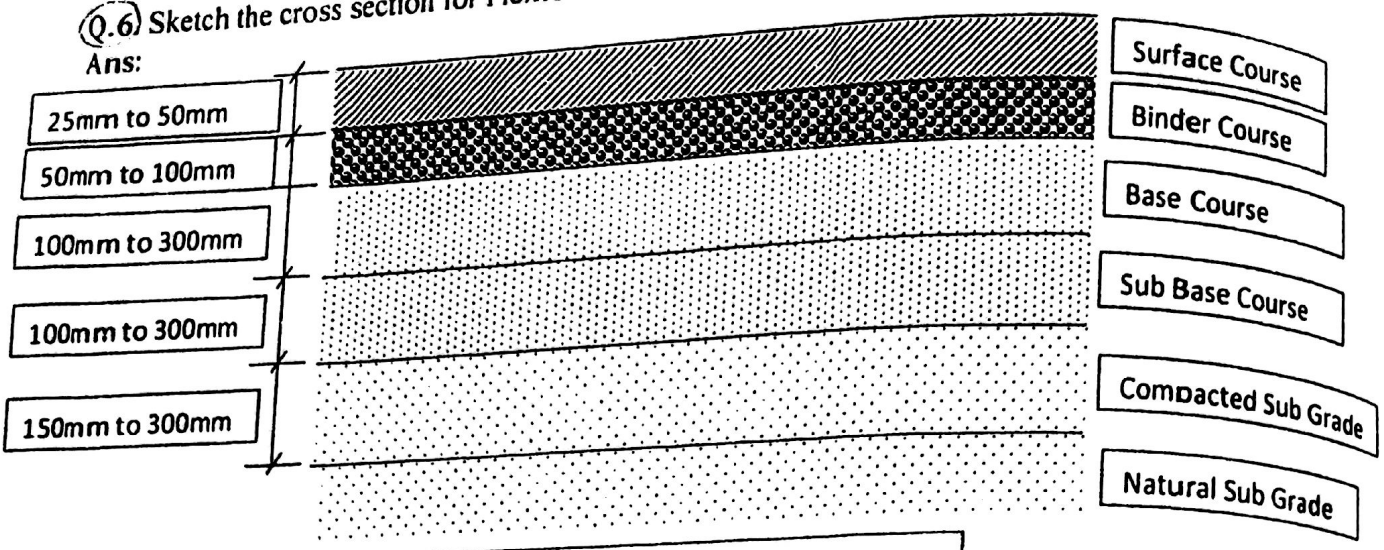


Fig. Cross section for Flexible Pavement

Q.7. Sketch the cross section for Rigid Pavement Road and show different components?

Ans:

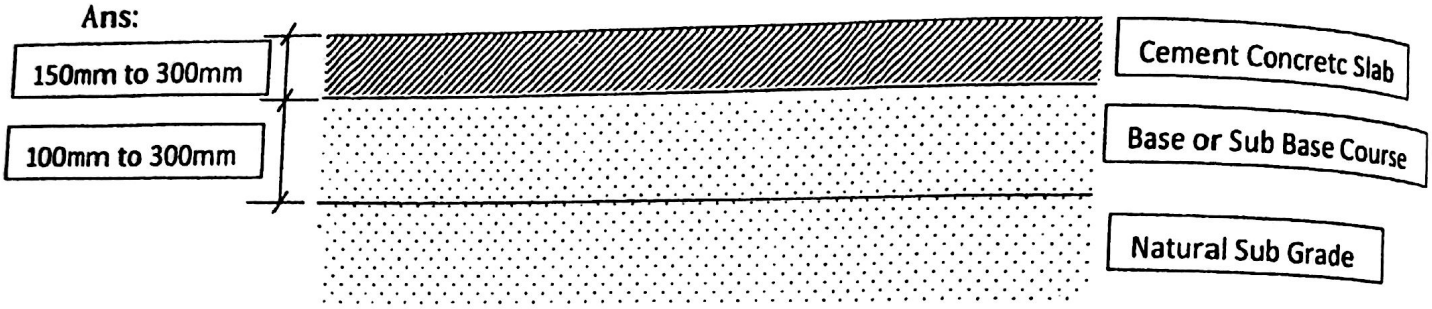


Fig. Cross section for Rigid Pavement

Q.8. Write down the definition of below terms?

Ans:

Sub grade: Soil, Sandy soil is preferable.

Improved sub grade: Good quality of soil such as sand is preferable.

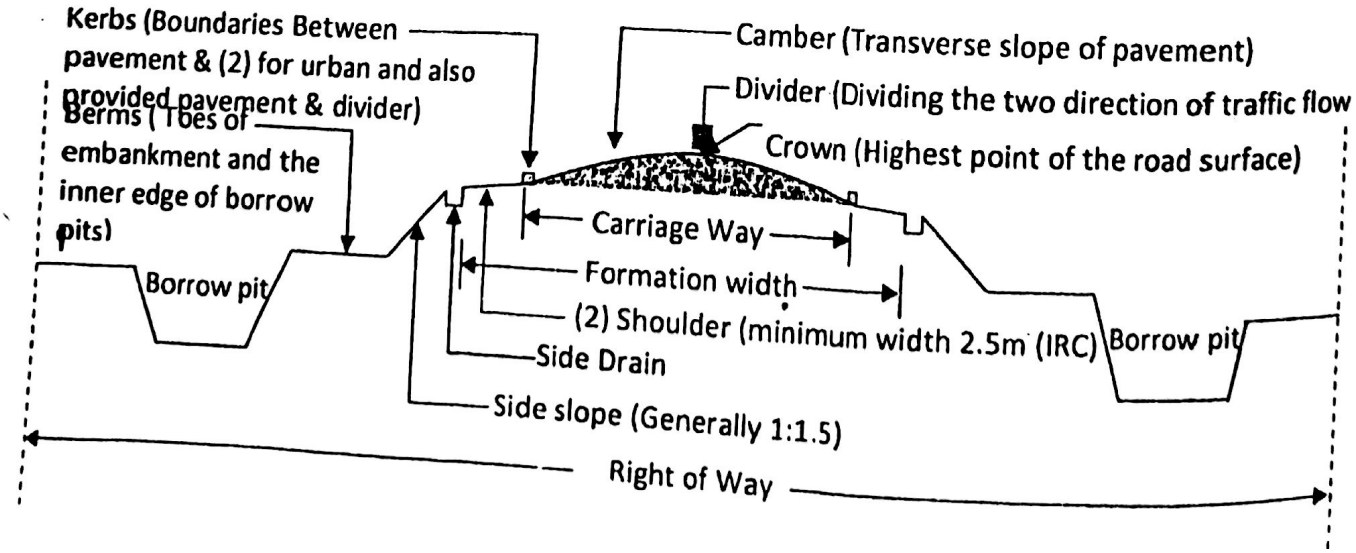
Base Course: It is constructed by mixing of very good quantity of sand with high grade of aggregate.

Wearing Course: It is made from asphalt or bitumen by mixing of coarse and fine aggregate.

Cement Concretc Slab: It is made from cement, coarse aggregate and fine aggregate.

Q.9. Draw the Right of way of a pavement?

Ans:



Q. SPT value of field 12 at 30' below GL with water level 20' below GL, if $\gamma = 100$ pcf and $\gamma' = 70$ pcf. Determine corrected N value

Soln

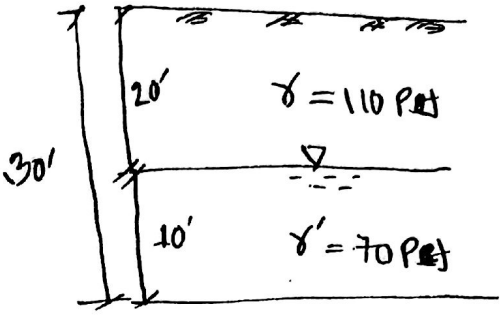
we know,

(*) Corrected, $N' = N_f \left(\frac{50}{P+10}\right)$

$\Rightarrow N' = 12 \times \frac{50}{P+10}$

$= 12 \times \frac{50}{20.14+10}$

$= 19.907 \approx 20$



(P) $= 20 \times 110 + 10 \times 70 = 2900$ psf

$= 20.14$ psi

< 40 psi (ok)

It is recommended at present that, if $N' > 2N_f$, the adjusted N' to be used in design should be divided by a factor of safety. say. 2

[Hb: overburden correction is applied only to cohesionless soil (dry moist or wet)]

(*) For very fine or silty or silt situated below water table – N'

$N' = 15 + \frac{1}{2}(N_f - 15)$ for $N_f > 15$

Q.10) Write down the definition of following terms?

Ans: Right of Way: The area of land acquired for construction and future development of a road symmetrically about the central alignment is called Right of Way.

Carriage Way: The portion of the road surface which is used for traffic movement is known as carriage way.

Spoil Bank: Extra earth excavated and to be dumped on the road sides in road in cutting.

Kerb: The boundary between the shoulder and the pavement is known as kerb.

Camber: The slope of a road in transverse direction is known as camber.

Gradient: The slope of the road pavement in longitudinal direction is known as Gradient.

Q.11. Write down the definition of macadam road and with their classification?

Ans: The road surface or base in which crushed or broken stones are mechanically keyed or interlocked by rolling and centered together by

There are four types-

1. Traffic bound, 2. Cement bound, 3. Water bound, 4. Bituminous macadam - i) Penetration Mac, ii) Inverted Mac, iii) Dense Mac, iv) Coated Mac.

Q.12. What is Water Bound Macadam (WBM) Road?

Ans: The road whose wearing surface consists of clean crushed aggregate, mechanically interlocked by rolling and bound together with filler materials and water and laid on a well compacted base course is called WBM Road.

Q13. Write down the design methods of flexible pavement?

Ans: The design methods are as below-

1. California Bearing Ratio (CBR) method	5. Bazmister method
2. The Asphalt Institute (AI) method	6. Tri-axial test method
3. American Association of State Highway & Transportation Officials (AASHTO) flexible pavement design method.	7. North Dakota cone (NDC) method
4. Group Index (GI) method	8. US Navy method

Q.14. Describe the flexible pavement design method?

Ans: The descriptions are -

California Bearing Ratio (CBR) method	Group Index (GI) method
1. It is the ratio of the force required to percentage a circular piston of $3in^2$ cross sectional area in a special container of 1.27mm/min to the standard force.	1. The group index of a soil is a number reflects the characteristic of the soil.
2. Mold size (dia = 6inch and height = 6 inch to 7 inch) ,compacted with 5 layer having 56 blows which hammer weight 10 lb and free fall in 18 in	2. Sub base course thickness is proportional to the GI.
3. Calculated, CBR = $\frac{\text{Measured force}}{\text{Standard Force}} \times 100$ or, Maximum Value is acceptable $\frac{\text{Unit Load in PSI for 0.1" or 0.2" penetration}}{\text{1000psi (for 0.1") or 1500psi (for 0.2")}} \times 100$ ---------- (i) $\frac{\text{Unit Load in PSI for 0.1" or 0.2" penetration}}{\text{3000psi (for 0.1") or 4500psi (for 0.2")}} \times 100$ ---------- (ii) **From equation (i) and (ii), Larger Value is Accepted**	3. Group Index value varies from 0 to 20 that are why higher GI value indicates the larger Sub-Base Course thickness.
4. CBR of a soil which varies from 0% to 100%	

Q.15. What is the difference between Highway Pavement and Airport Pavement?
Ans:

Highway Pavement	Airport Pavement
i) Design wheel load 4.1 ton	i) Design wheel load 100 ton
ii) Maintenance cost relatively low	ii) Maintenance cost high
iii) Tyre pressure 5kg/cm^2 to 7kg/cm^2	iii) Tyre pressure 17kg/cm^2 to 24kg/cm^2
iv) Load repetition per day 1000 to 2000 vehicle	iv) Load repetition per day 20,000 to 40,000 vehicle
v)Uniform pavement thickness	v) Pavement thickness are not uniform

Q.16. What is flash point of bituminous materials?
Ans: Flash point: The minimum temperature at which the bituminous materials take fire in the form of flash is known as Flash Point.

Q.17. Write down the different test of Bitumen?
Ans: The test are-
i) Specific gravity test
ii) Flash point and Fire point test
iii) Solubility test (Note: Pure bitumen is fully soluble in CS_2 and CCl_4)
iv) Softening Point test
v) Ductility test
vi) Viscosity test
vii) Loss of heating test
viii) Penetration test

Q.18. Difference between Bituminous materials (Asphalt and Tar)?
Ans:

Asphalt: Residues of petroleum oils	**Tar:** Residues from destructive distillation of organic matter such as coal,wood or petroleum
Color: It is usually black color	**Color:** It is usually brown-black color
Properties: i) Binding capacity, ii) Ductility, iii) Durability, iv) Temperature Susceptibility	**Properties:** i)Toxic in nature, ii) More Temperature Susceptibility, iii) Posses more free carbon, iv) becomes hard more rapidly

Q.19. Write down penetration test in bitumen?
Ans: This test is performed by allowing a needle of standard dimension loaded by 100gm to penetrate vertically in the bitumen at temperature 25°c for a period of 5sec.It is expressed in unit of 1/100 cm.

Q.20. What do you mean by 80/100 of bitumen?
Ans: 80/100 means that the bitumen having penetration value of 80 and the needle will sink by distance of 0.8cm in the bitumen at temperature 25°c provided load at 100gm during 5sec.

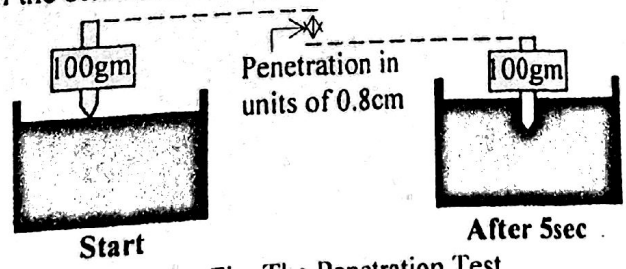


Fig. The Penetration Test

Q.16(a). What is fire point of bituminous materials?
Ans: The minimum temperature at which the bituminous materials get ignited and burn under specific condition of test.

Q.21. Write down the methods of mix design?

Ans: The methods are-

i) Marshall method

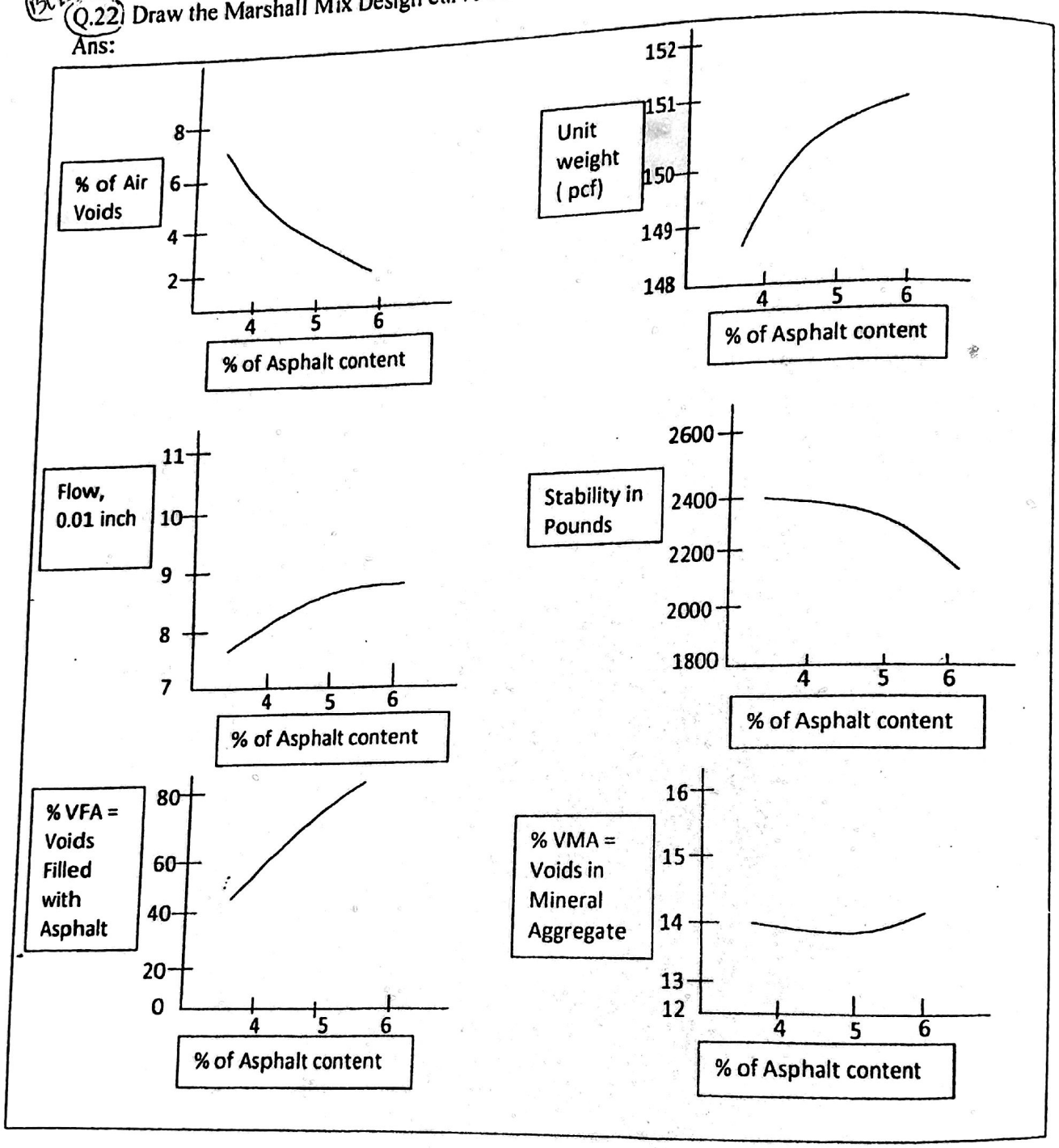
ii) Hveem method

iii) The Smith triaxial method

iv) The Hubbard Field method

(BUET) Q.22 Draw the Marshall Mix Design curve for Bituminous Materials (Asphalt) ?

Ans:



Q.23. What do you mean by Stability and Flow?

Ans: Stability is define as the maximum load that carried by a compacted specimen of 2.5 inch height and dia 4 inch at a standard temperature of 60^0c. The deformation at maximum load expressed in 1/100 during stability test is known as flow.

Q.24. Determine VMA (Voids in Mineral Aggregate) and VFA(Voids Filled in Asphalt) for following data which is shown as given data?

Sol":

We know that, $VMA = 100 - G_{mb}P_s / G_{sb}$ => VMA =100 – 2.29 x 86 /2.67 => VMA = 26.23% (Ans) Also, we know that, VFA = (100 (VMA- Va))/VMA => VFA = (100 x (26.23 – 3.79))/26.23 => VFA = 85.56% (Ans) Where Va = % of air voids = 3.79%	Given Data, Gmb = Bulk specific gravity of compacted mixture = Wa/(Wa – Ww) = 3041.2/(3041.2 – 1713.2) = 2.29 Ps = Aggregate (% by total weight of mixture = 56 + 30 = 86% P1= % by weight of coarse aggregate = 56% P2= % by weight of fine aggregate = 30% P3= % by weight of mineral filler = 7% g1= Bulk specific gravity of coarse aggregate = 2.611 g2= Bulk specific gravity of fine aggregate = 2.69 g3= Bulk specific gravity of mineral filler = 3.10 Gsb = Bulk specific gravity of aggregate = P1+P2+P3)/(P1/g1 + P2/g2 + P3/g3) = 2.67 VMA =? VFA=?

Q.25. Determine the total cost of highway transportation and unit cost of transportation if annual cost of highway is 20000tk and annual cost of vehicle operation (single vehicle) is 4000tk with total vehicle 100nos on the road per year also length of highway is 1000km?

Sol":

We know that, Total cost of highway transportation, A = B + CN => A = 20000 + 4000 x 100 => A = 420000tk (Ans) Also we know that, Unit cost of transportation, $A_U = A/(NL)$ => A_U = 420000/(100 x 1000) = 4.2tk per 1km per year (Ans)	Given data, Annual cost of highway ,B = 20000tk Annual cost of vehicle operation (single vehicle) , C = 4000tk Total number of vehicles on the road, N = 100nos per year Length of highway, L = 1000km Total cost of highway transportation, A =? Unit cost of transportation, A_U = ?

Q.26. Write down the design property and test of aggregate?

Ans: The design property and test of aggregate are-

Design property of aggregate	Test of aggregate	
i) Strength	i) Specific gravity test	ix) Water Absorption test
ii) Shear strength	ii) Flakiness index test	x) Unit weight test
iii) Shape and texture	iii) Elongation test	xi) Angularity test
iv) Cleanness and purity	iv) Durability test	xii) Abrasion test
v) Grading	v) Shear strength test	
vi) Porosity	vi) Crushing strength test	
vii) Durability	vii) Impact test	
viii) Crushing property	viii) Grading analysis	

Q.27.Described in math for Angularity test?

Ans:

Objective

For determination of angularity number of coarse aggregates.

Equipment & Apparatus

i) Balance (0-10kg) ,ii) Sieves (20,16,12.5,10,6.3,4.75mm), iii) Metal cylinder, iv) Tamping rod, v) Scoop

Test Sample Preparation

The test sample consist of aggregate retained between the appropriate pair of IS sieves from the following sets

PASSING	RETAINED
20 mm	16 mm
16 mm	12.5 mm
12.5 mm	10 mm
10 mm	6.3 mm
6.3 mm	4.75 mm

The aggregate to be tested is dried for at least 24 hours in a well ventilated oven maintained at a temperature of 100 to 110^0C.

Procedure

1. The aggregate is compacted in three layers, each layer being given 100 blows using the standard tamping rod at a rate of 2 blows/second by lifting the rod 5 cm above the surface of the aggregate and then allowing it to fall freely.
2. The blows are uniformly distributed over the surface of the aggregate. After compacting the third layer, the cylinder is filled to overflowing and excess material is removed off with temping rod as a straight edge.
3. The aggregate with cylinder is then weighed. Three separate determinations are made and mean weight of the aggregate in the cylinder is calculated.

Calculation

$$\text{Angularity Number} = 67 - \frac{100\,W}{CG_s}$$

Where,

W = mean weight of the aggregate filling cylinder.

C = Weight of water required to completely fill the cylinder (i.e. Volume of cylinder)

G_s = Specific Gravity of the aggregate

Q.28. Determine the angularity number if a 10cm x 30cm cylinder filled with aggregate?

Sol":

We know that, Angularity number = 67 – 100W/CGs => AN = 67 – 100 x 14.14/9.424 x 2.8 => AN = 67 – 53.6 => AN = 13.4 (Ans)	Given Data, Unit weight of water= 1000kg/m^3 Unit weight of aggregate= 1500kg/m^3 W = mean weight of the aggregate filling cylinder = π x 0.10^2 x0.30 x 1500 =14.14kg C = Weight of water required to completely fill the cylinder (i.e. Volume of cylinder) = π x 0.10^2 x0.30 x 1000 =9.424kg G_s = Specific Gravity of the aggregate = 2.8

Q.29.Described in math for of flakiness index test of coarse aggregate?

Ans:

For determination of flakiness index of coarse aggregate, where the size of the coarse ;aggregate are larger than 6.3mm .

Equipment & Apparatus

i) Thickness gauge, ii) Sieves [63, 50, 40, 31.5, 25, 20, 16, 12.5, 10 & 6.3mm], iv) Balance [0-10 kg] , v) Gauge

Preparation sample

Surface dry samples are used for the test. A minimum number of 200 pieces of any specified fraction is required to do the test.

Procedure

1. The sample is sieved through IS sieve specified in Table shown below.

DIMENSIONS OF THICKNESS AND LENGTH GAUGES

Size of Aggregate		Thickness Gauge*	Length Gauge†
Passing Through IS Sieve	Retained On IS Sieve		
(1)	(2)	(3)	(4)
		mm	mm
63-mm	50-mm	33·90	—
50-mm	40-mm	27·00	81·0
40-mm	25-mm	19·50	58·5
31·5-mm	25-mm	16·95	—
25-mm	20-mm	13·50	40·5
20-mm	16-mm	10·80	32·4
16-mm	12·5-mm	8·55	25·6
12·5-mm	10-mm	6·75	20·2
10-mm	6·3-mm	4·89	14·7

*This dimension is equal to 0·6 times the mean sieve size.

†This dimension is equal to 1·8 times the mean sieve size.

Dimension of Thickness and Length Gauge

A minimum of 200 pieces of each fraction is taken and weighed.

In order to separate flaky materials, each fraction is then gauged individually for thickness on a thickness gauge.

The total amount of flaky material retained by the thickness gauge is weighed to an accuracy of 0.1% of the weight of sample.

Calculation

In order to calculate the flakiness index of the entire sample of aggregates, first the weight of each fraction of aggregate passing and retained on the specified set of sieves is noted (Y1, Y2, Y3, Y4.....etc). Each piece of these are tried to be passed through the slot of the specified thickness of the thickness gauge are found and weighed (y1, y2, y3, y4...etc). Then the flakiness index is the total weight of the material retained on the various thickness gauges, expressed as a percentage of the total weight of the sample gauged.

$$\text{Flakiness Index} = \frac{(y1 + y2 + y3 + \ldots)}{(Y1 + Y2 + Y3 + \ldots)}$$

Q.30. Described in math for of los angeles abrasion test? (LAA)?

Ans:

Objective:

i) to determine the los angeles abrasion value.

ii) to find the suitability of aggregates for use in road construction.

Apparatus:

i) los angeles machine: it consists of a hollow steel cylinder. closed at both the ends with an internal diameter of 700 mm and length 500 mm and capable of rotating about its horizontal axis. A removable steel shaft projecting radially 88 mm into cylinder and extending full length (i.e.500 mm) is mounted firmly on the interior of cylinder. The shelf is placed at a distance 1250 mm minimum from the opening in the direction of rotation.

ii) Abrasive charge: cast iron or steel balls, approximately 48mm in diameter and each weighing between 390 to 445g; six to twelve balls are required.

iii) sieve: 1.70, 2.36,4.75,6.3,10,12.5,20,25,40,50,63,80 mm is sieves.

iv) balance of capacity 5kg or 10kg

v) drying oven

vi) miscellaneous like tray

Procedure:

The test sample consists of clean aggregates dried in oven at 105° – 110°c. The sample should conform to any of the gradings shown in table 1.

i) select the grading to be used in the test such that it conforms to the grading to be used in construction, to the maximum extent possible.

ii) take 5 kg of sample for gradings a, b, c & d and 10 kg for gradings e, f & g.

iii) choose the abrasive charge as per table 2 depending on grading of aggregates.

iv) place the aggregates and abrasive charge on the cylinder and fix the cover.

v) rotate the machine at a speed of 30 – 33 revolutions per minute. The number of revolutions is 500 for gradings a, b, c & d and 1000 for gradings e, f & g. The machine should be balanced and driven such that there is uniform peripheral speed.

vi) the machine is stopped after the desired number of revolutions and material is discharged to a tray.

vii) the entire stone dust is sieved on 1.70 mm is sieve.

viii) the material coarser than 1.7mm size is weighed correct to one gram.

Sieve size (square hole)	Weight of test sample in gm							
Passing (mm)	Retained on (mm)	A	B	C	D	E	F	G
80	63					2500*		
63	50					2500*		
50	40					5000*	5000*	
40	25	1250					5000*	5000*
25	20	1250						5000*
20	12.5	1250	2500					
12.5	10	1250	2500					
10	6.3			2500				
6.3	4.75			2500				
4.75	2.36				5000			

Table 1: grading of test samples [tolerance of ± 12 percent permitted.]

Grading	No of steel balls	Weight of charge in gm
A	12	5000 ± 25
B	11	4584 ±25
C	8	3330 ± 20
D	6	2500 ± 15
E	12	5000 ± 25
F	12	5000 ± 25
G	12	5000 ± 25

Table 2: selection of abrasive charge

Observations:

Original weight of aggregate sample = w_1 g

Weight of aggregate sample retained = w_2 g

Weight passing 1.7mm is sieve = $w_1 - w_2$ g

Abrasion value = $(w_1 - w_2) / w_1 \times 100$

Sl. No.	Type of pavement	Max. Permissible abrasion value in %
1	Water bound macadam sub base course	60
2	Wbm base course with bituminous surfacing	50
3	Bituminous bound macadam	50
4	Wbm surfacing course	40
5	Bituminous penetration macadam	40
6	Bituminous surface dressing, cement concrete surface course	35
7	Bituminous concrete surface course	30

(Q.31) Determine abrasion value for following data which is given by the below problem?

Sol":

We known that, Abrasion value = $(w_1 - w_2) / w_1 \times 100$ => AV = 60/100 x 100 => AV = 60 % (Ans) This materials is used only for sub base course for WBM	Given Data, Original weight of aggregate sample, w_1 =100 g Weight of aggregate sample retained, w_2= 40 g Weight passing 1.7mm is sieve, $w_1 - w_2$ = 100-30 =60 g Abrasion value = ?

(Q.32) Write down the classification of Aggregate?

Ans:

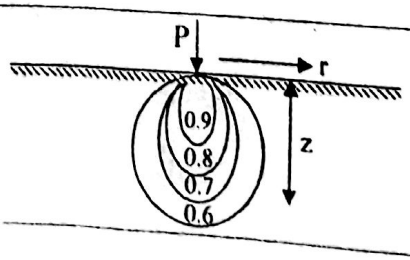
Type of Classify/Materials	Coarse Aggregate	Fine Aggregate	Mineral Filler
Transportation Engineering	Retained on #8	Passing #8 and Retained #200	Passing #200
RCC work	Retained on #4	Passing #4 and Retained #100	Passing #100

(Q.33) Why superior materials are used on upper portion of road?

Ans:

Because of –

The load intensity along the radial direction and along the depth is minimum and is maximum at the top most of the surface that is why the superior materials are used in upper portion.



Q. Calculate stopping sight distance for design speed 50mph and $\mu = 0.42$?

Sol":

We know, $SSD = 0.278Vt + \frac{V^2}{254(\mu \pm \%/100)}$ $\Rightarrow SSD = 0.278 \times 80.47 \times 2.5 + \frac{(80.47)^2}{254(0.42 \pm 0)}$ $\Rightarrow SSD = 55.93 + 60.70$ $= 116.63\ m$ (Ans)	Given data, $V = 50\ mph = 80.47\ km/h$ $t = 2.5\ sec$ $\mu = 0.42$ Gradient/Slope horizontal. $n = 0$ $SSD = ?$

Q.34. Detailed in aggregate test?

Ans:

Aggregate Crushing Value (ACV) test	Aggregate Impact Value (AIV) test
1) ACV test is a measure of resistance of aggregate to crushing under a gradually applied compression load.	1) AIV test is a measure of resistance of sudden socks of aggregate.
2. Test procedure: i) Dry aggregate passing through 12.5mm and retained on 10mm sieve are filled in a 11.5cm in dia and 18cm in height into 3 equal layers and compacted temper bar(dia-16mm and 60cm long) with 25blows at each layer. ii) The measure is subjected to a gradually compression load of 40ton@ 4ton/min iii) After loading the aggregate is sieved through 2.36mm iv) Calculated, ACV =	2. Test procedure: i) Dry aggregate passing through 12.5mm and retained on 10mm sieve are filled a cup 10.2cm in dia and 5cm in height into 3 equal layers and compacted temper bar(dia-16mm and 60cm long) with 25blows at each layer. ii) The cup is placed in a maching hammer of weight 14kg with a drop of 38mm iii) After loading the aggregate is sieved through 2.36mm iv) Calculated, AIV =
$\frac{\text{Wt. of aggregate passing through 2.36mm}}{\text{Wt. of dry aggregate before crushing}} \times 100$	$\frac{\text{Wt. of aggregate passing through 2.36mm}}{\text{Wt. of dry aggregate before test}} \times 100$
3. i) For Base course materials ACV ⋗45% ii) For surface course materials, ACV ⋗30%	3. i) For Base course materials ACV ⋗45% ii) For surface course materials, ACV ⋗30% **iii) AIV value – 10% - very strong** **iv) AIV value – 20 % to 10% - Strong** **v) AIV value -20% to 30% - Suitable for road**

Q.35. Define SSD (Stopping Sight Distance)?

Ans: It is the minimum distance required within which a vehicle moving at design speed can be stopped without colliding with stationary object on the road surface.

Formula,	Note : SSD for two way traffic on a single lane is twice of SSD
SSD = $0.278vt + v^2 / (254(\mu \pm n/100))$ meter Where, v = Design speed (km/h) t = Total reaction time (About = 2.5 sec) μ = Frictional Co- efficient (About =0.4) n = Gradient or slope for Ascending slope, n = (+)ve Descending slope, n = (-)ve Horizontal, n = 0	

Q.36. Calculate the stopping sight distance for design speed of 100 km/h in a highway if reaction time of the driver 3sec and $\mu = 0.42$?

Sol":

We know that, $SSD = 0.278vt + v^2 / (254(\mu \pm n/100))$ $\Rightarrow SSD = 0.278 \times 100 \times 3 + (100)^2 / (254 \times (0.42 \pm 0))$ $\Rightarrow SSD = 177.74m$ (Ans)	Given data, v = Design speed = 100 km/h t = Total reaction time = 3 sec μ = Frictional Co- efficient = 0.42 Gradient or slope Horizontal, n = 0 SSD =?

⊛ N.B. If no reaction time in a problem it always takes 2.5 sec to 3sec for solve the related problem

Q. Define parmanent way ? with sketch ?

Ans: The finished or completed track of a railway line is commonly known as the permanent way

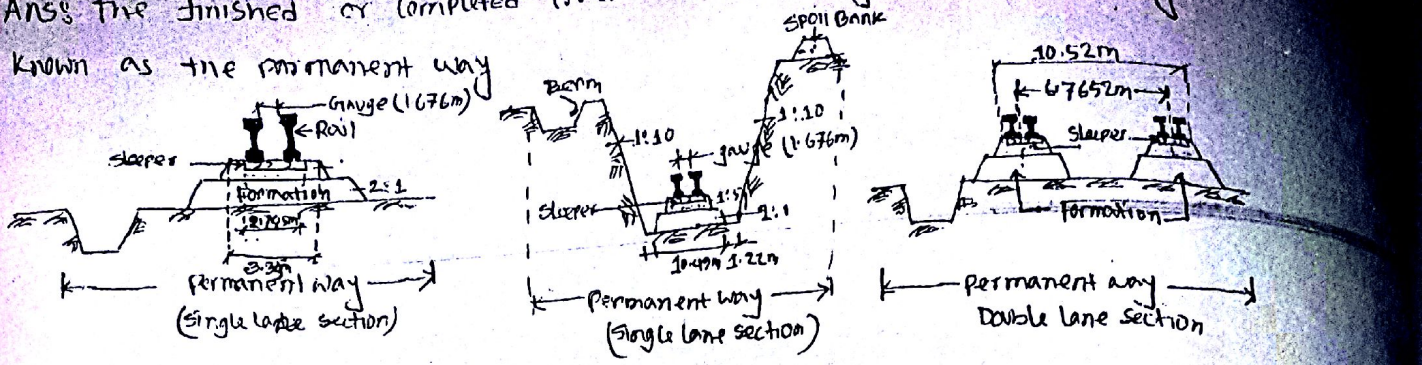
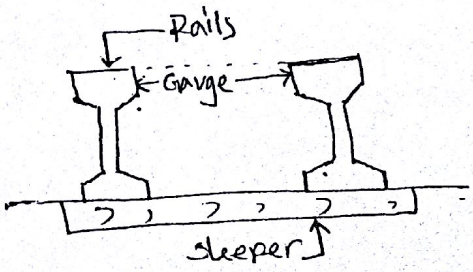


Figure. Permanent way.

Q. Define railway gauge with sketch ?

Ans: The gauge of a railway track is define as the clear minimum perpendicular distance between the inner faces of the two rails



BG = 1.676 m to 1.524 m

Standard gauge

SG = 1.435 m to 1.451 m

MG = 1.067 m to 1.0 m & 0.915 m

NG = 0.762 m or 0.610 m

Q. Write down the factor affecting of gauge?

Ans: The factors are

1) Traffic condition 2) Development of poor areas
3) Cost of track 4) Speed of movement
5) Nature of country.

Q. Write down the function of rail?

Ans: The function of rail are -

1) to bear the stresses developed due to heavy vertical load, lateral and braking forces and thermal stress
2) to provided a hard and smooth surface
3) to transmit load to the sleeper and consequently to reduce pressure on ballast and formation.

Q.37. Calculate the safe stopping sight distance for design speed of 60 km/h for i) Two way traffic on a two way lane road, ii) Two way traffic on a single lane road, iii) When grade is 3% ascending, iv) when grade is 3% decreasing. Assume reaction time 2sec and $\mu = 0.35$?

Sol":

We know that, i) $SSD = 0.278vt + v^2 / (254(\mu \pm n/100))$ $\Rightarrow SSD = 0.278 \times 60 \times 2 + (60)^2 / (254 \times (0.35 \pm 0)$ $\Rightarrow SSD = 73.85m$ (Ans) ii) Two way ~~traffic for single lane ,SSD = 2x 73.85~~ = 147.7m (Ans) iii) for 3% ascending, $SSD = 0.278vt + v^2 / (254(\mu + n/100))$ $\Rightarrow SSD = 0.278 \times 60 \times 2 + (60)^2 / (254 \times (0.35 + 3/100)$ $\Rightarrow SSD = 70.65$ m (Ans) iv) for 3% descending, $SSD = 0.278vt + v^2 / (254(\mu - n/100))$ $\Rightarrow SSD = 0.278 \times 60 \times 2 + (60)^2 / (254 \times (0.35 - 3/100)$ $\Rightarrow SSD = 77.65$ m (Ans)	Given data, v = Design speed = 60 km/h t = Total reaction time = 2 sec μ = Frictional Co- efficient = 0.35 ~~i) n = Gradient or slope Horizontal, n = 0~~ ii) n = Gradient or slope Horizontal, n = 0 iii) Ascending slope, n = +3% iv) Descending slope, n = -3% i) SSD for Two way traffic on a two way lane road =? ii) SSD for Two way traffic on a single lane road =? iii) SSD when grade is 3% ascending =? iv) SSD when grade is 3% decreasing =?

Q.38. Define OSD (Overtaking Sight Distance) or PSD (Passing Sight Distance)?

Ans: The minimum distance open to the vision of the driver of a vehicle intending to overtake slow vehicle ahead with safety against the traffic of opposite direction is known as OSD or PSD.

Q.39. The speed of overtaking and overtaken vehicles are 70km/hr and 40km/hr respectively on a two way traffic road. If the acceleration of overtaking vehicle 3.6km/hr/sec or $0.99m/sec^2$ and reaction time 2sec. Calculate PSD or OSD?

Sol":

We know that, $PSD = d_1 + d_2 + d_3$ ----------(i) Where, $d_1 = 0.28v_bt = 0.28 \times 40 \times 2 = 22.4m$ $d_2 = 2S + b = 2 \times 13.7 + 86.55 = 110.95m$ $d_3 = 0.28\ v_aT = 0.28 \times 70 \times 7.46 = 146.22m$ From (i) $\Rightarrow PSD = 22.4 + 110.95 + 146.22$ $\Rightarrow PSD = 279.68m$ (Ans) **Note: overtaking and overtaken vehicles speed difference 16km/hr**	Given data, Overtaking speed, $v_a = 70km/hr$ Overtaken speed, $v_b = 40km/hr$ Reaction time, t = 2 sec Acceleration overtaking vehicle ,F= 3.6km/hr/sec $S = 0.19\ v_b + 6.1 = 0.19 \times 40 + 6.1 = 13.7m$ $T = \sqrt{(14.4S/F)} = \sqrt{((14.4 \times 13.7)/3.6)} = 7.46sec$ $b = 0.28\ v_b T = 0.28 \times 40 \times 7.46 = 86.55m$

Q.40. Find the total wide of the pavement on a horizontal curve for a **new static highway with ruling maximum radius**, design speed 80km/hr for width of road 7.0m and maximum axle length 6.1m?

Sol":

We know that, Extra length of curve, $X = nL^2 /2R + v/9.5\sqrt{R}$ $\Rightarrow X = 2 \times (6.1)^2)/ (2 \times 334.4) + 80/9.5 \times \sqrt{334.4}$ $\Rightarrow X = 0.57m$ Total wide of the pavement = 7+ 0.57 =7.57m (Ans)	Given data, Axle length(between two wheel), L = 6.1m Design speed, v = 80km/hr Road wide = 7m No of Lane, n = 7/(3.5= for one lane wide) = 2 **New static highway with ruling maximum radius of curve**, $R=(v + 16)^2 /127(e_{max} + \mu_{max})$ $\Rightarrow R = (80+16)^2 / (127 \times (0.067 + 0.15)$ $\Rightarrow R = 334.4m$

Ex:1
Q. Calculate safe radius of road curve when design speed 80 km/h & $\mu = 0.12$ & $e = 0.02$?

Sol": We know that

$$\mu = \frac{v^2}{127R} - e$$

$$\Rightarrow 0.12 = \frac{80^2}{127 \times R} - 0.02$$

$$\Rightarrow R = 359.96\ m \quad (ans)$$

Given data,
$V = 80$ km/h
$\mu = 0.12$
$e = 0.02$
$R = ?$

$$f = \frac{v^2}{gR} - e$$

Q. Super elevation for Railway?

$$e = \frac{GV^2}{127R}$$

Where, G = Gauge (m)
V = Design speed (km/h)
R = Radius of curve of rail = (m)
e = super elevation (m/m)

BG = 1.676m — 1.524m
MG = 1.067m — 1.00 m
NG = 0.762m — 0.610m
SG = 1.435m — 1.451m

Maximum super-elevation,
BG = 0.165m
MG = 0.133m
NG = 0.076m

Maximum speed of
(i) train, $V = 4.4\sqrt{R-70}$ km/h (R in m) for BG & MG
(ii) for NG, $V = 3.6\sqrt{R-70}$ km/h

Q. Define Coning of wheel?

Ans: The act of providing an outward slope of 1 in 20 to the treads of wheel is known as coning of wheel.

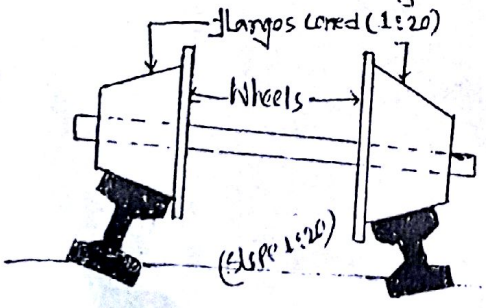


Fig. Behaviour of coned wheels

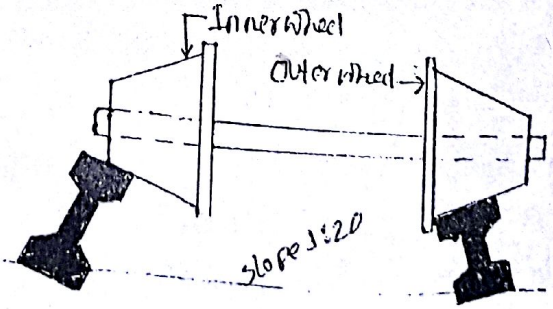


Fig. Behaviour of coned wheels

Q.41. Define Super Elevation?

Ans: In order to counter act the effect of centrifugal force at vehicle and to reduce the tendency of the vehicle to move outward or overturn skid, the outer edge of the pavement is raised with respect to inner edge at horizontal curve. This transverse inclination of the pavement surface is known as Super Elevation.

Q.42. Calculate the super elevation for a **4.3degree curve** or 400m radius of curve and speed of 80km/hr?

Sol":

We know that, Super elevation, $e = (0.75v)^2/127R$ $\Rightarrow e = (0.75 \times 80)^2/(127 \times 400)$ $\Rightarrow e = 0.078m > 0.067$ m **So, e = 0.067m** **Check for frictional Co-efficient for e_{max} = 0.067** Again We know that, $\mu = (v^2/127R) - 0.067 = (80^2/(127 \times 400)) - 0.067$ $\Rightarrow \mu = 0.059 < 0.15$(Limiting Value) So, Provided super elevation, e = 0.067 m (Ans) **Note: if calculated μ is exceed 0.15 then the design speed should be reduced at e_{max} =0.067**	Given Data, v = Speed in km/hr = 80km/hr D = Degree of curve = 4.3^0 R = Radius of curve = 1719/D = 1719/4.3 = 400m Super Elevation, e = ? **Always maximum super elevation e_{max} = 0.067** **Always maximum frictional co-efficient μ_{max} = 0.15**

Q.43. Design speed of a highway is 80kmphr of a horizontal curve of 150m radius. Calculate the super elevation?

Sol":

We know that, Super elevation, $e = (0.75v)^2/127R$ $\Rightarrow e = (0.75 \times 80)^2/(127 \times 150)$ $\Rightarrow e = 0.189m > 0.067$ m $\Rightarrow$ **e = 0.067m** **Check for frictional Co-efficient for e_{max} = 0.067** Again We know that, $\mu = (v^2/127R) - 0.067 = (80^2/(127 \times 150)) - 0.067$ $\mu = 0.269 < 0.15$(Limiting Value) **So the design speed must be reduced that is,** $\mu = (v^2/127R) - 0.067 = (v^2/(127 \times 150)) - 0.067$ $\Rightarrow 0.15 = v^2/19050 - 0.067$ $\Rightarrow v = 64.3$ km/h **So, Provided super elevation , e = 0.067 m (Ans)** **And design speed, v = 64.3 km/h (Ans)**	Given Data, v = Speed in km/hr = 80km/hr R = Radius of curve = 150m Super Elevation, e = ? **Always maximum super elevation e_{max} = 0.067** **Always maximum frictional co-efficient μ_{max} = 0.15**

Q.44. Define Passenger car unit (PCU)?

Ans: The passenger car unit may be considered as a measure of relative space requirement of a vehicle class compared to that of a passenger car under a specified set of roadway traffic and other conditions.

Q.45. Determine theoretical capacity of road if design speed 100km/h with reaction distance 2m and average length of vehicle is 6m?

Sol":

We know that , Theoretical capacity, C = 1000V/S $\Rightarrow C = 1000 \times 100/8$ $\Rightarrow C = 12500$ vehicle per hour per lane (Ans)	Given data, V = design speed = 100km/h S =Centre to Centre spacing of moving vehicle=Reaction distance + average length of vehicle=2+6 =8m

Q.46. Define for important term in transportation engineering?

Ans:

DTN: Design Traffic Number (DTN) is the average number equivalent of 18000 pounds single axial load application expected for the design lane during design period.

Design Lane: Design Lane is the outside lane of a multilane highway.

Traffic Volume: The number of vehicles passing a particular section per unit time at a specified time is known as Traffic Volume.

Traffic Density: Number of vehicles occupying a unit length of a moving lane is known as Traffic Volume

Critical Density: The traffic density when the volume is at its capacity on a given lane is known as Critical Density.

Annual Average Daily Traffic (AADT) =Total traffic volume in a year / No of days in year (365 or 366 = Leap year,2016)

Average Daily Traffic (ADT) = Total Volume of Traffic / No of days < 365

Traffic Capacity: It is the ability of highway to accept a given volume of vehicle in a prescribed time is known as Traffic Capacity.

Travel Time or Journey Time: It is the total elapsed time including stops and delay necessary for a vehicles travel from one point to another point and under existing traffic condition.

Delay Time: Delay time is the time lost by traffic due to traffic friction and traffic control device.

Running Time: Running time is that portion of travel time that the vehicle is actually in motion.

Time Mean Speed (TMS): TMS is the average of instantaneous speed of observed vehicle.

$$TMS = (V_1 + V_2 + V_3 + \text{----------})/n$$

Space Mean Speed (SMS): The average speed of vehicle in a certain road length of any time is called SMS.

$$SMS = (L_1 + L_2 + L_3 + \text{----------})/(t_1 + t_2 + t_3 + \text{----------})$$

Q.47. For an urban highway with an ADT(Average Daily Traffic) of 20000 vehicle per day. Determination DHV(Design Hour volume) for the peak direction of travel ?

Sol":

We know that, Design Hour Volume,DHV = ADT x k x D =>DHV = 20000 x 0.1 x 0.55 =>DHV = 1100 vehicle per hour (Ans) [Note : Directional Design Hour Volume (DDHV) = Annual Average Daily Traffic (AADT) x k x D]	Given data, ADT = Average Daily Traffic = 20000 **Veh/Day** Directional Dstribution Factor,D = usually used 55% to 80% [for urban =55%] = 0.55 k factor = 8% to 12% for urban And 12% to 18% for rural So, k factor = 10% =0.1

Q.48. Three cars travel over a 65m section at constant speed of 18m/sec, 19m/sec and 22m/sec. Compute TMS and SMS?

Sol":

We know that, $TMS = (V_1 + V_2 + V_3)/n$ => TMS = (18 + 19+ 22)/3 = 19.67m/sec (Ans) Again, we know that $SMS = (L_1 + L_2 + L_3)/(t_1 + t_2 + t_3)$ => SMS = (65 +65+65)/ ($L_1/V_1 + L_2/V_2 + L_3/V_3$) => SMS =196/(65/18+65/19+65/22) = 19.52m/sec(Ans)	Given data, V_1 = 1st car speed = 18m/sec V_2 = 2nd car speed = 19m/sec V_3 = 3rd car speed = 22m/sec n = No of travel car or vehicle = 3nos $L_1 = L_2 = L_3 = L$ = 65m TMS =? and SMS =?

Q.49. What do you meant by Traffic Signs and there are types?
Ans: The most common device for regulating, warning and guide drivers is the traffic sign. The signs should be placed such that the road user can see them easily and in time. These are generally installed at a height of 2.75m to 2.8m above the ground level.
There are three types
i) Regulatory or Mandatory signs
ii) Warning or Cautionary signs
iii) Informatory or Guide signs

Q.50. What do you meant by Traffic signals and there types?
Ans: All electrically operated devices employed for controlling, directing or warning motorists or pedestrians are known as traffic signals.
There are three types
i) Traffic control signals
ii) Pedestrian signals
ii) Special traffic signals

Q.51. Why traffic signals are used?
Ans: Because of-
1. to provided an orderly movement of traffic
2. to reduce the frequency of accident of some special nature
3. to control speed on the main and secondary highways
4. to direct traffic on different routes
5.to traffic control in various point like as rail crossing, draw-bridge and other hazardous situations.

Q.52. What do you meant by different color of traffic signals?
Ans:

Red	Yellow	Green
The vehicle on the street towards which it is facing must stop	The vehicle on the street towards which it is facing can proceed	The clearance time for the vehicle which have entered the intersection area by the end of green light

Q.53. Write down the definition of Runway?
Ans: Runway: Runway is a rectangle portion of land prepared for landing and take-off of aircraft. A runway dimension vary from as small as 245m long and 8m wide in smaller general aviation airport 5500m x 80m for longer interval airport to accommodate the larger sets.

Q.54. Define below term at a Airport Engineering?
Ans:
Taxiway: A taxiway is a path on an airport connecting runways with ramps, hangers, terminal and other facilities.
Hanger: A hanger is a closed structure to held aircraft in storage or to protect aircraft from weather or repair the aircraft. It may be use for assembly area for aircraft.
Apron or Ramp: A ramp or apron is that port of airport which is use to park the aircraft for loading and unloading or refueling where the pre flight activities are done.

[DPDC]

Q Draw the typical figure of grade-intersection?

Ans: Grade intersection: An intersection is the junction at grade (that is say, on the same level) of two or more roads either meeting or crossing

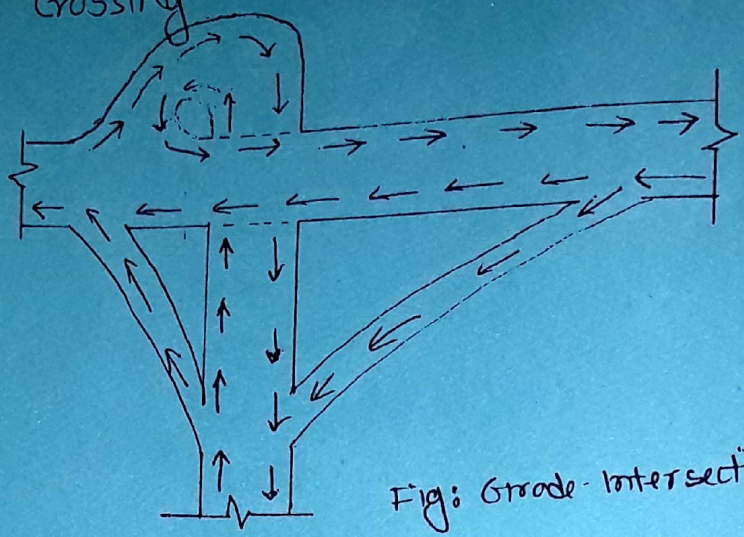


Fig: Grade-intersection/Trumpet interchange

[RPCL MIST]

Q Write down the six point of BRT (Bus Rapid Transit)?

Ans: Bus Rapid Transit (BRT) is a high quality bus based transit system that delivers fast, comfortable and cost effective urban mobility through the provision of segregated right of way infrastructure, rapid and frequent operations and excellence in marketing and customer service.

BRT are -

i) Low infrastructure cost

ii) ability to operation without subsides

iii) BRT project can be planned within a period 12 to 18 months

iv) Cost generally US1 million to US3 million

v) A standard BRT lane width 3.5m.

vi) BRT system serves approximately 45000 passengers per hour per direction.

vii) BRT system speed 23 km/h to 30 km/h

viii) The efficiency of the intersection will also be influenced by the location of the BRT station.

Q.56. Write down the application of Pavement Marking?

Ans:

Types	Application
Longitudinal Lines	
i) Broken White line	Multiple high way
ii) Broken yellow line	2-lane 2-way,PSD and OSD permitted
iii) Solid white line	Pavement edge marking
iv) Double solid white line	Channelizing line
v) Solid yellow line	No passing traffic
vi) Double broken yellow line	Edge of reversible traffic lane
vii) Dotted lines	Interchange area
Transverse Lines	
i) Cross hatched shoulder marking	Discourage use of shoulder for traffic
ii) Pair of solid white lines(wide=6" to 24",Spaced 6ft)	Crosswalk
iii) Solid white lines(12" to 24" width)	Vehicle must be stop

Q.57. Define road intersection and their types?

Ans: An intersection is the junction at grade (that is to say, on the same level) of two or more roads either meeting or crossing. An intersection may be three-way (a T junction or Y junction – the latter also known as a fork), four-way (a **crossroads**), or have five or more arms.

Q.58. Draw the diamond pattern of road intersection? or Draw a grade-intersection?

Ans:

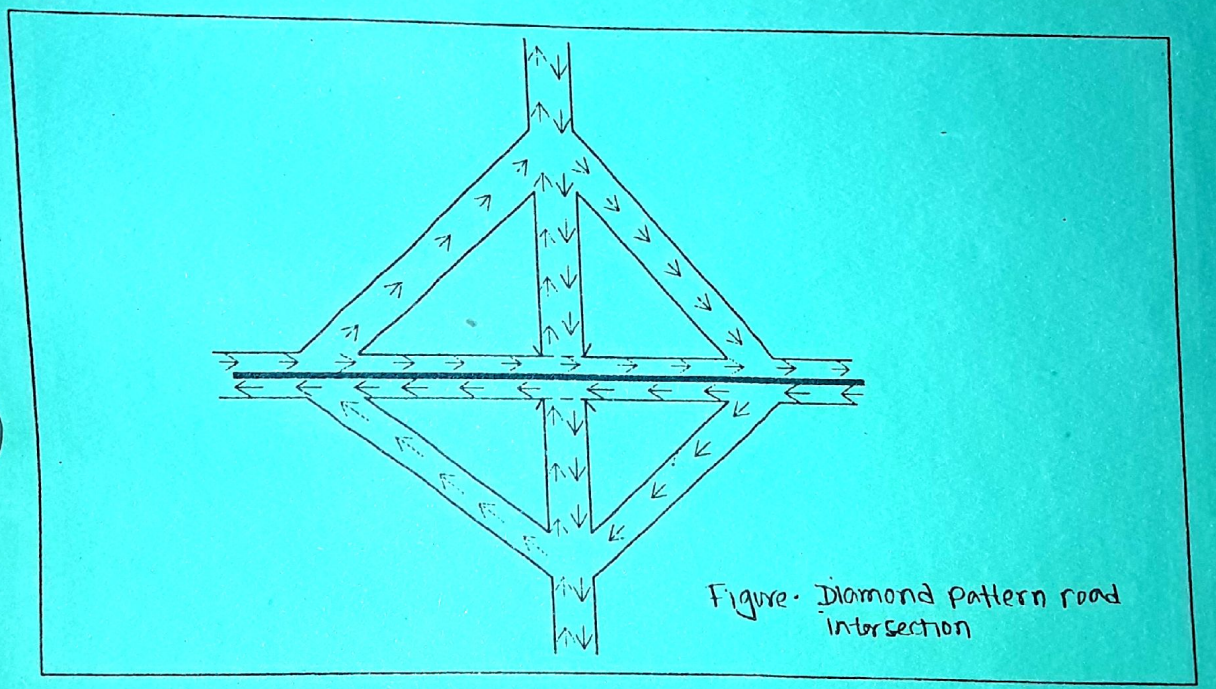


Figure: Diamond pattern road intersection

Q.59. Draw the clover leaf pattern of grade seperation/road intersection?

Ans:

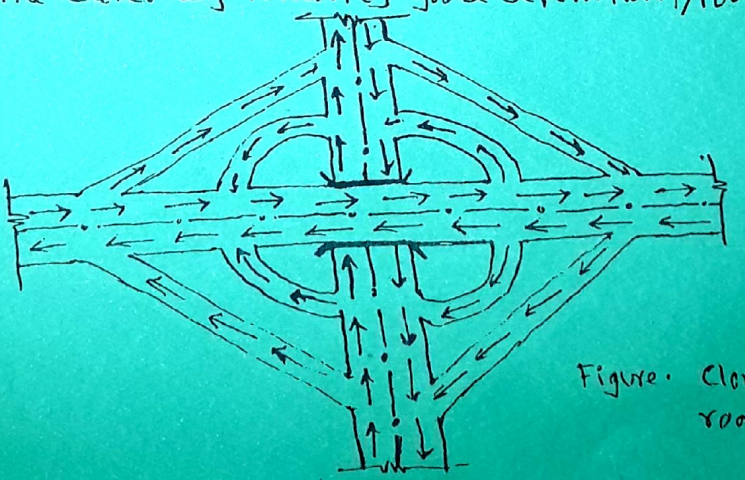


Figure: Clover leaf pattern for road intersection a

PRI, MIST

Q.1. জাতীয় পতাকার নকশা প্রথম করেন - কামরুল হাসান

Q.2. জাতীয় স্মৃতি সৌধের স্থপতি - সৈয়দ মইনুল হোসেন

Q.3. নিপাহ ভাইরাস বহন করে - ফ্রুট-ব্যাট বা বাদুড়

Q.4. বঙ্গবন্ধু উপাধি কে, কখন দেয়? - তোফায়েল আহমেদ, ফেব্রুয়ারি ১৯৬৯ সালে

Q.5. চা পাতা চাষি কত সালে কোথায়? - ১৯৫৫ সালে শ্রীমঙ্গলে

Q.6. দাদায় কয় অবস্থায় থাকে - কঠিন, তরল, বায়বীয়

Q.7. গম উৎপাদনে শীর্ষ দেশ - চীন

Q.8. সৌর শক্তি উৎপাদনে শীর্ষ দেশ - চীন

Q.9. বাংলাদেশের প্রথম রাষ্ট্রপতি - শেখ মুজিবুর রহমান, প্রথম প্রধানমন্ত্রী - তাজউদ্দীন আহমদ

Q.10. ICC কার্যালয় (2021) চট্টগ্রাম - আবুধাবি, সংযুক্ত আরব আমিরাত।

Q.11. Beauty of poet → keats

Q.12. বাংলাদেশে 1000 টাকার নোট চালু হয় কত সালে হয়-

Q.13. সবচেয়ে দামি সবচেয়ে কোনটি — অস্ট্রেলিয়া

Q.14. তুমি সবসময় সত্য বলিবে আমি কিভাবে হইব না নিম্নের বিষয়টি ইংরেজি করো -

Q.15. সাবমেরিন কেবলে বাংলাদেশ কবে যুক্ত হয় -

Q.16. বাংলাদেশে মুক্তিযুদ্ধের সময় কত সেক্টর কমান্ডার ছিল-

Q.17. Green Green Leaf কোথায় অবস্থিত -

Q.18. 'the long bay' কোথায় অবস্থিত -

Q.19. SAARC এর সচিবালয় কোথায় অবস্থিত -

Q.20.

প্রশ্ন: পদ্মা নদীর দৈর্ঘ কত? উঃ ৩২৪ কিঃ মিঃ।
প্রশ্ন: কুশিয়ারা নদীর দৈর্ঘ্য কত? উঃ ১১০ কিঃ মিঃ
প্রশ্ন: এক কিউসেক বলতে কি বাঝায়? উঃ প্রতি সেকেন্ডে এক ঘনফুট পানির প্রবাহ।
প্রশ্ন: ঢাকা শহরকে রক্ষার জন্য বুড়ীগঙ্গা নদীর তীরে যে বাঁধ দেয়া হয় তার নাম কি? উঃ বাকল্যান্ড বাঁধ।
প্রশ্ন: বাংলাদেশের কৃত্রিম হ্রদ কোনটি? উঃ রাঙ্গামাটি জেলার কাপ্তাই হ্রদ।
প্রশ্ন: কাপ্তাই জলবিদ্যুৎ কেন্দ্র নির্মাণ করা হয়? উঃ ১৯৬২ সালে।
প্রশ্ন: কাপ্তাই হ্রদ আয়তন কত? উঃ ৬৮৬.৯১ বর্গ কি.মি.।
প্রশ্ন: কোন নদী তিব্বতের মানস সরোবর হতে উৎপন্ন হয়েছে? উঃ ব্রহ্মপুত্র।
প্রশ্ন: ব্রহ্মপুত্র নদ কোন জেলার ভেতর দিয়ে বাংলাদেশে প্রবেশ করেছে? উঃ কুড়িগ্রাম।
প্রশ্ন: ব্রহ্মপুত্র নদের প্রধান শাখার নাম কি? উঃ যমুনা।
প্রশ্ন: পদ্মা নদী মেঘনার সাথে কোথায় মিলিত হয়েছে? উঃ চাঁদপরে।
প্রশ্ন: পদ্মা নদী যমুনার সাথে কোথায় মিলিত হয়েছে? উঃ গোয়ালন্দ।
প্রশ্ন: মেঘনা নদী ব্রহ্মপুত্রের সাথে কোথায় মিলিত হয়েছে? উঃ ভৈরব বাজার।
প্রশ্ন: পদ্মা কোন জেলার ভেতর দিয়ে বাংলাদেশে প্রবেশ করেছে? উঃ রাজশাহী।
প্রশ্ন: ভারত ফারাক্কা বাঁধ নির্মাণ করেছেন কোন নদীর উপর? উঃ গঙ্গা।
প্রশ্ন: পানি বিদ্যুৎ উৎপাদনের জন্য কাপ্তাই বাঁধ দেয় হয়েছে কোন নদীর উপরে? উঃ কর্ণফুলী।
প্রশ্ন: গঙ্গা নদীর উৎপত্তিস্থল কোথায়? উঃ হিমালয় পর্বতের গঙ্গোত্রী হিমবাহ।
প্রশ্ন: পদ্মা নদীর ভারতীয় অংশের নাম কি? উঃ গঙ্গা।
প্রশ্ন: তিস্তা উৎপত্তিস্থল কোথায়? উঃ হিমালয় পর্বত।
প্রশ্ন: বাংলাদেশের প্রধান নদী বন্দর? উঃ নারায়নগঞ্জ।
প্রশ্ন: বাংলাদেশের নদী গবেষনা ইনস্টিটিউট কোথায়? উঃ ফরিদপুর।
প্রশ্ন: কোন সালে ফারাক্কা ব্যারেজের নির্মান কাজ শেষ হয়? উঃ ১৯৭৪ সালে।
প্রশ্ন: কোন সাল থেকে ফারাক্কা বাঁধ চালু হয়? উঃ ১৯৭৫ সালে।
প্রশ্ন: ফারাক্কা বাঁধের দৈঘ্য কত? উঃ ৭৩৬৩ ফুট ৬ ইঞ্চি।

সংবিধানের ১১টি ভাগ সহজেই মনে রাখি
(প্ররামৌনি আবিনিম বাংজসংবি)

১। প্র- প্রজাতন্ত্র
২। রা-রাষ্ট্র পরিচালনার মূলনীতি
৩। মৌ- মৌলিক অধিকার
৪। নি- নির্বাহী বিভাগ
৫। আ- আইন সভা
৬। বি- বিচার বিভাগ
৭। নি- নির্বাচন
৮। ম- মহাহিসাব নিরীক্ষক ও নিয়ন্ত্রক
৯। বাং- বাংলাদেশের কর্মবিভাগ
৯ক। জ- জরুরী বিধানাবলী
১০। সং-সংবিধান সংশোধন
১১। বি- বিবিধ

Q প্যারাগ্রাফ লিখুন

➪ [TOPIC] এর স্থানে আপনার কাঙ্ক্ষিত প্যারাগ্রাফটির নাম লিখুন ...

প্যারাগ্রাফের-নামসমূহঃ

1. Copying in the examination, 2. Environment Pollution,3. Air pollution, 4. Terrorism in the campus, 5. Terrorism, 6. Black marketing,7. Unadult marriage, 8. Traffic jam, 9. Load-shedding, 10. Hartal day, 11. Road accident, 12. Drug addiction, 13. Dangerous of smoking, 14. Arsenic Pollution, 15. Conspiracy, 16. Gambling, 17. Dacoity, 18. Anarchy, 19. Bribery, 20. Black money, 21. Child labor, 22. Deforestation, 23. Acid throwing, 24. Superstition, 25. Corruption, 26. Political chaos, 27. Women & child trafficking/torturing, 28. Toli-extortion, 29. Population problem, 30. Conspiracy, 31. Brain-drain

Paragraph

➪ [TOPIC] is a great and harmful problem. It is not only a common matter for our own country but also for the other countries too. ➪ [TOPIC] destroying our social peach and happiness. Day by day it is going out of our control which is very alarming. Keeping this problem we cannot imagine our peace and happy life. Though ➪ [TOPIC] is very tough to remove this problem totally from the society but we have to try at any cost. Without removing this acute problem people can't get relief. Everybody wants a good solution for this problem. Beside govt. should come forward to overcome this problem. The law forces agencies should arrest them who are creating this kind of problem. ➪ [TOPIC] is possible to remove by creating public awareness. So we should be more active to get a better solution.

<u>All Kinds Of Great Qualities</u>

প্যারাগ্রাফের-নামসমূহঃ

[1. Brevity 2.Valu of time 3.Honesty 4.Discipline ,5.Perseverance 6.Confidence 7.Politeness 8.Ambition ,9.Glorious mind 10.Optimism 11.Hopefulness 12.Talent, 13.Selp-help 14.Truthfulness 15.Courtesy, 16.Friendship, 17.Labour 18.Education 19.Patriotism 20.Character, 21.Good manner 22.Popularity 23.Dignity 24.Love, 25.Integrity 26.Punctuality 27.Kindness 28.Liberty, 29.Dutifulness 30.Self-reliance 31.Obedience, 31.Faithfulness 32.Modesty 33.Industry 34.Co-operation, 35.Personality 36.Intellectuality 37.Humanity, 38.Gratitude, 39.Moral courage 40.Contenment 41.Common sense, 42.Charity 43.Diligence 44.Tolerance 45.Self-criticism, 46.Self-reliance 47.Civic-sence,48.Cleanliness]

➪ [TOPIC] is the most valuable and powerful element of our success in life. It enriches self confidence of our running life. If we want to reach of our aim we must attain such quality. It is need to have for mental faculty.➪ [TOPIC] can bring out reward for human beings. It is important to have ➪ [TOPIC] to retain the existence of human beings. Without ➪ [TOPIC] anybody cannot achieve anything great and glorious. A man can lose his prestigious life for its absence. Most of the greatest persons have gained success by it. ➪ [TOPIC] is a kind of knowledge which thing no training can teach. ➪ [TOPIC] broadens our outlook. Therefore we should have this quality at any cost.

<u>All Kinds Of Great Personalities</u>

প্যারাগ্রাফের-নামসমূহঃ

[1. Hazrat Muhammad (sm) 2. Sheikh Mujib , 3. A Virtuous Man 4. Rabindranath Tagore 5. Nazrul Islam 6. Mothr Teresa 7. Influence of a great man 8. Your favorite player 9. Moulana Bhashini 10. Your favourite person Friend, 11. Your Mother/Father/Grand mother 12. A great Politician 13. The teacher you like-most,14.You-ideal-man,15.My-pride/friend]

➪ [TOPIC] is considered as an ideal in my life. I like most him because of his wonderful activities beside his clear-cut and embedded character. His embedded personality could be impressed my heart. For this reason he is my favorite person. His views on society, love of humanity and duty to the every steps attract one a lot. His clarity of mind, uprightness of thought, glorious ideals, and simplicity of life make one his fan. I respect his creativity, speech and his responsibility. Man like ➪[TOPIC] is very necessary for the state. Everyone should try to build up character, morality and personality like him. It is impossible to be a real person without responsibility, morality, embedded character and lofty ideals. For the peace and happiness we should follow him.

Ans: ASTM- American Society for Testing Materials
ACI- American Concrete Institute
AASHO- American Association of State Highway Officials
BNBC- Bangladesh National Building Code
BSI- Bangladesh Standard Institute
ISTI- Indian Standard Testing Institute
AASHTO- American Association of State Highway & Transportation Officials
BGMEA- Bangladesh Garment Manufacturers and Exporters Association (Coal power-2015)
Wi-Fi- Wireless Fidelity (Coal Power-2015)
GDP- Gross Domestic Product (Coal Power-2015)
SAARC- South- Asian Association for Regional Cooperation -1985 (Coal Power-2015)
SAFTA- South Asian Free Trade Area (Coal Power-2015)
USDA- United State Department of Agriculture
USCS- Unified Soil Classification System
BTRC- Bangladesh Telecommunication Regulatory Commission
FBCCI- *Federation of Bangladesh Chambers of Commerce and Industries*
BAPEX- Bangladesh Petroleum Exploration and Production Company Limited
CIRCAP- Centre on Integrated Rural Development for Asia & the pacific
SARRC- South Asian Association for Regional Co- Operation.
GOOGLE - Global Organization of Oriented Group Language of Earth.
YAHOO - Yet another Hierarchical Officious Oracle.
WINDOW - Wide Interactive Network Development for Office work Solution.
COMPUTER - Common Oriented Machine Particularly United and used under Technical and Educational Research.
VIRUS - Vital Information Resources under Siege.
UMTS - Universal Mobile Telecommunicati ons System.
IMEI - International Mobile Equipment Identity.
UPS - Uninterruptible power supply.
APN - Access Point Name.
GOOGLE - Global Organization of Oriented Group Language of Earth.
YAHOO - Yet another Hierarchical Officious Oracle.
WINDOW - Wide Interactive Network Development for Office work Solution.
OLED - Organic light-emitting diode.
ESN - Electronic Serial Number.
UPS - Uninterruptible power supply.
HDMI - High-Definition MultimediaInterface.
VPN - Virtual private network.
SIM - Subscriber IdentityModule.
LED - Light emitting diode.
RAM - Random accessmemory.
ROM - Read only memory.
VGA - Video Graphics Array.
USB - Universal serial Bus.
WLAN - Wireless Local AreaNetwork.
LCD - Liquid Crystal Display.
GPRS - General Packet RadioService.
EDGE - Enhanced Data Ratesfor GlobalEvolution.
GPS - Global PositioningSystem.
DVD - Digital Video Disk.
WCDMA - Wide-band CodeDivision MultipleAccess.
GSM - Global System for Mobile Communications.
MPEG - moving picturesexperts group.

IVRS - Interactive VoiceResponse System.
HP - Hewlett Packard
DGFI - Directorate General of Forces Intelligence
SPARSO - Bangladesh Space Research & Remote Sensing.
NASA - National Aeronautics and Space Agency
↳ Head Quater → ওয়াশিংটন ডিসি (1958) → প্রশাসক - বার্কে গ্রিফিন (2018) / কর্মচারী (17500)
NATO - North Atlantic Treaty Organisation.
↳ Head Quater → ব্রাসেলস (বেলজিয়াম) 1949 → মহাসচিব - জেন্স স্টলটেনবার্গ / member 28 Contries
OPEC - Organization of the petroleum Exporting Countries
↳ Head Quater → ভিয়েনা (অস্ট্রিয়া) মহাসচিব - আবদালা সালেম এল বাদ্রি (১লা জুন/2007) (লিবিয়া)
Language → English, কার্যত চলে - Jan. সংস্থা দেশ - 12টি
Shortcut - ইরান, ইরাকের ইন্ধু আন্ত, আনু & নেভুতে ভেজাল নাই এবং জৌদি-আসাতে কাতকুদো।
ইরান, ইরাক, ইকুয়েডর, আঙ্গোলা, আলজেরিয়া, লিবিয়া, ভেনেজুয়েলা, নাইজেরিয়া
জৌদি আরব, সংযুক্ত আরব আমিরাত, কাতার, কুয়েত।

Q. মাস সম্পর্কিত কিছু গুরুত্বপূর্ণ নির্দেশনা ?
উত্তর:
i) ইংরেজী মাস থেকে ৫৯৬ বিয়োগ করলে বাংলা মাস পাওয়া যাবে।
যেমন, কাজীনজরুল ইসলাম জন্ম = ১৮৯৯ ই; বাংলা = ১৮৯৯ - ৫৯৬ = ১৩০৬ সাল.
ii) ইংরেজী মাস থেকে তিন মাস বিয়োগ করলে বাংলা মাস পাওয়া যায়।
তবে কিছু কিছু ক্ষেত্রে তা ০৪ মাস দিয়ে বিয়োগ করতে হয়।
যেমন; কাজী নজরুল ইসলামের জন্ম - মে মাসে, বাংলা = মে - ৩ মাস = ফেব্রুয়ারী = জৈষ্ঠ্য।
কেননা, Jan = বৈশাখ, Feb - জৈষ্ঠ্য, Mar - আষাঢ়, Apr - শ্রাবন
মে - ভাদ্র, Jun - আশ্বিন, July - কার্তিক, Aug - অগ্রায়ন
Sep - পৌষ, Oct - মাঘ, Nov - ফাল্গুন, Dec - চৈত্র.
iii) ইংরেজী মাস থেকে ৫৭৮ বিয়োগ করলে আরবী মাস পাওয়া যাবে।