V.S.B. ENGINEERING COLLEGE, KARUR
DEPARTMENT OF CIVIL ENGINEERING

Year/Semester : III / V – 'A' & 'B' Section
Subject Code & Name : CE 6501 – STRUCTURAL ANALYSIS I

PART 'A' QUESTIONS BANK
UNIT-I
INDETERMINATE FRAMES

1. Why is it necessary to compute deflections in structures?

Computation of deflection of structures is necessary for the following reasons:

a. If the deflection of a structure is more than the permissible, the structure will not look aesthetic and will cause psychological upsetting of the occupants.
b. Exessive deflection may cause cracking in the materials attached to the structure. For example, if the deflection of a floor beam is excessive, the floor finishes and partition walls supported on the beam may get cracked and unserviceable.

2. What is meant by cambering technique in structures?

Cambering is a technique applied on site, in which a slight upward curve is made in the structure/beam during construction, so that it will straighten out and attain the straight shape during loading. This will considerably reduce the downward deflection that may occur at later stages.

3. Name any four methods used for computation of deflections in structures.

1. Double integration method
2. Macaulay's method
3. Conjugate beam method
4. Moment area method
5. Method of elastic weights
6. Virtual work method- Dummy unit load method
7. Strain energy method
8. Williot Mohr diagram method

4. State the difference between strain energy method and unit load method in the determination of deflection of structures.

In strain energy method, an imaginary load P is applied at the point where the deflection is desired to be determined. P is equated to zero in the final step and the deflection is obtained.

In unit load method, an unit load (instead of P) is applied at the point where the deflection is desired.

5. What are the assumptions made in the unit load method?

` 1. The external & internal forces are in equilibrium.
2. Supports are rigid and no movement is possible.
3. The materials is strained well with in the elastic limit.

6. Give the equation that is used for the determination of deflection at a given point in beams and frames

Deflection at a point is given by,

Deflection$\Delta = \frac{Mm'}{M'2} \quad dx$

Where M = moment at a section X due to the applied load

m' = moment at a section X due to a unit load applied at that point I and in the direction of the Desired displacement

EI = flexural rigidity

7. Distinguish between pin jointed and rigidly jointed structure.

Sl.no	Pin jointed structure	Rigidly jointed structure
1.	The joints permit change of angle Between connected member.	The members connected at a rigid joint will maintain the angle between them even under deformation due to loads.
2.	The joints are incapable of transferring any moment to the connected members and vice-versa.	Members can transmit both forces and moments between themselves through the joint.
3.	The pins transmit forces between Connected member by developing shear.	Provision of rigid joints normally increase the redundancy of the structures.

8. What is meant by thermal stresses?

Thermal stresses are stresses developed in a structure/member due to change in temperature. Normally, determine structures do not develop thermal stresses. They can absorb changes in lengths and consequent displacements without developing stresses.

9. What is meant by lack of fit in a truss?

One or more members in a pin jointed statically indeterminate frame may be a little shorter or longer than what is required. Such members will have to be forced in place during the assembling. These are called members having Lack of fit. Internal forces can develop in a redundant frame (without external loads) due to lack of fit.

10. Write down the two methods of determining displacements in pin jointed plane frames by the unit load concept.

The methods of using unit loads to compute displacements are,

i) dummy unit load method

ii)Using the principle of virtual work.

11. What is the effect of temperature on the members of a statically determinate plane truss.

In determinate structures temperature changes do not create any internal stresses. The changes in lengths of members may result in displacement of joints. But these would not result in internal stresses or changes in external reactions.

12. Distinguish between 'deck type' and 'through type' trusses.

A deck type is truss is one in which the road is at the top chord level of the trusses. We would not see the trusses when we ride on the road way.

A through type truss is one in which the road is at the bottom chord level of the trusses. When we travel on the road way, we would see the web members of the trusses on our left and right. That gives us the impression that we are going` through' the bridge.

13. Define static indeterminacy of a structure.

If the conditions of statics i.e., $\Sigma H=0$, $\Sigma V=0$ and $\Sigma M=0$ alone are not sufficient to find either external reactions or internal forces in a structure, the structure is called a statically indeterminate structure.

14. Differentiate the statically determinate structures and statically indeterminate structures?

Sl.No	**statically determinate structures**	**statically indeterminate structures**
1	Bending moment and shear force is dependent on member properties	Bending moment and shear force is independent of member properties
2	No stresses are caused due to temperature change	Stresses are caused due to temperature change

3	Conditions of equilibrium are sufficient	Conditions of equilibrium are insufficient

15. Define: Trussed Beam.

A beam strengthened by providing ties and struts is known as Trussed Beams.

16. Define: Unit load method.

The external load is removed and the unit load is applied at th e point, where the deflection or rotation is to found.

17. Give the procedure for unit load method.

1. Find the forces P1, P2, ……. in all the members due to external loads.
2. Remove the ex ternal loads and apply the unit vertical point load at the joint if the vertical deflection is required and find the stress.
3. Apply the equation for vertical and horizontal deflection.

UNIT-II

INFLUENCE LINES

1. Where do you get rolling loads in practice?

Shifting of load positions is common enough in buildings. But they are more pronounced in bridges and in gantry girders over which vehicles keep rolling.

2. Name the type of rolling loads for which the absolute maximum bending moment occurs at the midspan of a beam.

(i) Single concentrated load (ii) udl longer than the span (iii) udl shorter than the span (iv) Also when the resultant of several concentrated loads crossing a span, coincides with a concentrated load then also the maximum bending moment occurs at the centre of the span.

3. What is meant by absolute maximum bending moment in a beam?

When a given load system moves from one end to the other end of a girder, depending upon the position of the load, there will be a maximum bending moment for every section. The maximum of these bending moments will usually occur near or at the midspan. The maximum of maximum bending moments is called the absolute maximum bending moment.

4. Where do you have the absolute maximum bending moment in a simply supported beam when a series of wheel loads cross it?

When a series of wheel loads crosses a simply supported beam, the absolute maximum bending moment will occur near midspan under the load W_{cr} , nearest to midspan (or the heaviest load). If W_{cr} is placed to one side of midspan C, the resultant of the load system R shall be on the other side of C; and W_{cr} and R shall be equidistant from C. Now the absolute maximum bending moment will occur under W_{cr} . If W_{cr} and R coincide, the absolute maximum bending moment will occur at midspan.

5. What is the absolute maximum bending moment due to a moving udl longer than the span of a simply supported beam?

When a simply supported beam is subjected to a moving udl longer than the span, the absolute maximum bending moment occurs when the whole span is loaded.

$$M_{max\ max} = \frac{wl^2}{8}$$

6. State the location of maximum shear force in a simple beam with any kind of loading.

In a simple beam with any kind of load, the maximum positive shear force occurs at the left hand support and maximum negative shear force occurs at right hand support.

7. What is meant by maximum shear force diagram?

Due to a given system of rolling loads the maximum shear force for every section of the girder can be worked out by placing the loads in appropriate positions. When these are plotted for all the sections of the girder, the diagram that we obtain is the maximum shear force diagram. This diagram yields the 'design shear' for each cross section.

8. What is meant by influence lines?

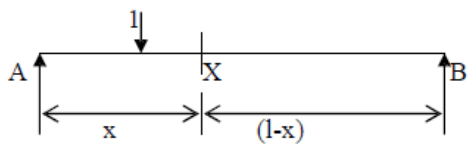
An influence line is a graph showing, for any given frame or truss, the variation of any force or displacement quantity (such as shear force, bending moment, tension, deflection) for all positions of a moving unit load as it crosses the structure from one end to the other.

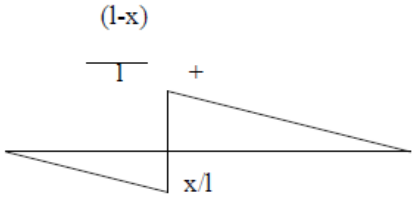
9. What are the uses of influence line diagrams?

(i) Influence lines are very useful in the quick determination of reactions, shear force, bending moment or similar functions at a given section under any given system of moving loads and

(ii) Influence lines are useful in determining the load position to cause maximum value of a given function in a structure on which load positions can vary.

10. Draw the influence line diagram for shear force at a point X in a simply supported beam AB of span 'l' m.





12. What do you understand by the term reversal of stresses?

In certain long trusses the web members can develop either tension or compression depending upon the position of live loads. This tendancy to change the nature of stresses is called reversal of stresses.

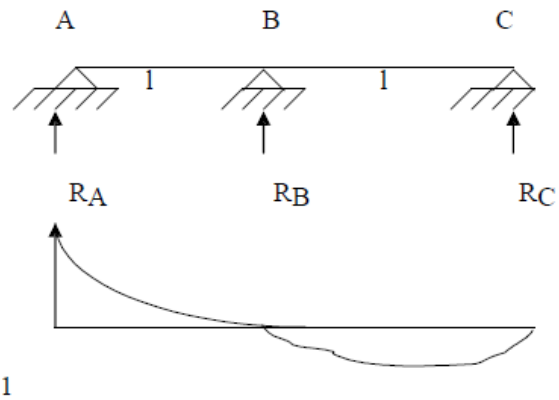
13. State Muller-Breslau principle.

Muller-Breslau principle states that, if we want to sketch the influence line for any force quantity (like thrust, shear, reaction, support moment or bending moment) in a structure,

(i) We remove from the structure the resistant to that force quantity and

(ii) We apply on the remaining structure a unit displacement corresponding to that force quantity. The resulting displacements in the structure are the influence line ordinates sought.

14. State Maxwell-Betti's theorem.



In a linearly elastic structure in static equilibrium acted upon by either of two systems of external forces, the virtual work done by the first system of forces in undergoing the displacements caused by the second system of forces is equal to the virtual work done by the second system of forces in undergoing the displacements caused by the first system of forces.

Maxwell Betti's theorem helps us to draw influence lines for structures.

15. What is the necessity of model analysis?

(i) When the mathematical analysis of problem is virtually impossible.

(ii) Mathematical analysis though possible is so complicatedand time consuming that the model analysis offers a short cut.

(iii) The importance of the problem is such that verification of mathematical analysis by an actual test is essential.

16. Define similitude.

Similitude means similarity between two objects namely the model and the prototype with regard to their physical characteristics:

- Geometric similitude is similarity of form
- Kinematic similitude is similarity of motion
- Dynamic and/or mechanical similitude is similarity of masses and/or forces.

17. State the principle on which indirect model analysis is based.

The indirect model analysis is based on the Muller Breslau principle.

Muller Breslau principle has lead to a simple method of using models of structures to get the influence lines for force quantities like bending moments, support moments, reactions, internal shears, thrusts, etc.

To get the influence line for any force quantity, (i) remove the resistant due to the force, (ii) apply a unit displacement in the direction of the (iii) plot the resulting displacement diagram. This diagram is the influence line for the force.

18. What is the principle of dimensional similarity?

Dimensional similarity means geometric similarity of form. This means that all homologous dimensions of prototype and model must be in some constant ratio.

19. What is Begg's deformeter?

Begg's deformeter is a device to carry out indirect model analysis on structures. It has the facility to apply displacement corresponding to moment, shear or thrust at any desired point in the model. In addition, it provides facility to measure accurately the consequent displacements all over the model.

20. Name any four model making materials.

Perspex, plexiglass, acrylic, plywood, sheet araldite and bakelite are some of the model making materials. Micro-concrete, mortar and plaster of paris can also be used for models.

21. What is 'dummy length' in models tested with Begg's deformeter.

Dummy length is the additional length (of about 10 to 12mm) left at the extremities of the model to enable any desired connection to be made with the gauges.

22. What are the three types of connections possible with the model used with Begg's deformeter.
(i) Hinged connection (ii) Fixed connection (iii) Floating connection

23. What is the use of a micrometer microscope in model analysis with Begg's deformeter.

Micrometer microscope is an instrument used to measure the displacements of any point in the x and y directions of a model during tests with Begg's deformeter.

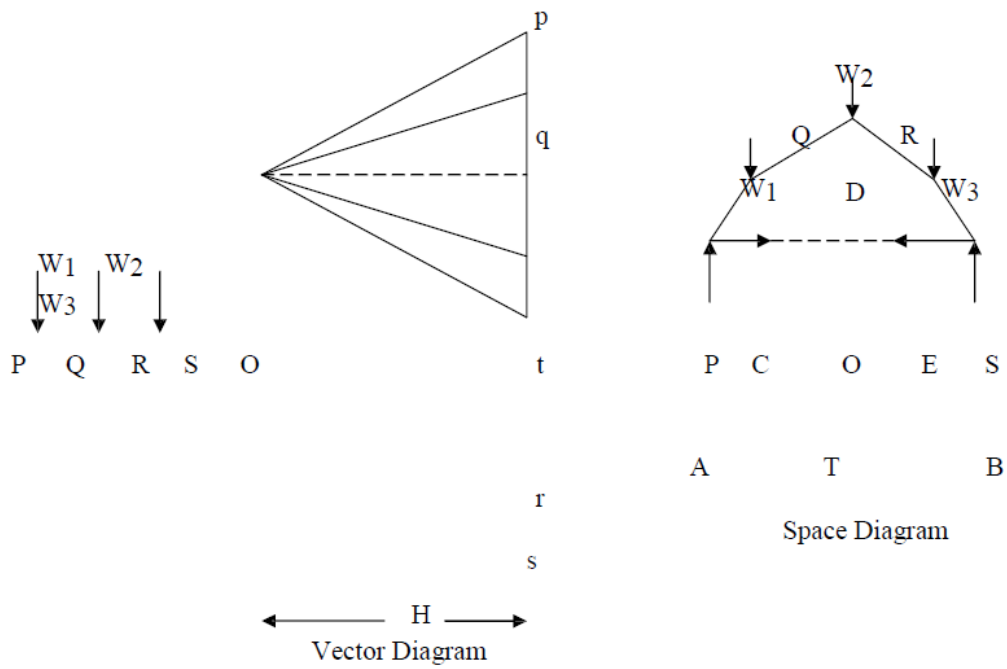
UNIT-III
ARCHES

1.What is an arch? Explain.

An arch is defined as a curved girder, having convexity upwards and supported at its ends.The supports must effectively arrest displacements in the vertical and horizontal directions. Only then there will be arch action.

2.What is a linear arch?

If an arch is to take loads, say W_1, W_2, and W_3 (fig) and a Vector diagram and funicular polygon are plotted as shown, the funicular polygon is known as the linear arch or theoretical arch.



The polar distance 'ot' represents the horizontal thrust. The links AC, CD, DE, and EB will be under compression and there will be no bending moment. If an arch of this shape ACDEB is provided, there will be no bending moment.

For a given set of vertical loads W_1, W_2…..etc., we can have any number of linear arches depending on where we choose 'O' or how much horizontal thrust (ot) we choose to introduce.

3.State Eddy's theorem.

Eddy's theorem states that " The bending moment at any section of an arch is proportional to the vertical intercept between the linear arch (or theoretical arch) and the centre line of the actual arch."

4.What is the degree of static indeterminacy of a three hinged parabolic arch?

For a three hinged parabolic arch, the degree of static indeterminancy is zero. It is statically determinate.

6.Which of the two arches, viz. circular and parabolic is preferable to carry a uniformly distributed load? Why?

Parabolic arches are preferably to carry distributed loads. Because, both, the shape of the arch and the shape of the bending moment diagram are parabolic. Hence the intercept between the theoretical arch and actual arch is zero everywhere. Hence, the bending moment at every section of the arch will be zero. The arch will be under pure compression which will be economical.

7.What is the difference between the basic action of an arch and a suspension cable?

An arch is essentially a compression member which can also take bending moments and shears. Bending moments and shears will be absent if the arch is parabolic and the loading uniformly distributed.

A cable can take only tension. A suspension bridge will therefore have a cable and a stiffening girder. The girder will take the bending moment and shears in the bridge and the cable, only tension.

Because of the thrusts in the cables and arches, the bending moments are considerably reduced.

If the load on the girder is uniform, the bridge will have only cable tension and no bending moment on the girder.

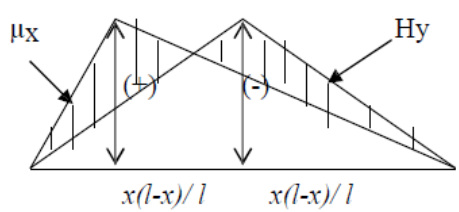
8.Under what conditions will the bending moment in an arch be zero throughout.

The bending moment in an arch throughout the span will be zero, if

(i) the arch is parabolic and (ii) the arch carries uniformly distributed load throughout the span.

9.Draw the ILD for bending moment at a section X at a distance x from the left end of a three hinged parabolic arch of span 'l' and rise 'h'.

$$M_X = \mu_X - Hy$$



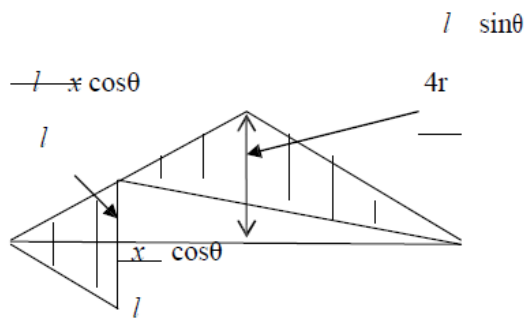
10. Indicate the positions of a moving point load for maximum negative and positive bending moments in a three hinged arch.

Considering a three hinged parabolic arch of span 'l' and subjected to a moving point load W, the position of the point load for

a. Maximum negative bending moment is $0.25l$ from end supports.
b. Maximum positive bending moment is $0.211l$ from end supports.

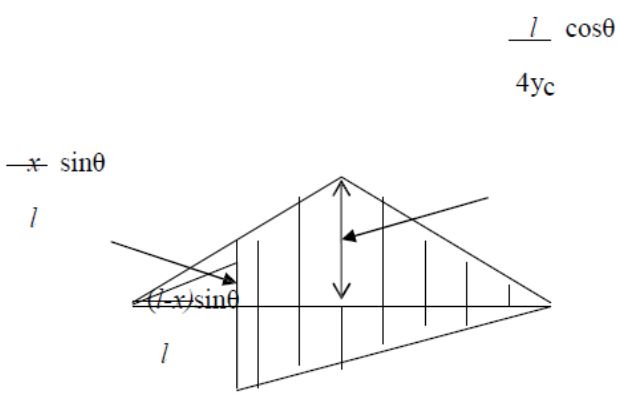
11. Draw the influence line for radial shear at a section of a three hinged arch.

Radial shear is given by $F_X = H \sin\theta - V \cos\theta$,
where θ is the inclination of tangent at X.



12. Sketch the ILD for the normal thrust at a section X of a symmetric three hinged parabolic arch.

Normal thrust at X is given by $P = H \cos\theta + V \sin\theta$,
where θ is the inclination of tangent at X.



13. Distinguish between two hinged and three hinged arches.

Sl.No.	*Two hinged arches*	*Three hinged arches*
1.	Statically indeterminate to first degree	Statically determinate
2.	Might develop temperature stresses	Increase in temperature causes increase in central rise. No stresses.
3.	Structurally more efficient	Easy to analyse. But in costruction, the central hinge may involve additional expenditure.
4.	Will develop stresses due to sinking of supports	Since this is determinate, no stresses due to support sinking.

14. Explain rib-shortening in the case of arches.

In a two hinged arch, the normal thrust which is a compressive force along the axis of the arch will shorten the rib of the arch. This in turn will release part of the horizontal thrust. Normally, this effect is not considered in the analysis (in the case of two hinged arches).

Depending upon the importance of the work we can either take into account or omit the effect of rib shortening. This will be done by considering (or omitting) strain energy due to axial compression along with the strain energy due to bending in evaluating H.

15. Explain the effect of yielding of support in the case of an arch.

Yielding of supports has no effect in the case of a 3 hinged arch which is determinate. These displacements must be taken into account when we analyse 2 hinged or fixed arches under

$$\frac{\partial U}{\partial H} = \Delta H \quad \text{instead of zero}$$

$$\frac{\partial U}{\partial V_A} = \Delta V_A \quad \text{instead of zero}$$

Here U is the strain energy of the arch and ∂H and ΔV_A are the displacements due to yielding of supports.

16. Write the formula to calculate the change in rise in three hinged arch if

$$\text{Change in rise} \quad \left(\frac{l^2 + 4r^2}{4r}\right) \alpha T$$

where l = span length of the arch

r = central rise of the arch

α = coefficient of thermal expansion

T = change in temperature

17. In a parabolic arch with two hinges how will you calculate the slope of the arch at any point.

$$\text{Slope of parabolic arch} = \theta = \tan^{-1}\left[\frac{4r}{l^2}(l-2x)\right]$$

where θ = Slope at any point x (or) inclination of tangent at x.

l = span length of the arch

r = central rise of the arch

18. How will you calculate the horizontal thrust in a two hinged parabolic arch if there is a rise in temperature.

$$\text{Horizontal thrust} = \frac{l\,\alpha\,TEI}{\int_0^l y^2 dx}$$

where l = span length of the arch

y = rise of the arch at any point x

α = coefficient of thermal expansion

T = change in temperature

E = Young's Modulus of the material of the arch

I = Moment of inertia

19. What are the types of arches according to the support conditions.

i. Three hinged arch

ii. Two hinged arch iii. Single hinged arch

iv. Fixed arch (or) hingeless arch

UNIT-IV

SLOPE-DEFLECTION METHOD

1. What are the assumptions made in slope-deflection method?

(i) Between each pair of the supports the beam section is constant.

(ii) The joint in structure may rotate or deflect as a whole, but the angles between the members meeting at that joint remain the same.

2. How many slope deflection equations are available for a two span continuous beam?

There will be 4 nos. of slope-deflection equations, two for each span.

3. What is the moment at a hinged end of a simple beam?

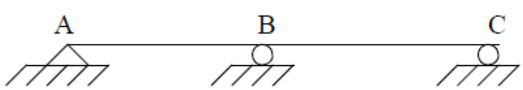
Moment at the hinged ends of a simple beam is zero.

4. What are the quantities in terms of which the unknown moments are expressed in slope-deflection method?

In slope-deflection method, unknown moments are expressed in terms of

(i) slopes (θ) and (ii) deflections (Δ)

5. The beam shown in Fig. is to be analysed by slope-deflection method. What are the unknowns and, to determine them, what are the conditions used?



Unknowns: θ_A, θ_B, θ_C

Equilibrium equations used: (i) $M_{AB} = 0$ (ii) $M_{BA} + M_{BC} = 0$ (iii) $M_{CB} = 0$

6. How do you account for sway in slope deflection method for portal frames?

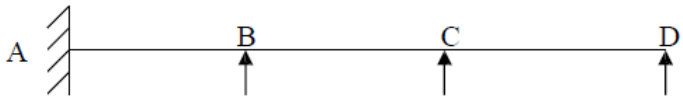
Because of sway, there will br rotations in the vertical members of a frame. This causes moments in the vertical members. To account for this, besides the equilibrium, one more equation namely shear equation connecting the joint-moments is used.

7. Write down the equation for sway correction for the portal frame shown in Fig.

The shear equation (sway correction) is

$$\frac{M_{AB} + M_{BA}}{} + \frac{\quad}{} \quad M_{CD} + M_{DC} = 0$$

8. Write down the slope deflection equation for a fixed end support.

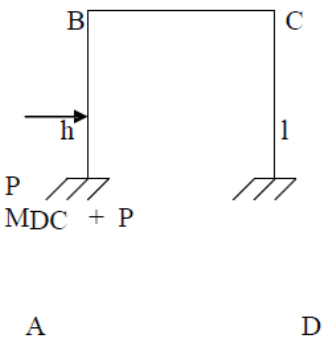


The slope deflection equation for end A is $M_{AB} = M'_{AB} + \frac{2EI}{l}\left[2\theta_A + \theta_B\right] + 3\Delta$

Here $\theta_A = 0$. Since there is no support settlement, $\Delta = 0$.

$$M_{AB} = M'_{AB} + \frac{2EI}{l}\left[\theta_B\right] + 3\Delta$$

9. Write down the equilibrium equations for the frame shown in Fig.



Unknowns : θ_B , θ_C

Equilibrium equations : At B, $M_{BA} + M_{BC} = 0$

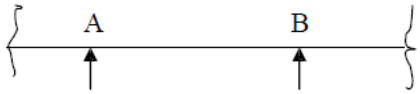
At C, $M_{CB} + M_{CD} = 0$

Shear equation : $\frac{M_{AB} + M_{BA}}{l} - \frac{Ph}{l} + \frac{M_{CD}}{l} + = 0$

10. Who introduced slope-deflection method of analysis?

Slope-deflection method was introduced by Prof. George A.Maney in 1915.

11. Write down the general slope-deflection equations and state what each term represents?



General slope-deflection equations:

$$M_{AB} = M'_{AB} + \frac{2EI}{l}\left[2\theta_A + \theta_B\right] + 3\Delta$$

$$M_{BA} = M'_{BA} + \frac{2EI}{l}\left[2\theta_B + \theta_A\right] + 3\Delta$$

where, M'_{AB} , M'_{BA} = Fixed end moment at A and B respectively due to the given loading.

θ_A , θ_B = Slopes at A and B respectively

Δ = Sinking of support A with respect to B

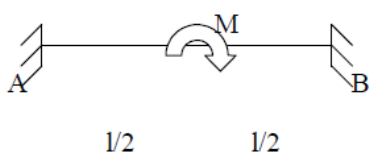
12. Mention any three reasons due to which sway may occur in portal frames.

Sway in portal frames may occur due to (i) unsymmetry in geometry of the frame (ii) unsymmetry in loading or (iii) Settlement of one end of a frame.

13. How many slope-deflection equations are available for each span?

Two numbers of slope-deflection equations are available for each span, describing the moment at each end of the span.

14. Write the fixed end moments for a beam carrying a central clockwise moment.



Fixed end moments : $M'_{AB} = M'_{BA} = \frac{M}{4}$

15. State the limitations of slope deflection method.

(i) It is not easy to account for varying member sections

(ii) It becomes very cumbersome when the unknown displacements are large in number.

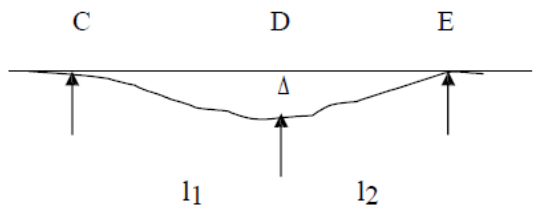
16.Why is slope-deflection method called a 'displacement method'?

In slope-deflection method, displacements (like slopes and displacements) are treated as unknowns and hence the method is a 'displacement method'.

17. Define degrees of freedom.

In a structure, the number of independent joint displacements that the structure can undrgo are known as degrees of freedom.

18. In a continuous beam, one of the support sinks. What will happen to the span and support moments associated with the sinking of support.



Let support D sinks by Δ. This will not affect span moments. Fixed end moments (support moments) will get developed as under $M'_{CD} = M'_{DC} = -\frac{6EI\Delta}{l_1^2}$

$$M'_{DE} = M'_{ED} = -\frac{6EI\Delta}{l_1^2}$$

19. A rigid frame is having totally 10 joints including support joints. Out of slope-deflection and moment distribution methods, which method would you prefer for analysis? Why?

Moment distribution method is preferable.

If we use slope-deflection method, there would be 10 (or more) unknown displacements and an equal number of equilibrium equations. In addition, there would be 2 unknown support momentsper span and the same number of slope-deflection equations. Solving them is difficult.

20. What is the basis on which the sway equation is formed for a structure?

Sway is dealt with in slope-deflection method by considering the horizontal equilibrium of the whole frame taking into account the shears at the base level of columns and external horizontal forces.

The shear condition is $\frac{M_{AB} + M_{BA} - Ph}{l} + \frac{M_{CD} + M_{DC}}{l} + P = 0$

UNIT-V

MOMENT DISTRIBUTION METHOD

1. What is the difference between absolute and relative stiffness?

Absolute stiffness is represented in terms of E, I and *l*, such as 4EI / *l*.

Relative stiffness is represented in terms of I and *l*, omitting the constant E. Relative stiffness is the ratio of stiffness to two or more members at a joint.

2. Define: Continuous beam.

A Continuous beam is one, which is supported on more than two supports. For usual loading on the beam hogging (- ive) moments causing convexity upwards at the supports and sagging (+ ve) moments causing concavity upwards occur at mid span.

3. What are the advantages of Continuous beam over simply supported beam?

1. The maximum bending moment in case of continuous beam is much less than in case of simply supported beam of same span carrying same loads.

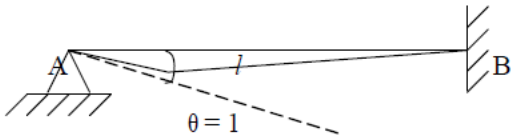
2. In case of continuous beam, the average bending moment is lesser and hence lighter materials of construction can be used to resist the bending moment.

4. In a member AB, if a moment of –10 KNm is applied at A, what is the moment carried over to B?

Carry over moment = Half of the applied moment

∴Carry over moment to B = -10/5 = -5 KNm

5. What are the moments induced in a beam member, when one end is given a unit rotation, the other end being fixed. What is the moment at the near end called?

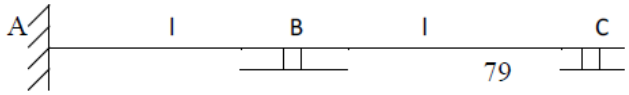


When θ = 1,

$M_{AB} = \frac{4EI}{l}$ $M_{BA} = \frac{2EI}{l}$

M_{AB} is the stiffness of AB at B.

6.A beam is fixed at A and simply supported at B and C. AB = BC = *l*. Flexural rigidities of AB and BC are 2EI and EI respectively. Find the distribution factors at joint B if no moment is to be transferred to support C



Joint B: Relative stiffness: $\frac{I}{l} = \frac{2I}{l}$ for BA. $K_{BA} = 2$

$\frac{3}{4} \times \frac{I}{l} = \frac{3I}{4l}$ for BC $K_{BC} = 3/4 = 0.75$

Distribution factors:

DF for BA: $\frac{K_{BA}}{K_{BA} + K_{BC}} = \frac{2}{2 + 0.75} = 8/11 = 0.727$

DF for BC: $\frac{K_{BC}}{K_{BC} + K_{BA}} = \frac{0.75}{2 + 0.75} = 3/11 = 0.273$

7. Define: Moment distribution method.(Hardy Cross mrthod).

It is widely used for the analysis of indeterminate structures. In this method, all the members of the structure are first assumed to be fixed in position and fixed end moments due to external loads are obtained.

8. Define: Stiffness factor.

It is the moment required to rotate the end while acting on it through a unit rotation, without translation of the far end being

(i) Simply supported is given by $k = 3\ EI / L$
(ii) Fixed is given by $k = 4\ EI / L$

where, E = Young's modulus of the beam material.

I = Moment of inertia of the beam

L = Beam's span length.

9. Define: Distribution factor.

When several members meet at a joint and a moment is applied at the joint to produce rotation without translation of the members, the moment is distributed among all the members meeting at that joint proportionate to their stiffness.

Distribution factor = Relative stiffness / Sum of relative stiffness at the joint

If there is 3 members, Distribution factors $= \dfrac{k_1}{k_1 + k_2 + k_3}, \dfrac{k_2}{k_1 + k_2 + k_3}, \dfrac{k_3}{k_1 + k_2 + k_3}$

10. Define: Carry over moment and Carry over factor.

Carry over moment: It is defined as the moment induced at the fixed end of the beam by the action of a moment applied at the other end, which is hinged. Carry over moment is the same nature of the applied moment.

Carry over factor (C.O) : A moment applied at the hinged end B " carries over" to the fixed end A, a moment equal to half the amount of applied moment and of the same rotational sense. C.O =0.5

11. Define Flexural Rigidity of Beams.

The product of young's modulus (E) and moment of inertia (I) is called Flexural Rigidity (EI) of Beams. The unit is $N\ mm^2$.

12. Define: Constant strength beam.

If the flexural Rigidity (EI) is constant over the uniform section, it is called Constant strength beam.

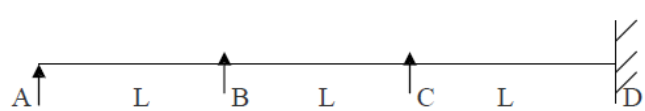
13. What is the sum of distribution factors at a joint?

Sum of distribution factors at a joint = 1.

14. Define the term 'sway'.

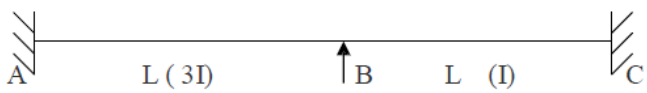
Sway is the lateral movement of joints in a portal frame due to the unsymmetry in dimensions, loads, moments of inertia, end conditions, etc.

15. Find the distribution factor for the given beam.



Joint	Member	Relative stiffness	Sum of Relative stiffness	Distribution factor
A	AB	4EI / L	4EI / L	(4EI / L) / (4EI / L) = 1
B	BA	3EI /L	3EI /L + 4EI / L = 7EI / L	(3EI / L) / (7EI / L)= 3/7
C	CB	4EI / L	4EI / L + 4EI / L =8EI / L	(4EI / L) / (8EI / L) =4/8
D	DC	4EI / L	4EI / L	(4EI / L)/ (4EI / L) = 1

16. Find the distribution factor for the given beam.



Join	Member	Relative stiffness	Sum of Relative stiffness	Distribution factor
A	AB	4E (3I) / L	12EI / L	(12EI / L) / (12EI / L) = 1
B	BA	4E(3I) /L	12EI /L + 4EI / L = 16EI / L	(12EI / L) / (16EI / L)= 3/4
C	CB	4EI / L	4EI / L	(4EI / L) / (4EI / L) =1

17. Find the distribution factor for the given beam.

Join	Member	Relative stiffness	Sum of Relative stiffness	Distribution factor
B	BA	0(no support)	3EI / L	0
C	CB	3EI / L	3EI /L + 4EI / L = 7EI / L	(3EI / L) / (7EI / L)= 3 / 7
D	DC	4EI / L	4EI / L	(4EI / L) / (4EI / L) =1

18. What are the situations where in sway will occur in portal frames?

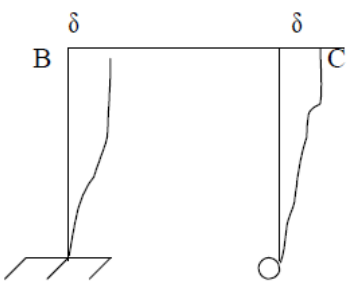
a. Eccentric or unsymmetric loading
b. Unsymmetrical geometry

c. Different end conditions of the columns
d. Non-uniform section of the members

e. Unsymmetrical settlement of supports
f. A combination of the above

19. What is the ratio of sway moments at column heads when one end is fixed and the other end hinged? Assume that the length and M.I of both legs are equal.

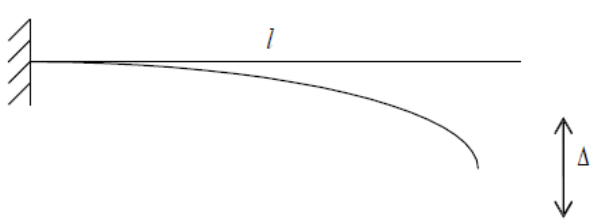
Assuming the frame to sway to the right by δ



Ratio of sway moments =

$$\frac{M_{BA}}{M_{CD}} = \frac{-\left(\frac{6EI\delta}{l^2}\right)}{-\left(\frac{3EI\delta}{l^2}\right)} = 2$$

20. A beam is fixed at its left end and simply supported at right. The right end sinks to a lower level by a distance 'Δ' with respect to the left end. Find the magnitude and direction of the reaction at the right end if l is the beam length and EI, the flexural rigidity.



M_A (due to sinking of B) = $\frac{3EI\Delta}{l^2}$

21. What are symmetric and antisymmetric quantities in structural behaviour?

When a symmetrical structure is loaded with symmetrical loading, the bending moment and deflected shape will be symmetrical about the same axis. Bending moment and deflection are symmetrical quantities.

CE6501-STRUCTURAL ANALYSIS – I
PART 'B' & 'C' QUESTION BANK
UNIT – I
INDETERMINATE FRAMES

1. Determine the force in the members of the truss shown in figure. The cross sectional area of vertical and horizontal members is 4000mm^2 and that of the diagonal is 6000 mm^2.

al area of vertical and horizontal members is 4000 mm^2 and that of the m^2.

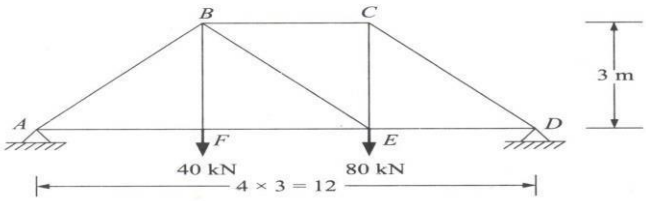
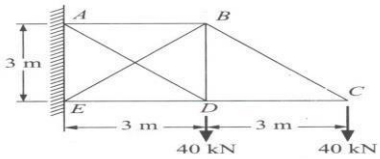


Figure 10.4(a) Example 10.1

2. Find the forces in the members of truss shown in figure. The cross sectional area and young's modulus of all the members are the same.



3. Find the forces developed in all the members of truss shown in fig, if the temperature of member AC goes up by 20°c. Take the co efficient of thermal expansion α=12X10^{-6}/°c. Cross sectional area of all the members is 2500mm^2 and young's modulus is 200KN/mm^2.

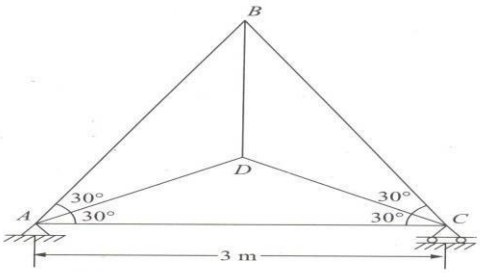
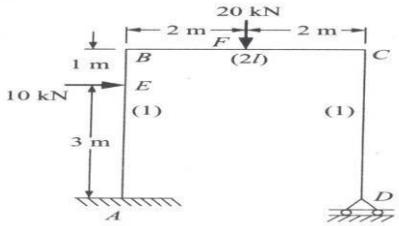


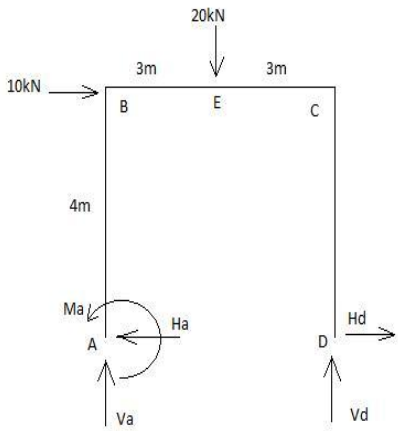
Figure 10.14(a) Example 10.7

4. In the frame ABCD shown in fig, end A is fixed and end D is on roller. Analyse the frame for the loading shown.

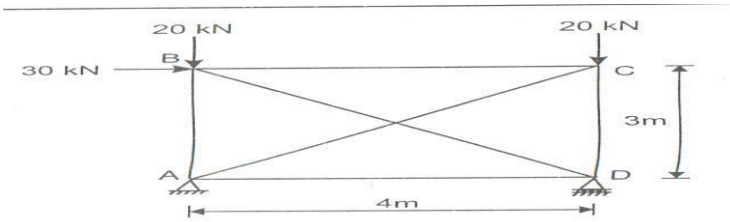
In the frame *ABCD* shown in Figure 11.20(*a*), end *A* is fixed a
ıe for the loadings shown.



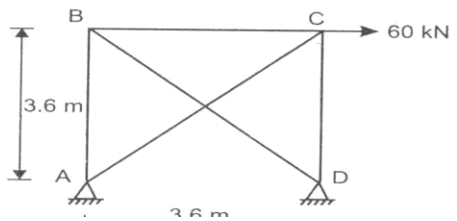
5. Analyses the frame shown in fig, using the consistent deformation method. Flexural rigidity is constant throughout.



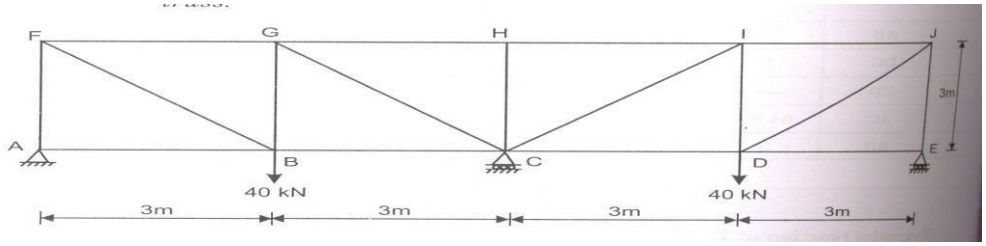
6. Find the stresses in all the members of the given frame, in which the cross sectional areas of vertical members are 3000mm2 each and those of all other members are 2200mm2. E=2x10^5 N/mm2.



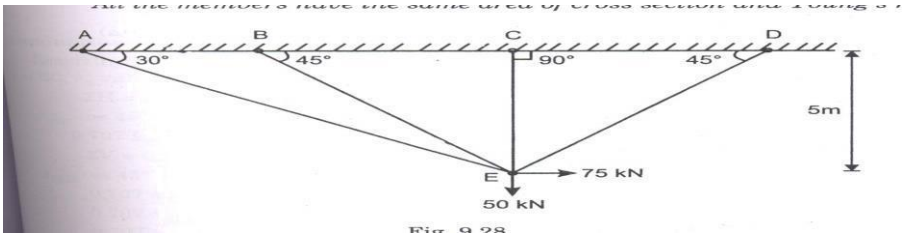
7. Determine the forces in the members of the truss shown. AE is constant for all the members



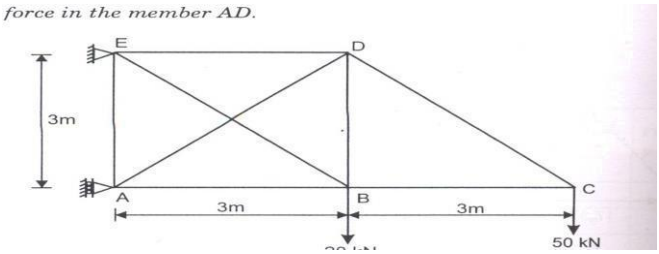
8. A two span continuous truss is loaded as shown. All the members are of the same material and have the same cross sectional area. Find the reaction at the central support C. also fined the forces in all the members of the truss.



9. Find the forces in all the members of the pin-jointed frame work as show. All the members have the same area of cross section and Young's modulus.



10. A braced cantilever truss is loaded as shown. All the members are of the same material and have the same cross-sectional area. Find the axial force in the member AD.



UNIT- II
MOVING LOADS AND INFLUENCE LINES

1. A system of four loads 80, 160, 160 and 120 kN crosses a simply supported beam of span 25m with the 120 kN load leading. The loads are equally spaced at 1m. Determine the values of the following using influence lines.

i. Maximum bending moment at a section 10m from left support and

ii. Absolute maximum shear force and bending moment in the beam.

2. A beam has a span of 24m, draw the influence line diagram for the bending moment and shear force at a section 8m from the left and also determine maximum bending moment and shear force at this section due to two point loads of 10kN and 6kN at a fixed distance of 2m apart rolling from left to right with 6kN load leading

3. Two point loads of 100kN and 200kN spaced 3m apart cross a girder of span 12 meters from left to right with the 100kN leading. Draw the ILD for shear force and bending moment and find the values of maximum bending moment and find the values of maximum shear force and bending moment at a section 4m from the left hand support. Also evaluate the absolute maximum bending moment due to the given loading system.

4. A simply supported beam has a span of 16m,is subjected to a UDL(dead load) of 5kN/m and a UDL(live load) of 8kN/m(longer than the span) travelling from left to right. Draw the ILD for shear force and bending moment at a section 4m from left end. Use these diagrams to determine the maximum shear force and bending moment at this section.

5. The following system of wheel loads crosses a span of 25m

Wheel load (KN)	16	16	20	20
Distance between centre (m)	3	3	4	4

6. Draw the influence line for M_B for the continuous beam ABC simply supported at A and C using Muller Breslau`s principle. AB=3m, BC=4m.EI is constant.

7. Draw the influence line diagram for the propped reaction of a propped cantilever beam having span 6m. EI=Constant.

8. Determine the influence line diagram for bending moment at a point D, the middle point of span AB of a continuous beam ABC of span AB=6m and BC=4m simply supported at supports A,B and C. Compute the ordinates at every 1m interval.

9. The warren girder of 25m span is made of 5 panels of 5m each. The diagonals are inclined at 60° to the horizontal. Draw the influence line diagram for force in upper chord member in the second panel from left. Hence evaluate the forces in it when there is load of 60 kN at each lower joint.

10. Draw the influence line for R_A for the continuous beam ABC of span AB = BC = 4m simply supported at A, B &C. Compute the ordinates at every 1m interval, EI= constant.

UNIT – III

ARCHES

1. A circular three hinged arch of span 25m with a central rise of 5m is hinged at the crown and the end supports. It carries a point load of 100 kN at 6m from the left support. Calculate

i. The reaction at the supports
ii. Moment at 5m from the left support.

2. A three hinged circular arch of span 16m and rise 4m is subjected to two point loads of 100 kN and 80 kN at the left and right quarter span points respectively. Find the reaction at the supports. Find also the bending moment, radial shear and normal thrust at 6m from left support.

3. A symmetrical three hinged arch has a span of 50 & rise 5m. Find the maximum bending moment at a quarter point of the arch caused by a uniformly distributed load of 10kN/m which occupies any portion of the span. Indicate the position of the load for this condition.

4. A three hinged parabolic arch of span 30m and rise 5m carries a uniformly distributed load of 40kN per meter on the whole span and a point load of 200kN at a distance of 5m from the right

end. Find the horizontal thrust, resultant reaction, bending moment and normal thrust at a section 5m from the left end.

5. A three hinged parabolic arch has supports at different levels having span 20m and carries a UDL of 30kN/m over the left half of the span. The left support is 5m below the crown and the right support is 4m below the crown. Draw the BMD. Also find the normal thrust and radial shear at a section 4m from the left support.

6. A parabolic two hinged arch has a span of 40m and a rise of 5m. A concentrated load 10kN acts at 15m from the left support. The second moment of area varies as the secant of the inclination of the arch axis. Calculate the horizontal thrust and reactions at the hinge. Also calculate maximum bending moment at the section.

7. Evaluate the horizontal thrust in a two hinged parabolic arch of span 10m and rise 25m carrying an UDL of 24 kN/m over the left half span, assuming secant variation of its sectional moment of area. Also calculate the Bending Moment at the crown and draw the BMD.

8. Derive the expression for horizontal thrust in a two hinged parabolic arch carrying a point load P at distance one fourth span from left support .Assume $I=I_o \sec\theta$.

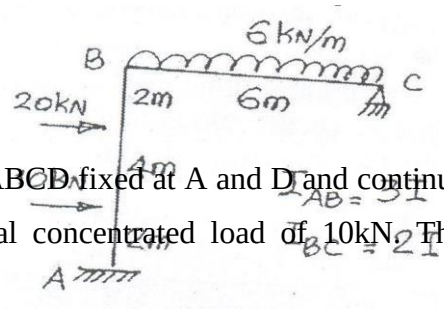
9. A two hinged parabolic arch of span L and rise h carries a triangular load covering a distance a from the left end ,the intensity varying uniformly from zero to W. Obtain an expression for the horizontal thrust.

10. Derive the expression for horizontal thrust in a two hinged semi circular arch of radius R, carrying a point load W at the crown.

UNIT – IV

SLOPE DEFLECTION METHOD

1. Analyse the rigid frame shown in fig. by slope deflection method and draw the bending moment diagram.

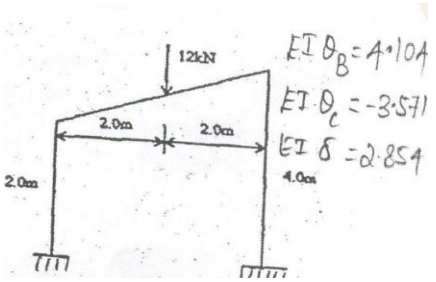


2. A Continuous beam ABCD fixed at A and D and continuous over supports B and C. The span AB=5m carries a central concentrated load of 10kN. The span BC=4m carries a uniformly

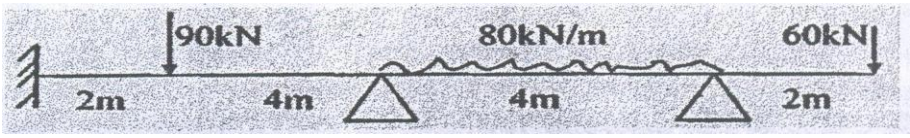
distributed load of 4 kN/m over the entire span of BC. The span CD=6m carries a non central concentrated load of 8 kN acting at a distance of 2m from the end D. Analyse the beam and draw bending moment diagram using slope deflection method.

3. A continuous beam ABC consist of span AB=3m and BC=4m, the ends A and C being fixed. AB and BC carry uniformly distributed loads of intensity 4kN/m and 5kN/m respectively. Find the support moments and draw the bending moment diagram for the beam. The beam is of uniform section throughout.

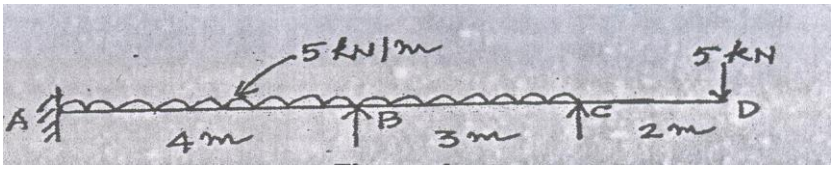
4. Analyse the portal frame shown in fig. by slope deflection method. EI = constant.



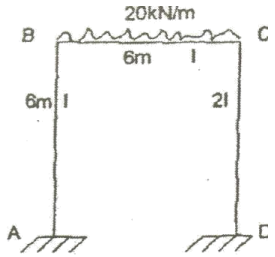
5. Analyse the beam shown in fig. by slope deflection method and draw the SFD and BMD.EI=Constant.



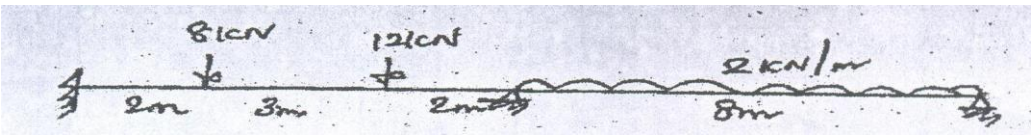
6. Analyse the continuous beam ABCD shown in fig. by slope deflection method .Take EI=Constant. Also sketch the shear force and Bending Moment diagram.



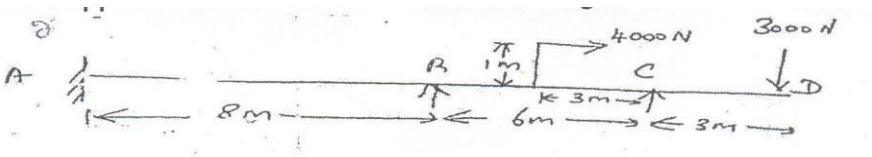
7. Analyze the continuous beam shown in fig. by slope deflection method. Support B settles by 8mm and C settles by 12 mm. I=60000cm^4,E=210x10^{6}kN/m^2.Draw the SFD and BMD.



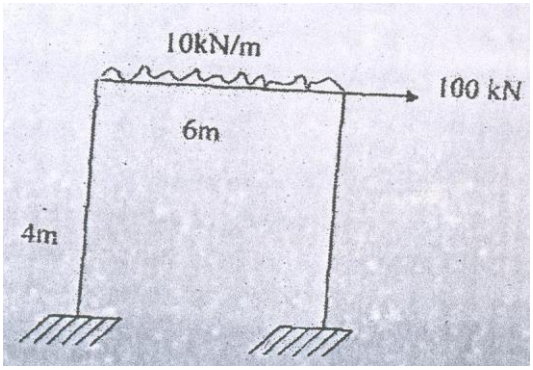
8. Draw the BMD and SFD of the beam shown in fig. by slope deflection method.



9. A Continuous beam of constant moment of inertia is loaded as shown in fig. Find the support moments and draw the B.M diagram.



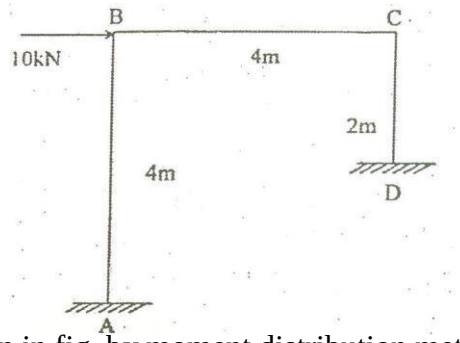
10. Analyse the portal frame shown in fig. by slope deflection method.



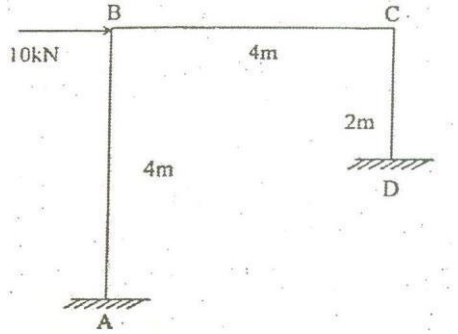
UNIT- V

MOMENT DISTRIBUTION METHOD

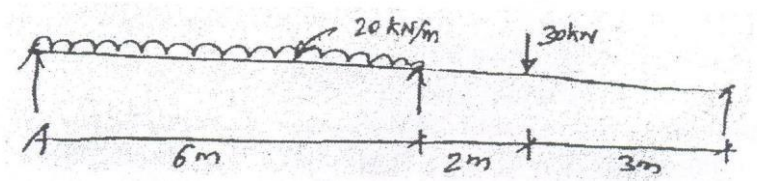
1. Analyse the frame shown in fig. by moment distribution method & draw the SFD & BMD



2. Analyse the frame shown in fig. by moment distribution method.

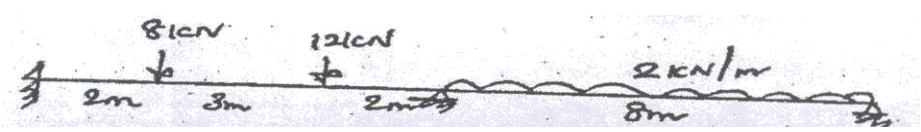


3. Analyse the continuous beam shown in fig. by the method of moment distribution.

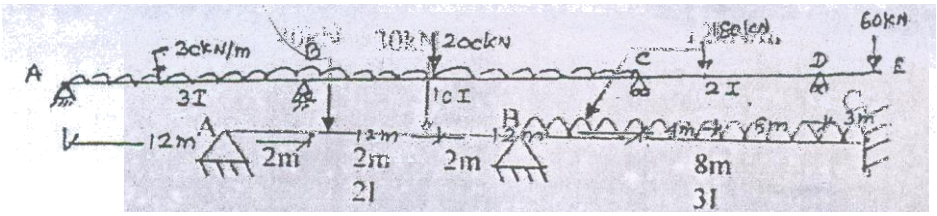


4. A beam ABC 5.8 meters long is fixed at A and simply supported at B,4 meters from A so as to provide an overhang BC 1.8 meters long. It carries a point load of 5kN at C. Analyse the beam.

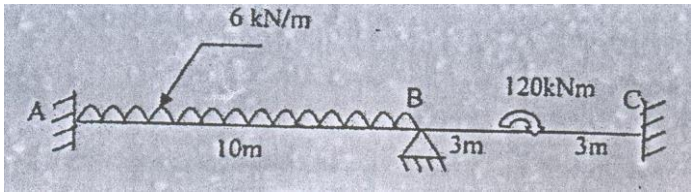
5. Draw BMD and SFD of the beam shown in fig. by moment distribution method. EI constant.



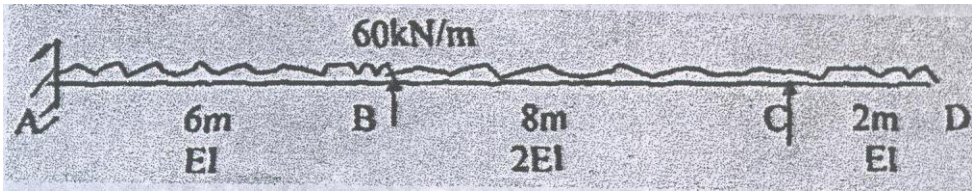
6. Analyse the continuous beam shown in fig. and plot the BMD and SFD. Use Moment distribution method.



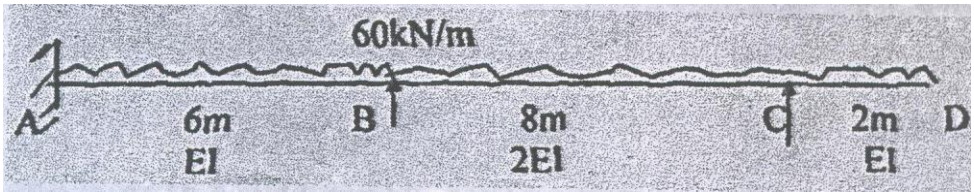
7. Analyse the continuous beam shown in fig. and plot the BMD and SFD. Use Moment distribution method. EI is constant.



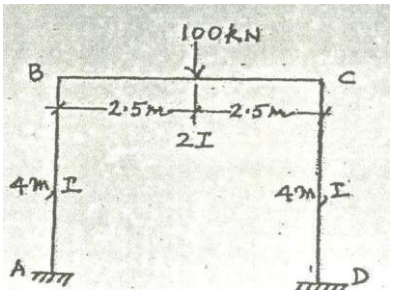
8. Draw the SFD and BMD for the beam shown in fig. by moment distribution method.



9. Analyse the continuous beam shown in fig. by moment distribution method. Draw BMD



10. Analyse the portal frame ABCD shown in fig. by moment distribution method & also draw the bending moment diagram.



V.S.B. ENGINEERING COLLEGE, KARUR
DEPARTMENT OF CIVIL ENGINEERING

Year/Semester : III / V – 'A' & 'B' Section
Subject Code & Name : CE 6502 – FOUNDATION ENGINEERING

PART 'A' QUESTIONS BANK
UNIT-I
SITE INVESTIGATION AND SELECTION OF FOUNDATION

1. **List the various methods of soil exploration techniques.**
   1. Pits and trenches
   2. Boring: a) augur boring b) wash or water boring c) rotary boring d) percussion boring
   3. Geophysical methods: a) seismic refraction b) electrical resistivity
   4. Standard penetration test
   5. Static cone penetration test
2. **Write short notes on Augur boring.**
   An augur is a type of tool which is used for understanding the characteristics of the subsurface soil. Generally there are two types of augurs,
   a) Manually operated augur
   b) Mechanically operated augur
3. **Define standard penetration number.**
   The number of blows required to penetrate 300 mm of the split spoon sampler beyond a seating drive of 150mm is known as penetration number (N).
4. **List the various corrections to be carried out in SPT test.**
   The two corrections are
   a) Dilatancy correction (Silty sand)
   b) Over burden pressure correction (Granular soil)
5. **What are the uses of soil exploration?**
   a) To select type and depth of foundation for a given structure
   b) To determine the bearing capacity of the soil of the selected foundation
   c) To investigate the safety of the existing structure
   d) To establish ground water level
6. **What is soil exploration?**
   The process of collection subsoil sample by an appropriate method to a needed depth and check those samples for knowing the properties is called soil exploration.
7. **List the different types of samplers.**
   a) Standard split spoon sampler
   b) Shelby and thin walled tube sampler
   c) Denison sampler
   d) Piston sample
   e) Scraper bucket sampler

8. Define area ratio.

Area ratio is defined as the ratio of maximum cross sectional area of the cutting edge to the area of soil sample.

9. List the various parameters affecting the sampling disturbance.

a) Area ratio
b) Inside clearance
c) Outside clearance
d) Inside wall friction
e) Position of non-return wall
f) Recovery ratio
g) Methods of applying force

10. Write the advantages of SCPT over SPT.

a) There is no need of hammering action, just pushing into the ground.
b) No need of bore holes, it is carried out on the ground
c) Engineering properties of the soil like permeability, Shear strength, Compressibility can be evaluated.

11. Write short notes on spacing of bore holes.

The spacing of bore holes depends upon the variation of subsurface soil in the horizontal direction. The factors influencing the spacing of bore holes are,

a) Type of soil
b) Fluctuation of water table
c) Load coming from structure
d) Importance of the structure.
e) Economical feasibility.

12. What is the difference between disturbed and undisturbed soil sample?

Disturbed soil sample:
Natural structure of soils get partly or fully modified and destroyed
Undisturbed soil sample:
Natural structure and properties remain preserved

13. What is the information obtained in general exploration?

(i) Preliminary selection of foundation type
(ii) Depth of water,
(iii) Depth, extent and composition of soil strata
(iv) Engineering properties required disturbed or partly disturbed
(v) Samples approximate values of strength and compressibility

14. Define significant depth?

Exploration depth, in general it should be carried out to a depth upto which increase in the pressure due to structural loading is likely to cause shear failure, such depth is known as significant depth.

15. Define liquefaction of sand?

The mass failure occurs suddenly, and the whole mass appears flow laterally as if it were a liquid such failure is referred to as liquefaction.

16. What are the disadvantages of wash boring?

It is a slow process in stiff soil
It cannot be used effectively in hard soil, rocks ,etc.

UNIT-II
SHALLOW FOUNDATION

1. **Safe Bearing Capacity:**

   Maximum intensity of loading that the foundation will safely carry without the risk of shear failure of soil irrespective of any settlement that may occur.

   As per Rankine's formula

   $D_{min} = P/W[(1-\sin\emptyset)/(1+\sin\emptyset)]^2$ Where,

   P-safe bearing capacity in N/m^2

   W = Unit weight of soil in KN / m^3

   $\emptyset$-Angle of repose of soil in degrees

2. What are components of total foundation settlement?

elastic settlement, consolidation settlement, secondary consolidation settlement

3. What are the types of shear failure?

general shear failure, local shear failure, punching shear failure

4. What are assumptions in Terzaghi's bearing capacity theory?

(i) The base of the footing is rough
(ii) The load on footing is vertical and uniformly distributed
(ii) The footing is continuous

5. List out the methods of computing elastic settlements?

Based on the theory of elasticity, Pressure meter method, Janhu –Bjerram method, Schmentmann's method

6. What is the limitation of Terzaghi's analysis?

(i)As the soil compresses, pi changes slight down ward movement of footing may not develop fully the plastic zones
(ii)Error due to assumption that the resultant passive pressure consists of three components is small

7. Define ultimate bearing capacity?

Gross pressure at the base of the foundation at which the soil fails in shear is called ultimate bearing capacity.

8. Define net ultimate bearing capacity?

Net pressure increase in pressure at the base of the foundation that causes failure in shear, is called as net ultimate bearing capacity

9. Define allowable bearing capacity?

It is the net loading intensity at which neither the soil fails in shear nor there is excessive settlement detrimental to the structure.

10. Write the expression for correction due to dilatancy.

$N_e = 15 + (N_o-15)$

11. What are the requirements for a stable foundation?

(i) Must be safe from failure
(ii) Must be properly located
(iii) Must not settle or deflect sufficiently to damage the structure or impair its usefulness.

12. Write the assumptions in Terzaghi are bearing capacity theory

1. The base of the footing is rough
2. The footing is laid at a shallow depth (D_f<B) or (D_f=B)
3. The load on footing is vertical and uniformly distributed
4. The shear strength of soil is governed by mohr'scolumb equations
5. $Z=C+\sigma\tan\phi$

The ratio of L/B is infinite. Where L is the length and B is the width of footing.

13. List the limitations of plate load test

1. Size effect
2. Scale effect
3. Time effect
4. Interpretation of failure load
5. Reaction load
6. Water table

14. List the various methods of computing elastic settlement:

1. Based on the theory of elasticity
2. Pressure meter method
3. Janhu –Bjerram method
4. Schmentmann's method

15. What are the factors which depends depth?

Type of soil, size of structure, magnitude of loads, environmental conditions, etc

16. When Trapezoidal combined footing provided?

(i) When the projection parallel to the length of the footing is restricted on both the sides
(ii) When the length of the footing is restricted.

UNIT-III
FOOTINGS AND RAFTS

1. Under what circumstances, a strap footing is adopted?

When the distance between the two columns is so great, so that trapezoidal footing is very narrow and so it is uneconomical. It transfers the heavy load of one column to other column.

2. What is a mat foundation?

It is a combined footing that covers the entire area beneath a structure and supports all the walls and columns.

3. Where mat foundation is used?

It is used when the area of isolated footing is more than fifty percentage of whole area or the soil bearing capacity is very poor.

4. Define spread footing?

It is a type of shallow foundation used to transmit the load of isolated column, or that of wall to sub soil. The base of footing is enlarged and spread to provide individual support for load.

5. What are types of foundation?

Shallow foundation, deep foundation

6. **What are the footings comes under shallow foundation?**

Spread footing or pad footings, strap footings, combined footings, raft or mat foundation

7. What are the footings comes under deep foundation?

pile, caisons(well foundation)

8. Define floating foundation?

It is defined as a foundation in which the weight of the building is approximately equal to the full weight of the soil including water excavated from the site of the building.

9. What is mean by proportioning of footing?

Footings are proportional such that the applied load including the self-weight of the footing including soil .the action are not exceeding the safe bearing capacity of the soil.

10. What are the assumptions made in combined footing?

(i)The footing is rigid and rests on a homogenous soil to give rise to linear stress distribution on the bottom of the footing.

(ii)The resultant of the soil pressure coincides with the resultant of the loads, and then it is assumed to be uniformly distributed.

11. Give the advantages of floating foundation.

(i) The structural load on a floating foundation is reduced $Q^{/} = Q-W_s$

Q = Gross load, W_s = Excavated soil weight

(ii) In a soil having almost no shear strength, floating foundation could be an effective solution.

12. Under what circumstances, a strap footing is adopted?

A strap footing may be provided where the distance between the columns is so great that the combined trapezoidal footing becomes quite narrow, with high bending moments or where $x < L/3$.

13. What are the methods of design of raft foundation as per IS?

(i) Conventional method

(ii) Elastic method or soil line method

14. Name the different type of raft.

(i) Flat plate type
(ii) Flat plate thickened under column
(iii) Beam and slab construction
(iv) Box structures
(v) Mats placed on piles

15. What is floating raft foundation?

If the weight of soil removed is equal to the total load of building imposed on the raft foundation, then the raft is a floating raft. Since it is not transferring any, pressure on the bearing of soil below the raft. The result is zero settlement of the building.

16. List out the types foundation for a shallow depth.

(i) Spread footing
  a. Isolated footing
  b. Strip/continuous footing
(ii) Strap footing
(iii) Combined footing
  a. Rectangular footing
  b. Trapezoidal footing
(iv) Raft footing

17. What is the design method available for the mat foundation?

(i) Design of mat foundation by conventional rigid method
(ii) Design of mat foundation by elastic plate method.

UNIT-IV
PILE FOUNADTION

1. List out the type of pile based on material used?

Timber pile, concrete pile, steel pile, composite pile

2. How is the selection of pile carried out?

The selection of the type, length and capacity is usually made from estimation based on the soil condition and magnitude of the load.

3. What is mean by group settlement ratio?

The settlement of pile group is found to be many times that of a single pile. The ratio of the settlement of the pile group to that of a single pile is known as the group settlement ratio.

4. What are the factors consider while selecting the type of pile?

(i) The loads
(ii) Time available for completion of the job
(iii) Availability of equipment
(iv)The ground water conditions
(v) The characteristics of the soil strata involved

5. What is the type of hammer?

Drop hammer, diesel hammer, double acting hammer, single acting hammer, vibratory hammer

6. What is pile driver?

Piles are commonly driven by means of a hammer supported by a crane or by a special device known as a pile driver.

7. What are methods to determine the load carrying capacity of a pile?

(i) Dynamic formulae
(ii) Static formula
(iii) Pile load test
(iv) Penetration tests

8. What are the two types of dynamic formulae?

(i) Engg. news formula
(ii)Hiley's formula

9. What is meant by single-under reamed pile?

The pile has only one bulb is known as single under reamed pile

10. Write down the static formulae?

The static formulae are based on assumption that the ultimate bearing capacity Qup of a pile is the sum of the ultimate skin friction Rf and total ultimate point or and bearing resistance Rp.

Qup=Rf+Rp Qup=Asrf+Ap.rp

11. Define modulus of subgrade reaction?

The ratio of soil reaction (p) to the deflection (y) at any point is defined as the modulus of subgrade reaction Es or soil modulus.

12. What is use of batter pile?

The batter piles are used to resist large horizontal forces and inclined forces

13. What is meant by friction pile?

Friction is used totransfer loads to a depth of a friction load carrying material by means of skin friction along the length of the pile.

14. What is negative skin friction?

Negative skin friction is a downward drag force acting on a pile due to the downward movement of surrounding compressible soil relative to the pile.

15. For identical soil conditions, the load permitted on bored pile is lesser than driven pile of identical shape and dimensions, why?

The load carrying capacity of bored cast in situ pile will be much smaller than that of a driven pile in sand. The angle of shearing resistance of the soil is

reduced by 30, to account for the loosening of the sand due to the drilling of the hole.

16. Define end bearing pile.

End bearing piles are used to transfer load through water or soft soil to a suitable bearing stratum. The end bearing pile is driven through poor soil strata and rests on a firm incompressible stratum such as rock, developing the bearing pressure of its base, and passing it to that firm stratum.

17. What is group efficiency of pile?

The ratio of resisting capacity of a pile group to the sum of individual capacities of piles in the group is termed as group efficiency.

Group efficiency, $n = Q_g/nxQ_p$

Q_g = Group capacity

Q_p = pile load on single pile

n = Number of piles

18. What are the conditions where a pile foundation is more suitable than a shallow foundation?

a. Huge vertical load with respect to sol capacity

b. Very weak soil

c. Huge lateral loads e.g., Towers, chimneys

d. Ccour depth criteri

e. For fills having very large depth

f. Uplift situation

Urban areas for future large and huge construction near the existing building

g. for high rise buildings.

UNIT-V
RETAINING WALLS

1. Define conjugate stresses?

The stress acting on the conjugate planes is called conjugate stresses

2. How do you check the stability of retaining walls?

(i) The wall should be stable against sliding

(ii) The wall should be stable against overturning

(iii) The base of the wall should be stable against bearing capacity failure

3. Define angle of repose.

Maximum natural slope at which the soil particles may rest due to their internal friction, if left unsupported for sufficient length of time

4. Define theory of plasticity?

The theory on which the condition of the stress in a state of a plastic equilibrium is called as theory of plasticity.

5. What are assumptions in coulomb wedge theory?

(i) The backfill is dry, cohesionless, isotropic, homogenous,
(ii) The slip surface is plane which passes through the head of the wall
(iii) The wall surface is rough
(iv) The sliding wedge itself acts as a rigid body

6. How to prevent land sliding?

Sheet piles, retaining wall may be used to prevent the land sliding

7. Write down any two assumptions of Rankine's theory? - semi infinite soil
- cohesion-less backfill - homogenous soil
- the top surface is a plane which may be inclined or horizontal.

8. Distinguish Coloumb's wedge theory from Rankine's theory?

Rankine considered a soil particle at plastic equilibrium but Coulomb considered the whole soil mass.

9. Define coefficient of earth pressure.

The ratio of the horizontal stress to the vertical stress is called the coefficient of earth pressure.

$$K = \sigma_h / \sigma_i$$

Where, σ_h = Horizontal stress
σ_i = Vertical stress

10. Give the criteria of design of gravity walls.

a. The base width of the wall must be such that the maximum pressure exerted on the foundation soil does not exceed the safe bearing capacity of the soil
b. not tension should be developed anywhere in the wall

c. The wall must be safety against overturning

d. The wall must be safety against sliding

11. Retaining walls are usually designed for active earth pressure. Why?

A retaining structure is required to provide lateral support to the soil mass behind it. The tendency of the backfill is to push the retaining wall away from it such that the soil stretches horizontally. This state is active state. Hence the retaining walls are designed for active earth pressure.

12. List the assumption common to Rankine and Coulomb theory of earth pressure.

a.In both theories the back fill material is assumed as semi-infinite homogenous and isotropic
b. The deformation of backfill occurs exclusively parallel to the vertical plane at right angle at the back of the wall
c. the ground surface is plane, which may be horizontal or vertical

13. Define plastic equilibrium.

A mass of soil is said to be in a state of plastic equilibrium if failure is incipient or imminent at all points within the mass.

14. What are the conditions to be satisfied while designing a retaining wall?

Sliding resistance:

Factor of safety = sum of resisting force / Sum of driving force

Overturning:

To avoid overturning the resultant thrust must fall with in the middle third of the wall base

Factor of safety = sum of resisting force / Sum of overturning force

Factor of safety against overturning should be at least 1.5 for sandy soil and 2.0 for clayey soil

Bearing capacity:

Factor of safety = allowable bearing pressure / Maximum contact pressure

Factor of safety against bearing capacity should be at least 2.5 for sandy soil and 3 for clayey

15. Compare Rankine's theory and coulomb theory.

Rankine's theory:

(i)The intensity of earth pressure at each depth is known. So point of application of earth pressure is known at any depth.

(ii) Wall is smooth and vertical

(iii) Wall moved sufficiently, so solis in plastic mass

Coulomb theory:

(i) Only the total earth pressure value acting on the retaining wall can be calculated. The point of application of the earth pressure can be calculated for coulomb assumption that all points on the back of the retaining wall are essentially considered as feet of failure surface

(ii) Wall is rough and sloped

(iii) Wall is rigid, straight failure plane and rigid wedge

CE6502-FOUNDATION ENGINEERING
PART 'B' & 'C' QUESTION BANK
UNIT-I
SITE INVESTIGATION AND SELECTION OF FOUNDATION

1. Explain any two methods of site exploration in detail?
2. Explain wash boring method of soil exploration?
3. Explain the arrangements and operations of stationary piston sampler?
4. Explain about standard penetration test?
5. Explain any two important types of samplers
6. Explain with neat sketch auger boring method of soil exploration.
7. Explain dynamic cone penetration test.
8. Describe the salient features of a good sub-soil investigation report?

UNIT-II
SHALLOW FOUNDATION

1. What is shallow foundation? Explain its types?
2. What is settlement? What are the components of settlement? Distinguish between them?
3. Explain the test to be conducted for find out the bearing capacity?
4. What is bearing capacity? What are the factors affecting bearing capacity? what are improving factors of bearing capacity?
5. A Strip footing of width 3m is founded at a depth of 2m below the ground surface in a (c-φ) soil having a cohesion c = 30 kN/m^2 and angle of shearing resistance $\varphi = 35^o$. The water table is at a depth of 5m below ground level. The moist weight of soil above the water table is 17.25 kN/m^2.For $\varphi = 35^o$, $N_c = 57.8$, $N_q = 41.4$ and $N_\gamma = 42.4$ Determine.
   (i) the ultimate bearing capacity of the soil
   (ii) the net bearing capacity of soil
   (iii) the net allowable bearing pressure and the load/m length for a FS = 3.Use the general shear failure theory of Terzaghi.

6. Size of an isolated footing is to be limited to 1.5 metres square. Calculate the depth at which the footing should be placed to take a load of 200 kN, with a factor of safety 3. The soil is having angle of internal friction $\varphi = 30^o$. The weight of the soil is 21 kN/m^3. Bearing capacity factor for $\varphi = 30^o$, N_q=22 and $N_\gamma = 20$.

7. Calculate the settlement of a structure founded on a clay. Thickness of clay stratum is 6m at 10m below from the ground level. The overlaying layer is sand upto ground level. Water table is at 6m from the ground level. Unit weight of sand above the water table is 18 kN/m^3 and below water table it is 21 kN/m^3. Specific gravity of the clay is 2.75, natural moisture content of the clay is 40% and its liquid limit is 45%. Increase in overburden pressure at the centre of the clay structure, due to proposed construction of the building is 100 kN/m^2.

8. Explain Terzaghi's analysis of bearing capacity of soil in general shear failure.

9. A Strip footing of width 3m is founded at a depth of 2m below the ground surface in a (c-φ) soil having a cohesion c = 30 kN/m^2 and angle of shearing resistance $\varphi = 35^o$.
   The moist weight of soil above the water table is 17.25 kN/m^2.

For $\varphi = 35^o$, $N_c = 57.8$, $N_q = 41.4$ and $N_\gamma = 42.4$ For $\varphi = 25^o$, $N_c = 25.1$, $N_q = 12.7$ and $N_\gamma = 9.7$

The water table is at a depth of 5m below ground level. Determine (i) the ultimate bearing capacity of the soil

(ii) The net bearing capacity of soil

(iii) The net allowable bearing pressure and the load/m length for a FS = 3. Assume the soil fails in local shear .

10. A Strip footing of width 3m is founded at a depth of 2m below the ground surface in a (c-φ) soil having a cohesion c = 30 kN/m^2 and angle of shearing resistance $\varphi = 35^o$.
The moist weight of soil above the water table is 17.25 kN/m^2. For $\varphi = 35^o$, $N_c = 57.8$, $N_q = 41.4$ and $N_\gamma = 42.4$
For $\varphi = 25^o$, $N_c = 25.1$, $N_q = 12.7$ and $N_\gamma = 9.7$ If the water table occupies any of the positions
(i) 1.25 m below Ground Level or
(ii) 1.25 m below the base level of the foundation, What will be the net safe bearing pressure?
Assume $\gamma_{sat} = 18.5$ kN/m^3, γ (above WT) = 17.5 kN/m^3, Factor of Safety = 3

11. Explain different types of shear failures of soil with neat sketch
12. Compute the consolidation settlement by oedometer test data method

13. A footing rests at a depth of 1m has a size of 3m x 1.5m and it causes a pressure increment of 200 kN/m^2 at its base. The soil profile at the site consists of sand for the top 3 m, which is underlined by a clay layer of 3m. Water table is at a depth of 2.5m from the ground surface. The unit weight of sand layer above and below water table are 16kN/m^3 and 18 kN/m^3 respectively. The unit weight of clay is 15 kN/m^3. The initial void ratio is 0.8 and compression index is 0.3. Determine the consolidation settlement at the middle of the clay layer. Assume 2:1 pressure distribution and consider the variation of pressure across the depth of the clay layer.

14. Compute the safe bearing capacity of a square footing 1.5 m x 1.5 m located at a depth of 1 m below the ground level in a soil of average density 20 kN/m^3. $\Phi = 20°$, Nc = 17.7, Nq = 7.4 and $N\gamma = 5$. Assume a suitable factor of safety and that the water table is very deep. Also compute the reduction in safe bearing capacity of the footing if the water table rises to the ground level.

UNIT-III
FOOTINGS AND RAFTS

1. What are the different types of raft foundations? 2. State the design requirement of a foundation?
3. Briefly explain about the structural design of spread footing
4. Briefly explain how proportioning and structural design of trapezoidal combined footing is done with diagram
5. Derive the relation between the dimensions of trapezoidal combined footing and unequal column loads Q1 and Q2?

6. A trapezoidal footing is to be produced to support two square columns of 30 cm and 50 cm sides respectively. Columns are 6 meters apart and the safe bearing capacity of the soil is 400 kN/m^2. The bigger column carries a load of 500 kN and the smaller carries a load of 3000kN. Design a suitable size of the footing so that if does not extend beyond the face of the columns.

UNIT-IV
PILE FOUNADTION

1. Explain the method of determining the load carrying capacity of a pile?
2. What are the cased cast in-situ concrete piles?
3. What are the uncased cast in-situ concrete piles?
4. What are different types of piles and their functions?
5. What is group capacity by different method
6. What are the various factors influencing the selection of pile?
7. Explain briefly cyclic load test on pile.
8. A pile is driven with a single acting steam hammer of weight 15kN with a free fall of 900mm. The final set, the average of the last three blows, is 27.5mm. Find the safe load using the Engineering News formula.
9. A group of 16 piles of 50 cm diameter is arranged with a center to center spacing of 1.0 m. The piles are 9m long and are embedded in soft clay with cohesion 30kN/m. Bearing resistance may be neglected for the piles. Adhesion factor is 0.6. Determine the ultimate load capacity of the pile group.

UNIT-V
RETAINING WALLS

1. Explain the active and passive states of earth pressure acting on a retaining wall.
2. Explain the Coulomb wedge theory with neat sketches
3. Explain the Rebhann's graphical method for active earth pressure calculation
4. Explain the Culmann's graphical method and the effect of line load
5. Explain the Rankine's theory for various backfill conditions to calculate active state earth pressure.
6. A retaining wall is 4 metres high. Its back is vertical and it has got sandy backfill upto its top. The top of the fill is horizontal and carries a uniform surcharge of 85 kN/m^2. Determine the active earth pressure on the wall per metre length of wall. Water table is 1m below the top of the fill. Dry density of soil = 18.5 kN/m^3. Moisture content of soil above water table = 12%. Angle of internal friction of soil = 30°, specific gravity of soil particles = 2.65. Porosity of backfill = 30%. The wall friction may be neglected.

V.S.B. ENGINEERING COLLEGE, KARUR
DEPARTMENT OF CIVIL ENGINEERING

Year/Semester : III / V – 'A' & 'B' Section
Subject Code & Name : CE 6503 – ENVIRONMENTAL ENGINEERING I

PART 'A' QUESTIONS BANK
UNIT I
PLANNING FOR WATER SUPPLY SYSTEM

1. **What are the objectives of public water supply scheme? (AU April 2015, Dec 2014)**
   - To provide the treated water to the consumers for various purposes
   - To provide the water to meet the water requirements for emergencies like fires etc
   - To provide the water without impurities and to prevent the pollution of water
   - To provide the arrangements of future requirements.

2. **Distinguish between shallow well and deep well. (AU April 2015)**

Shallow well	Deep well
A shallow well/ tube-well; bellow 50 feet. This technology is applicable in shallow water tables, hence often in soft soil/ sandy formations. Due to their shallowness, shallow wells are prone to pollution from seepage of polluted water and drying up during dry season. Their biggest advantage is their relatively low cost	A deep well/ tube-well; over 50 feet (about 15m) depth. Although the construction technology is similar to a machine drilled shallow well, the type of pump is different since water has to be pumped from a deeper level

3. **Distinguish between carbonate and non-carbonate hardness(AU Dec 2014)**
   Carbonate hardness: This is due to the presence of bicarbonates of calcium and magnesium. Examples-Ca $(HCO_3)_2$and Mg $(HCO_3)_2$
   Non- Carbonate hardness: This is due to the presence of chlorides and sulphates of calcium and magnesium. Examples- $CaCl_2$, $CaSO_4$, $MgCl_2$, $MgSO_4$

4. **What are the components of a water supply (scheme) system? (AU May 2013)**
   - Collection work
   - Transmission work
   - Purification work
   - Distribution work

5. **What are the acceptable quality standards as per BIS10500:1983 for Fluoride and Nitrates? (AU May 2013)**

   For Fluoride –Should not exceeds 1.5 mg/l

   For Nitrates - Should not exceeds 45 mg/l. if exceeds Blue baby disease will take place.

6. **How do you determine the storage needed for and impounding reservoir? (AU May 2014)**

   A reservoir with gate-controlled outlets wherein surface water may be retained for a considerable period of time and released for use at a time when the normal flow of the stream is in sufficient to satisfy requirements.

7. **State the drinking quality standards for any four physic-chemical parameters. (AU May 2014)**

   pH- 6.5-8.5

   TDS (total dissolved solids) - 500mg/l

   Calcium- 75mg/l

   Chloride- 250mg/l.

8. **Define design period? (AU Dec 2012)**

   The future period for which a provision is mode in the water supply scheme is known as design period.

   The factors governing design period are,

   - Design period should not exceed the life period of the structure.
   - If the funds are not in a sufficient, the design period as to be decreased.
   - The rate of interest on borrowing and the additional money invested.

9. **What are rivers? What are the types of river?**

   Riversarethemostimportantsourcesofwaterforpublicwatersupplyscheme

   Riversareoftwotypes, they are

   a. Perennial rivers.

   b. Non perennial rivers

10. **Define per capita demand?**

    The quantity of water required for a person per day is known as per capita per demand.

    The factors affecting per capita demand are,

    - ✓ Climatic condition.
    - ✓ Habit of people.
    - ✓ Size of city.
    - ✓ Cost of water.
    - ✓ Quantity of water.
    - ✓ System of sanitation.
    - ✓ Supply of system.

11. What are the methods of population forecasting?
1. Arithmetic increase method
2. Geometric increase method
3. Method of varying increment (or) Incremental increase method
4. Decreasing rate of growth method
5 .Simple graphical method
6. Comparative graphical method
7. Master plan method (or) zoning method
8. The logistic curve method

12. Define design period?
The future period for which a provision is mode in the water supply scheme is known as design period.

13. What are the factors governing the design period?
The factors governing design period are,
a. Design period should not exceed the life period of the structure.
b. If the funds are not in a sufficient, the design period as to be decreased.
c. The rate of interest on borrowing and the additional money invested.

14. What are various type of water demand?
a. Domestic water demand
b. Industrial
c. Institution and commercial
d. Demand for public use
e. Fire demands

15. What are the various type of water available on the earth?
1. Surface sources such as
a. ponds and lakes
b. Stream and rivers
c. Storage reservoirs
d. Ocean.
2. Sub surface sources
a. Spring
b. Infiltration galleries
c. Infiltration wells
d. Wells and tube wells

16. What is hydrologic cyde?
Water is lost to the atmosphere as vapor from the earth. Which is then precipitated back in the form of rain, snow, hail dew, sleet or frost etc.This process is known as hydrologic cycle.

17. What are rivers? What are the types of river?
Rivers are the most important sources of water for public water supply schemes.
Rivers are of two types, they are
a. Perennial rivers.
b. Non perennial rivers.

18. What is jack well?
The various infiltration wells are connected by porous pipes to a sump well called jack well.

19. What are springs?
The natural out flow of ground water at the earth surface is called as springs.
10. What are the types of springs?
a. Gravity springs.
b. Surface springs.
c. Artesian springs.

20. What are artesian springs?
The pervious layer which contains water combined between two impervious layers are called artesian springs.

21. What are the different types of wells?
a. Open wells
1. Shallow wells.
2. Deep wells.
b. Tube wells.

22. What is artesian spring?
The pervious layer which contains water combined between two impervious layers is called artesian spring.

UNIT II

CONVEYANCE SYSTEM

1. **What is the role of intake structure in water supply scheme? (AU April 2015, Dec 2014)**
    - The basic function of the intake structure is to help in safely withdrawing water from the source over predetermined pool levels.
    - To discharge this water into the withdrawal conduit (normally called intake conduit), through which it flows up to water treatment plant.

2. **List out any two appurtenances in water conveyance system. (AU April 2015)**

   - Polyvinyl chloride appurtenances
   - Cast iron appurtenances

3. **What is an intake? (AU Dec 2014)**
   - Intake is a well type masonry or concrete structure, whose function is provide clam and still water, free from floating matter for water supply schemes.
   - Its main purpose is to provide canals and still water conditions so that comparatively pure water may be conveniently collected from the source.

4. **What are the properties of ductile iron pipe? (AU May 2014)**
   - High Tensile Strength
   - High Corrosion Resistant
   - Flexible and Leak Resistant
   - Durable Cement Mortar Lining
   - Excellent Workability

5. **Enlist the external forces acting on water transmission main if the pipe is laid under heavy traffic(AU May 2014)**
   - High water pressure
   - Heavy current
   - Forces from floating materials

6. **What is meant by economic diameter of a pumping main? (AU Nov 2014)**
   - The diameter corresponding to this minimum cost is known as the economic pipe diameter. The diameter of the pipe strongly influences the present value of the plant, through both the annual cost of electric power and the installation cost of the piping system.
   - For Yamuna River diameter of pumping main is 400mm. Several methods have been developed to provide quick estimates of the economic pipe diameter without going through detailed economic calculations.

7. **What are the two types of "Intake' according to their position? (AU May 2013)**
   - *Open or free-level intake*
   - *controlled level intake*
8. **How do you select pipe material for water supply (AU Nov 2012)**

   - Strength of pipe
   - Water carrying capacity
   - Durability

- Expenditure on transportation

9. **How will you calculate the total head in the design of pumps for water supply schemes? (AU May 2013)**

   Pump Design for Raw Water: The main factor that affects the pump design is the requirement of the total head for the pump. We calculate the total head using the following equation is

   Total Head = Static Head + Friction Head + Hammer Head. Based on Flow and Head requirement.

10. **What are various type pressure pipes?**

    a. Cast iron pipes
    b. Steel pipes
    c. Rick pipes
    d. Home steel pipe
    e.Vitrified clay pipes
    f. Asbestos cement pipes
    g. Miscellaneous type of pipes.

11. **What are types of joint?**

    a. Socket and spigot joint
    b.Flanged joint
    c. Mechanical joint called dresser coupling
    d.Flexible joints
    e. Expansion joints

12. **How the corrosion of metal pipes is reduced?**

    The corrosion of metal pipes can be reduced by following method
    a. Protective coating
    b. Selecting proper pipe material
    c. Quality of water
    d. Cathodic protection.

13. **What are the factors governing location of intake?**

    a. Intake structures are nearer to the treatment.
    b. Intake structures must never be located near the disposal of water.
    c. Intake structures should never be located near the navigation channel.
    d. There should be sufficient scope for future expansion.

14. **What are the types of intake?**

    1. Simple submerge intake.
    a. Simple concrete blocks.
    b. Rock fill timber blocks.

2. Intake structures.
a. Wet intake.
b. Dry intake.

15. What are vitrified clay pipes?

They are not generally used as pressure pipe for carrying because they are weak in tension. They are extensively used for carrying sewage and drainage at partial depth.

16. What are the advantages and disadvantages of RCC pipes?

Advantages:
a. They can resist excessive compressive load and do not collapse under normal vacuums.
b. They are not corroded from inside by normal portable water.

Disadvantages:
a. By means of acid they are corroded.
b. They cannot with stand very high pressure.

17. What are tube wells?

Tube wells which a long pipe or a tube is bored or drilled deep in to the ground.

18. What are the factors affecting per capita demand?

The factors affecting per capita demand are,
a. Climatic condition.
b. Habit of people.
c. Size of city.
d. Cost of water.
e. Industry.
f. Pressure in water tank.
g. Quantity of water.
h. System of sanitation.
i. Supply of system.

UNIT III

WATER TREATMENT

1) **Enumerate the mechanism of disinfection process? (AU April 2015)**
   - Water disinfection means the removal, deactivation or killing of pathogenic microorganisms. Microorganisms are destroyed or deactivated, resulting in termination of growth and reproduction. When microorganisms are not removed from drinking water, drinking water usage will cause people to fall ill. Sterilization is a process related to disinfection. However, during the sterilization process all present microorganisms are killed, both harmful and harmless microorganisms.

2) **What are the factors influencing settling of discrete particle? (AU April 2015)**
   - size (volume), mass, shape. particles that settle slower are more likely to remain suspended or get put back into suspension as the energy of the depositional environment increases, so high energy environments tend to only have those bigger, more massive particles, and only smaller, more easily suspended stuff will manage to migrate into lower energy evironments.
3) **What is the significance of velocity gradient in flash mixer?(AU April 2014) (AU Nov 2014)**
   - The **velocity gradient** is a measurement of the intensity of mixing in the chamber. The velocity gradient determines how much the water is agitated in the tank, and also determines how much energy is used to operate the flash mixer or flocculator.
4) **What is break point chlorination?(AU April 2014)**
   - Breakpoint chlorination is the point where the demand for chlorine has been fully satisfied in terms of chlorine addition to water.
   - When chlorine is added to water, a reaction is produced in the compounds present in the water. These compounds utilize the chlorine, resulting in zero chlorine residual.
5) **Define: Detention time and surface overflow rate for a sedimentation tank? (AU May 2013)**
   - The **surface overflow rate** is equal to the settling velocity of the smallest particle which the basin will remove. Surface loading is calculated by dividing the flow by the surface area of the tank. Overflow rate should usually be less than 1,000 gal/day-ft.^{2}
   - Detention time recommended in settling tank is 1 x 1.5 = 1.5 h
6) **What are tests to be done to find the residual chlorine in water? (AU May 2013)**
   - They are two different methods are available to estimate the residual chlorine as per our IS Code.
   - (i) Iodometric Method: This method is more precise than colorimetric method where residual concentration exceeds 1mg/L, but for lower concentration it is not so accurate.
   - (ii) Stabilized Neutral Ortho-Toluidine method: This method is useful to determine free available chlorine and combine chlorine. This method is sensitive to low residual chlorine concentrations.
7) **Distinguish between BOD and COD? (AU April 2012)**
   - BOD (Biological Oxygen Demand) means the amount of oxygen (in mg/l) microorganisms like bacteria need to 'eat' the organic pollution (sugars, fat, proteins). Note that not all pollution can be removed (eaten) by bacteria. BOD

value in polluted water is normally higher than the fresh water. Increased BOD can be resulted due to domestic sewage, petroleum residues and wastes of animals and crops.

- COD (Chemical Oxygen Demand) is the amount of oxygen required to degenerate all pollution in a chemical way (by adding oxidising agents and heating). In general with chemical destruction you can remove more pollution than with the biological way.
- As BOD is only a measurement of consumed oxygen by aquatic microorganisms to decompose or oxidize organic matter and COD refers the requirement of dissolved oxygen for the oxidation of organic and inorganic constituents both. Hence COD must be greater than BOD.

Name any two softwares used in design of sewers.(AU April 2012)

- EGOUT® software is a professional program used by environmental and civil engineers to design urban sewer systems. It helps you draw sewer plan in ACAD and design with EGOUT and draw profile of wastewater collection system. It provides tools for calculation all types of flows.

8) What are difference between Unit Operations and Unit Process?(AU Nov 2012)

- Unit process includes all the treatment methods in which the removal of contaminants is brought about by chemical or biological reactions. It is considered as a secondary treatment. While Unit Operation involves only the methods in which physical forces predominates. It is considered as primary treatment.

9) What are the advantages of chlorine as disinfectant?(AU Nov 2012)

- Chlorine is more cost-effective than other disinfection methods
- The chlorine residual that remains in the discharged wastewater can prolong disinfection even after initial treatment and also provides a measure of the effectiveness.
- Chlorine disinfection is reliable and effective against a wide spectrum of microorganisms.
- Flexible dosing enables greater control over disinfection since waste water characteristics vary from time to time.
- Chlorine can eliminate noxious odors while disinfecting

10) State the stokes equation for finding settling velocity of particles.(AU April 2011)

Calculate Terminal Velocity

$$V = \frac{g \times D^2 \times (d_p - d_m)}{18 \times v}$$

V = Terminal Velocity
D = Diameter Of a Particle

g = Acceleration Of Gravity
v = Viscosity Of Medium
d_p = Density Of Particle
d_m = Density Of Medium

11) On What factors does the dose of coagulants depend? (AU April 2011)

- The coagulant choice will depend on the conditions at the plant. The concentration of coagulant also depends on the water conditions, and a jar test can be used to determine the correct concentration to use at any given time. Coagulants are usually fed into the water using a gravimetric feeder or a metering pump. A **gravimetric feeder** feeds dry chemicals into the water by weight. A **metering pump** feeds a wet solution (a liquid) into the water by pumping a volume of solution with each stroke or rotation.

12) Give the design criteria for a flash mixer and state its use in water supply scheme. (AU Nov 2011)

- Static or flash mixer is used to mix chemicals into the water quickly. It does this by the turbulence created by the mixer.

- Design Criteria: **For flash mixing:** $G = (P/\mu\forall)^{.5}$ units p.88
  $GT=300\text{-}1600\ s^{-1}$

UNIT IV

ADVANCED WATER TREATMENT

1) What is meant by adsorption of isotherm? (AU April 2015)

- The process of Adsorption is usually studied through graphs known as Adsorption isotherm. It is the graph between the amounts of adsorbate (x) adsorbed on the surface of adsorbent (y) and pressure at content temperature. Different adsorption isotherms are,
  1. Freundlich isotherm
  2. Langmuir isotherm
  3. ET theory isotherm

2) List the different methods of defluoridation? (AU April 2015)

- Following treatment methods can be adapted to the remove the excess fluoride in water.
- (i) Nalgonda technique
- (ii) Treating with Activated alumina (called **Prashanti Technology**)
- (iii) Electro coagulation
- (iv) Reverse Osmosis Technique

3) How will you do regeneration of softener? (AU May 2014)

- In the zeolite softener, if the sodium molecule has been replaced by calcium and magnesium (present in the hard water), it is regenerated by first washing the softener with water, by reversing the flow and then treating it with 10% brine solution (NaCl Solution). The excess brine solution retained in the zeolite after the treatment is removed by again washing with good water. The regenerated zeolite can be used afresh for softening.

4) What do you mean by break point chlorination? (AU Nov 2014)

- Break point chlorination is defined as the process of extend of chlorine added to the water beyond which any further addition of chlorine will equally appear as free residual chlorine.

5) Mention the types of aerators used in the water treatment. (AU May 2013)

- Gravity (or Free Fall) Aerators
  a) Cascade Aerators
  b) Slat tray Aerators
  c) Gravel (or Trickling) Bed Aerators
  d) Inclined Apron Aerators
- Spray Aerator
- Air diffuser Tanks

6) Write any two effects of hardness in water. (AU May 2013)

- The hardness in water will scales in the boiler
- The hard water also greatly interferes with the dyeing works
- It makes food tasteless, tough or rubbery

7) Bring out the difference between self cleansing velocity and non-scouring velocity (AU April 2012)

- The flow velocity in the sewers should be such that the suspended materials in sewage do not get silted up; i.e. the velocity should be such as to cause automatic self-cleansing effect. The generation of such a minimum ***self cleansing velocity*** in the sewer, atleast once a day is important, because if certain deposition takes place and is not removed, it will obstruct free flow, causing further deposition and finally leading to the complete blocking of the sewer.
- The smooth interior surface of a sewer pipe gets scoured due to continuous abrasion caused by the suspended solids present in sewage. It is, therefore, necessary to limit the maximum velocity in the sewer pipe. This limiting or non-scouring velocity will mainly depend upon the material of the sewer.

8) What is the maximum permissible limit of fluoride in drinking water?(AU Nov 2012)

- The maximum permissible limit of fluoride in drinking water is 1 mg/l

9) How do you protect water treatment plants from corrosion?(AU Nov 2012)

- Pre treatment of water
- Use of non-corrosive metal coatings for plant
- Continuous maintenance of plants.

10) State the objectives of aeration process in water treatment.(AU April 2011) (AU Nov 2011)

- To remove the taste and odour (caused by gases produced due to the organic decomposition

- To increase D.O. (Dissolved Oxygen) content of the water
- To remove iron and manganese (by converting them into insoluble slats)
- To mix the chemicals along the air etc.

11) Mention any four methods of desalination process? (AU April 2011)

- a) Desalination by distillation
  b) Electro dialysis method
  c) Reverse osmosis system
  d) Freezing process

UNIT V

WATER DISTRIBUTION AND SUPPLY TO BUILDINGS

1) What are the requirements of a good water distribution system? (AU April 2015)

- The various requirements for proper functioning of a distribution system are given below.
  1. It should have the capability of supply the water with adequate pressures.
  2. The fire demand should meet out sufficiently.
  3. Purity of water should be maintained.
  4. It should be easy for operation and maintenance.
  5. Cost for operation, maintenance and reinstallation should be minimum.
  6. It should not make any disturbance to the surrounding nature.

2) List the major components of house service connection? (AU April 2015)

- 1. Ferrule
  2. Goose Neek
  3. Service Pipe
  4. Stop Cock or Curb Valve
  5. Water Meter

3) What is the function of service reservoir in distribution system? (AU May 2014)

- Following are the important functions of the service reservoir.
  1. Based on the hourly variation in demand, it directs the treatment units to operate at a uniform rate.
  2. Reservoirs maintain the pressure of water in water mains.
  3. Reservoirs supply the water during emergencies such as fires etc.
  4. It increases the pressure considerably in the case of elevated reservoirs.
  5. It reduces the overall cost reduction in pumping and makes the distribution system economical.

4) Name any two appurtenances used in water distribution system.(AU May 2014)

- Sluice Valves (or) Shut off valves (or) Gate Valves
- Non Return Valves (or) Check valves (or) Reflex valves
- Air Valves
- Drain Valves (or) Blow-off Valves (or) Scour Valves
- Safety Valves (or) Pressure Relief Valves
- Hydrants

- Meters

5) What are the requirements of water distribution system? (AU Nov 2014)

- It should have the capability of supply the water with adequate pressures.
- The fire demand should meet our sufficiently.
- Purity of water should be maintained.
- It should be easy for operation and maintenance
- Cost for operation, maintenance and reinstallation should be minimum.
- It should not make any disturbance to the surrounding nature.

6) Enumerate the methods of leak detection in water distribution system. (AU Nov 2014)

- Water Waste Surveys
- Leakage Location

7) What are the layouts of water distribution system. (AU May 2013)

- Radial System
- Dead End System (or Tree system)
- Grid Iron System (or Reticulation System)
- Circulation System (or Ring System)

8) What is "Ferrule" in house service connection. (AU May 2013)

- A Ferrule is a right angled sleeve made of brass, bronze or gun metal and its joint to a hole in the water main. The diameter of ferrule may varies from 1.5cm to 5cm. If the connection having more than 5cm dia, Tee branch connection may be used.

9) What is the purpose of providing trap in sanitary plumbing. (AU April 2012)

10) What is the role of computer applications in Water Supply Systems?(AU Nov 2012)

11) How do you identify leakage in pipeline?(AU Nov 2012)

1. Water Waste Surveys
2. Leakage Location

12) What factor control water supply to buildings?.(AU April 2011)

1. Pressure of water in the supply mains
2. Quantity of water available and required
3. System of water supply (continuous or intermittent)
4. Usage of overhead or underground tanks
5. Cost factors
6. Availability of power and pumping etc.

13) What is an equivalent pipe? (AU April 2011)

- An equivalent pipe is a single pipe will replace the all complex system of pipes with equal head loss for the given flow of water.

14) What do you mean by sanitary fitting. (AU Nov 2011)

- Sanitary fittings are defined as the accessories using sewage correction transmission and treatment units, to collect, regulate and control the series flow.

  Example: Wash Basin, Water closet, Valves, Urinals etc.

CE6503-ENVIRONMENTAL ENGINEERING I
PART 'B' & 'C' QUESTION BANK
UNIT I
PLANNING FOR WATER SUPPLY SYSTEM

1. Explain the different methods used for prediction of future population of a city, with reference to the design of a water supply system. **(AU April 2015)**
2. Discuss the various sources of water and give brief account of the characteristics of water. **(AU April 2015)**
3. Enumerate and explain the characteristics of surface and ground water and state their environmental significance**.(AU May 2014)**
4. The population of a town as per past census records are furnished below. Forecast the population in the year 2031 and 2041 Using the following methods: **(AU May 2014)**
   (i) Arithmetical increase method
   (ii) Geometrical increase method
   (iii) Incremental increase method

Census year	1941	1951	1961	1971	1981	1991	2001	2011
Population	44642	50487	56816	63859	71458	78543	88131	100290

5. The population of a town as per past census records are furnished below. Forecast the population in the year 2031 and 2041 Using the following methods: **(AU Dec 2014)**
   (iv) Arithmetical increase method
   (v) Geometrical increase method
   (vi) Incremental increase method

Census year	1941	1951	1961	1971	1981	1991	2001	2011
Population	35642	39487	46816	57859	70458	78543	92131	116500

6. (i) Discuss the factors to be considered in fixing the design periods for water supply components?
   (ii) Explain the various sources of surface and ground water? **(AU Dec 2014)**

7. Explain the different sources of water and their characteristics with respect to turbidity, Hardness, Chloride and microbiology. **(AU May 2013)**
8. (i) Write a note on water demand.
   (ii) In two periods each of 20 years a city has grown from 50000 to 110000 and 160000. Find the population expected in the next 20 years and also the saturation population. **(AU May 2013)**

UNIT II

CONVEYANCE SYSTEM

1. Mention the points which should be taken into consideration in deciding the location of and intake for the water supply of a large town, the source being a perennial river. Draw a neat sketch of a canal intake and explain the salient features.**(AU April 2015)**
2. (i) What are the factors to be considered in the selection of pipe material for water transmission?
   (ii) Describe the various joints used in the pipeline construction. (**AU April 2015)**
3. (i) What are the important considerations which govern the selection of site of an intake structure?
   (ii). Explain the salient features of river intake with the aid of a neat sketch.
   (AU May 2014)
4. (i) Describe the various pipe materials used in conveyance of water
   (ii) What factor are required to be considered in the selection of the type of a pump?
   (AU May 2014)
5. (a). In a water supply scheme to be designed for serving a population of 12 lakhs, the storage reservoir is situated at 9km away from the city and the loss of head from the source to city is 19.5m. Calculate the size of the supply main by using Darcy Weisbach formula as well as by using Hazen's formula assuming a maximum daily demand of 150 lpcd and 2/3 of the daily supply to be pumped in 10 hours. Assume friction factor (4f) for the pipe material as 0.005 in Weishbach formula and $C_H = 110$ in Hazen's formula.
   (AU Nov 2014)
6. (i) What are the important considerations, which govern the selection of site of an intake?
   (ii) Discuss the factors to be considered in the selection of pipe material for water transmission. **(AU Nov 2014)**
7. (i) What are the classification of intakes based on source also explain with a sketch any one of the intakes?
   (ii)What are the different pipe materials used in the water transmission? **(AU May 2013)**
8. (i) List the classification of pipe joints depending their ability to movement and briefly explain the factors that influence the decision on the type of joints.
   (ii). Write a note on pumps used in water supplier. **(AU May 2013)**
9. (i) What actions are required for sustainable development?
   (ii) What are the factors to be considered in the selection of source for water supply scheme? **(AU Apr 2012)**

UNIT III

WATER TREATMENT

1. Explain the various

(i) Design a flash mixer for a proposed water treatment plant with a capacity of 25ML/d and draw a neat sketch of the unit. (8)

(ii) Estimate the alum and quick lime requirements with reactions involved to treat 2ML/d of water with raw water alkalinity of 9mg/L as $CaCO_3$ if the alum dosage adopted was 40mg/L. (purity of quicklime – 80%).**(AU April 2015)** (8)

2. Briefly explain the mechanism of sand filtration. Draw a neat sketch of rapid sand filter unit and explain the working principle. **(AU April 2015)**

3. (i) Calculate the average chlorine required per day to treat 150ML/d of water. Also calculate the storage required for 60days. Assume an average chlorine dosage of 5mg/L. **(AU April 2014)** (4)

(iii) Explain the various unit operations and unit processes involved in water treatment (4)

4. A new township is to have a population of 5,00,000 and 90 Lpcd of water supply. Design a rapid sand filter unit with details of under drainage and water washing including gutter arrangement. Limit the maximum spent backwash water as 3.5% **(AU April 2014)** (12)

5. Design a clariflocculator for a proposed water treatment plant with a capacity of 80 Ml/d and draw a neat sketch of the unit.

6. (i) Draw the longitudinal section of a rectangular sedimentation tank indicating the various zones. (8)

(ii) The following data are corresponding to a clariflocculator find the volume of the flocculation and its diameter.

Detention: 30min, Depth: 3m, Outer diameter of the inlet shaft = 0.9m, Water to be treated: 10 ML/d **(AU May 2013)** (8)

7. (i) With a neat sketch (cross section) explain the working of a rapid wound filter.

(ii) Write a note on 'Break Point Chlorination' **(AU May 2013)** (8)

8. Design a sedimentation tank for water treatment plant to treat 8MLD of water. Assume a surface rate of $30m^3/m^2/day$. Check the adequacy of detention time. Draw the plan of the water treatment plant? **(AU Nov 2012)**

9. With the help of the diagram, explain the process of Rapid sand filter. **(AU Nov 2012)**

10. (i) Explain the sedimentation process used in water treatment plant. (8)

(ii) Sketch and explain break point chlorination **(AU April 2011)** (8)

11. Find the area of rapid sand filter required for a town having a population of 80,000 with an average rate of demand 180 lpcd. Assume suitable data for design. Draw the cross section of the designed filter. **(AU April 2011)**

12. (i) Discuss the sedimentation by coagulation process using alum and sate the merits and demerits of using alum. (8)

13. (ii) What are the methods of disinfection and state the quality requirements of a good disinfectant. **(AU Nov 2011)** (8)

14. Find the settling velocity of a particle of 0.06mm diameter having specific gravity of 2.65 in water at a temperature of 20^oC.Take kinematic velocity $\gamma=1.007 \times 10^{-6}$ m^2/sec.(8)

15. Design a slow sand filter for a town of population 6,00,000 persons, provided water supply at the rate of 160 litres/head/day. Take the filtration rate as 2.5 litres/minute.m^2, L/B ratio as 2, maximum demand as 1.8 times average demand. (8)

UNIT IV

ADVANCED WATER TREATMENT

1. Determine the volumes of cation and anion exchanger beds to demineralize 0.35ML/d water that has the following chemical quality.

Cations	Anions
Ca^{2+} = 30mg/L	HCO^-_3 = 50mg/L
Mg^{2+} = 5mg/L	SO^{2-}_4 = 45 mg/L
NA^+ = 25mg/L	Cl^- = 45 mg/L
K^+ = 10mg/L	NO^-_3 = 10 mg/L

The ion exchange capacities of cation and anion exchange resins are 70,000 and 40,000 g CaCO3/m^3 cycle, respectively, Also calculate the required quantities of regeneration chemicals. The regeneration cycle is once per day. **(AU April 2015)**

2. Describe various methods of removing excess iron and manganese from groundwater **(AU April 2015)**

3. Design a zeolite softner for an industrial establishment working for 2 shifts of 8 hours each for the following data and draw a neat sketch of the unit.

Soft water requirement = 2.5ML/d in 16 hours
Raw water hardness = 800mg/L as $CaCo_3$
Product water hardness = 50mg/L as $CaCo_3$
Exchange capacity of the resin = 35kg ($CaCo_3$) /m^3
Salt required for regeneration = 50kg (NaCl)/ m^3 of resin. **(AU Nov 2014)**

4. Draw a schematic diagram of a DM plant and explain the mechanism of cations as well as anions removal. Also briefly outline the design procedure. **(AU Nov 2014)**

5. (i) What are the effects of excess concentration of Fluoride in water and list the methods available for defluoridation and explain any one of them. (10)
(ii) write a note on iron removal from water for small communities **(AU May 2013)** (6)

6. (i) What are the types of hardness present in water? (4)
(ii) Explain the Ion exchange method of water softening with a sketch **(AU May 2013)**(12)

7. What is aerators? Explain different type of aerators with sketches **(AU Nov 2012)**

8. Write notes on (i) Membrane process (8)
(ii) Desalination. **(AU Nov 2012)** (8)

9. Describe the need for removal of Iron and Manganese from water. Explain the methods of removal of Iron and Manganese from water when present without combination with organic matter and in combination with organic matter. **(AU April 2011)**

10. Sketch and explain Zeolite process for the removal of permanent hardness from water. **(AU April 2011)**

11. Explain the activated carbon treatments and the pollutants removed and advantages of the process. **(AU Nov 2011)** (8)

12. Explain the following water treatments. **(AU Nov 2011)**

13. (i) Softening by lime-soda process (8)

(ii) Reverse osmosis and the residue management (8)

UNIT V

WATER DISTRIBUTION AND SUPPLY TO BUILDINGS

1. Find the flow in each pipe in the loop shown in Figure, Use Hardy Cross method for analyzing the Loop. Consider C_H as 110 for all pipes. **(AU April 2015)**

2. What are the functions of service reservoir? Briefly outline the design aspects of service reservoir? **(AU April 2015)**

3. Describe the various layouts of distribution network in a water supply system and state their advantages and disadvantages . **(AU May 2014) (AU Nov 2014)**

4. Draw a sketch of a water supply service connection from the Street main to a residential building and state the functions of each fitting. **(AU May 2014) (AU Nov 2014)**

5. (i) What are the general design guidelines for a water distribution system (8)

(ii) Briefly explain the house service connection with a sketch. **(AU May 2013)**(8)

6. Find the equivalent pipe AD for the network ABCD shown in the figure by equivalent pipe method. **(AU May 2013)**

7. State briefly the basic principle governing the design of water supply in buildings with particular reference to the quantity of flow, the determination of pipe sizes and the layout of the pipe system. **(AU April 2012)**

8. (i) Describe with the help of sketches various types of joints used in water supply pipeline. (10)

(ii) Explain the procedure for backfilling the trenches. **(AU April 2012)** (6)

9. Discuss with neat sketches the various types of layout of distribution system **(AU Nov 2012)**

10. Discuss the various possible water distribution arrangements in multi storage buildings. **(AU Nov 2012)**

V.S.B. ENGINEERING COLLEGE, KARUR
DEPARTMENT OF CIVIL ENGINEERING

Year/Semester : III / V – 'A' & 'B' Section
Subject Code & Name : CE 6504 – HIGHWAY ENGINEERING

PART 'A' QUESTIONS BANK
UNIT I
HIGHWAY PLANNING AND ALIGNMENT

1. What is meant by "TRANSPORTATION"?

Transportation engineering is a branch of engineering dealing with planning, designing, estimation, construction, operation, maintenance, rehabilitation and management of transportation infrastructure for movement of people and goods from one place to the other safely, timely, conveniently, comfortably, economically by using various modes like highways, railways, air ways, water ways and pipe ways also.

2. List out the modes of transportation.

- Land
- Water and
- Air

3. What is the importance of jayakar committee?

In the year 1927 the Indian Roads and Transport Develoment Association (IRTDA) was set up with a view to study the transport problems of the country and recommend improvement. At the recommendations of IRTDA, Mr. M.R.Jayakar was appointed as the Chairman by the Central Government for a committee to look into the road development in India and submit a report. This committee is generally referred to as Jayakar committee.

4. What are the objectives of Central Road Fund?

As per the recommendations of Jayakar Committee a "Central Road Fund" was created in 1st March 1929. The consumers of petrol were then charged an extra levy of 2.64 paise per litre. Twenty percent of the revenue collected through the fund was retained as Central Reserve and the balance allotted to the various states based on the actual petrol consumptions.

5. What are the objectives of Indian Road Congress?

- To promote and encourage the science and practice of construction and maintenance of roads.
- To suggest improved methods of administration, planning design,construction, operation,use and maintenance of roads.
- To promote the use of standard specifications and to propose specifications.
- To advise regarding education, libraries,research connected works, like publication, etc.

6. What are the main factors for consideration in third twenty year road development programme?

- Growth of Industry and agriculture
- Requirements of hills, deserts and coastal areas
- Expansion of tourism
- Rural and Urban development
- Environmental consideration

7. Write a short note about National Transport Policy Committee.

- It was formed by central government in 1978 to prepare a comprehensive national transport policy for the country.
- Report was submitted in 1980.
- Major recommendations in the report are accepted by central government.
- Some important recommendations are regarding strengthening of existing
- NH'S, development plans, maintenance of NH, funds required for development.

8. What are the objectives of highway research board?

- To collect and analyze results on research
- To coordinate and conduct the correlation services in transport research
- To evaluate the nature and extend of research required.
- To regulate the consultive services

9. State the names of various patterns of the road.

- Rectangular or block pattern
- Radial or star block pattern
- Radial or star circular pattern
- Radial or star grid pattern
- Hexagonal pattern
- Minimum travel pattern

10. Mention the functions of medians in urban roads.

- To avoid the head-on collision between vehicles moving in opposite direction
- To channelize the traffic in to streams at intersections
- To provide protection for pedestrians
- To separate slow moving traffic

11. What is BOT project?

- BOT means Build, Operate and Transfer.
- It is public private partnership model where a private organization is given responsibility of construction and operation of roads and then the control is transferred to the government.

12. How length of National Highways has to be computed as per 3rd road development plan?

4. As per 3rd road development plan, the National Highways are designed based on the concept of 1km length per 50 sq.km area.
5. Hence the total length of NH in an area can be calculated by dividing the total area by 50.

13. What is the objective of highway planning?

- To create awareness of unforeseen events changed policies and other current developments.
- To prepare a plan in such a way that traffic operations are carried out efficiently.
- To assist the general planner for serving what transportation demands.

14. Define the role of IRC.

Indian Road Congress (IRC) was constituted to provide a forum for regular pooling of experience and ideas on all matters affecting the planning construction and maintenance of roads in India.

15. Define the main objectives of CRRI.

- To carry out the basic and applied research for investigation, design, construction and maintenance of different types of roads and runways.
- To carry out research on road traffic and transportation, including traffic safety and transport economics.
- To render technical advice and consultancy services to various organizations.

16. What are the classifications of urban roads?

- Arterial roads
- Sub-arterial roads
- Collector roads and
- Local roads.

17. What are the different classifications of roads according to Nagpur road plan?

- National highways (NH)
- State highways (SH)
- District highways (DH)
- Major district roads (MDR)
- Other district roads (ODR)
- Village roads (VR)

18. List twenty-year road development plans.

- Nagpur plan (1941 -61)
- Bombay plan (1961 -81)
- Road development plan (1980 -2001)
- Road development plan (2001 -2021)

19. What are ideal alignment and its requirements?

The course or position of the centre line of the highway on ground is called highway alignment **Requirements:**

- Short
- Easy
- Safe
- Economical

20. What is road ecology?

Road ecology is a relatively new sub discipline of ecology that focuses on understanding the interactions between road systems and the natural environment.

21. What are the factors controlling highway alignment?

- Obligatory points
- Traffic
- Geometric design
- Economics
- Other considerations

22. Define obligatory point.

The controlling points which govern the highway alignment are known as obligatory points and they are mainly responsible for the deviation of highway from its straight location.

UNIT II
Geometric Design of Highway

5. What do you understand by geometric design?

The geometric design of highway deals with the dimensions and layout of visible features of the highway such as alignment sight distance and intersections. The geometrics of highway should be designed to provide optimum efficiency in traffic operations.

2. What are the elements in Geometric design?

- Cross section elements
- Sight distance considerations
- Horizontal alignment details
- Vertical alignment details
- Intersection elements
-

3. Define right of way.

RoW is the area of land acquired for the road along its alignment. The width of this acquired land is known as land width and its depends on the importance of the road and possible future development.

4. Define camber.

Camber (or) cross slope is the slope provided to the road surface in the transverse direction to drain off the rain water from the road surface.

5. Define carriage way or width of pavement.

The pavement or carriage way width depends on the width of traffic lane and number of lanes. The carriage way intended for one line of traffic movement may be called a traffic lane.

6. What is mean by sight distance?

Sight distance available from a point is the actual distance along the road surface. Which a driver from a specified height above the carriage way has visibility of stationary or moving objects. In other words sight distance is the length of road visible ahead to the driver at any distance.

7. Define SSD.

Stopping sight distance is also called non-passing sight distance.

SSD is the minimum sight distance available on a highway at any spot having sufficient length to enable the driver to stop a vehicle travelling at design speed, safely without collision in event of any obstruction.

8. Define passing sight distance or OSD.

Overtaking sight distance is also called passing sight distance.

Overtaking Sight Distance is the minimum distance open to the vision of the driver of

a vehicle intending to overtake the slow moving vehicle ahead safely against the traffic in opposite direction.

9. What are the factors affecting sight distance?

- Reaction time of the driver
- Speed of the vehicle
- Efficiency of brakes
- Frictional resistance between the tyre and the road
- Gradient of the road

10. What is PCU?

- PCU is passenger Car Unit
- For traffic analysis, all vehicles are converted to car by multiplying with their PCU value.

  Eg: PCU for Bus – 3, two wheeler – 0.75.

11. Define traffic density.

Traffic density is defined as the number of vehicles occupying a unit length of roadway at a given instant and is expressed in vehicles per kilometer.

12. Define Super elevation.

To counteract the effect of centrifugal force and reduce the tendency of the vehicle to overturn or skid, the outer edge of the pavement is raised with respect to the inner edge, thus providing a transverse slope throughout the length of the horizontal curve. This transverse inclination to the pavement surface is known as super elevation.

13. What are the four parts of PIEV theory?

- perception
- Intellection
- Emotion
- Volition

14. What is total reaction time?

Reaction time of the driver is the time taken from the instant the object is visible to the driver to the instant the brakes are effectively applied. The total reaction time may be split up into two parts:

Perception time
Brake reaction time

15. What is setback distance?

Setback distance or the clearance distance is the distance required from the centerline of a horizontal curve to an obstruction on the inner side of the curve to provide adequate sight distance at a horizontal curve.

16. What are the factors affecting the design of curve?

- Design speed of the vehicle
- Allowable friction
- Maximum allowable super elevation
- Permissible centrifugal ratio

17. What is meant by extra widening at curves?

Extra widening refers to the additional width of carriageway that is required on a curved section of a road over and above that required on a straight alignment.

18. Define gradient.

Gradient is the rate of rise or fall along the length of the road with respect to the horizontal. It is expressed as a ratio of 1 in X. Sometimes the gradient is also expressed as a percentage.

19. Define limiting gradient.

This gradient is adopted when the ruling gradient results in enormous increase in cost of construction. On rolling terrain and hilly terrain it may be frequently necessary to adopt limiting gradient. But the length of the limiting gradient stretches should be limited and must be sandwiched by either straight roads or easier grades.

20. Define vertical curves and categories of vertical curves?

The vertical alignment of highway is necessary to introduce vertical curve at the intersections of different grades to smoothen out the vertical profile and thus ease off the change in gradient for the fast moving vehicles.

Categories:

- Summit or Crests curves
- Valley or sag curve

UNIT III
DESIGN OF FLEXIBLE AND RIGID PAVEMENTS

1. Define pavement.

- Highway pavement is a structure consisting of superimposed layers of processed materials above the natural soil sub-grade, whose primary function is to distribute the applied vehicle loads to the sub-grade.
- The pavement structure should be able to provide a surface of acceptable riding quality, adequate skid resistance, favourable light reflecting characteristics, and low noise pollution.

2. What is rigidity factor in design for highway pavement?

The ratio of contact pressure to the tyre pressure is called Rigidity Factor.

3. Define 'ESWL' (Equivalent Single Wheel Load).

Equivalent Single Wheel Load (ESWL) is the single wheel load having same contact pressure which produces the same value of maximum stress, deflection, tensile stress or contact pressure at desired depth.

4. How do you calculate the ESWL at a given depth below the pavement for a dual wheel assembly?

- ESWL for any depth can be calculated using the following formula.

$$\log_{10} ESWL = \log_{10} P + \frac{0.301 \log_{10}\left(\frac{z}{d/2}\right)}{\log_{10}\left(\frac{2S}{d/2}\right)}$$

- At any depth greater than 2S, the stress due to dual wheel is considered to be equivalent to a single load of magnitude 2P.

5. Define rigid pavement.

Rigid Pavement is defined as the highway pavements with high flexural strength, against the action of loads. These are made of cement concrete and pre-stressed concrete slabs.

6. What is meant by flexible pavements?

Flexible pavements are those, which on the whole have low or negligible flexural strength and are rather flexible in their structural action under the loads. The flexible pavements layer reflects the deformation of the lower layers on to the surface of the layer.

7. What are the factors affecting stability of pavement?

- Traffic factors
- Moisture factors
- Climatic factors
- Soil factors
- Stress dissipation factors

8. What are the components in flexible pavements?

A typical flexible pavement consists of four components
Soil sub grade
Sub base course
Base course
Surface course

9. State the function of wearing course.

- To provide a smooth surface for the traffic
- To drain away rain water
- To act as a cushion between the wheels and base
- To provide resistance against wear and tear

10. Compare flexible and rigid pavements

Flexible pavement	Rigid Pavement
(i) Deformation in the sub grade is transferred to the upper layers (ii) Design is based on load distributing characteristics of the component layers (iii) Have low Flexural strength (iv) Load is transferred by grain to grain contact (v) Have low completion cost but repairing cost is high (vi) Have low life span	(i) Deformation in the sub grade is not transferred to the subsequent layers. (ii) Design is based on flexural strength or slab action. (iii) Have high Flexural strength (iv) No such phenomenon of grain to grain load transfer exists. (v) Have low repairing cost but completion is high (vi) Have high life span

11. What are the factors considered in design of pavements?

The various factors to be considered for the design of pavements are given below

- Design wheel load
- Sub grade soil
- Climatic factors
- Pavement component materials
- Environment factors
- Special factors in the design of different types of pavements.

12. What are the drawbacks of CBR method?

- Same design procedure is used for dual carriageway and multi-lane single carriageway and there is no difference in design procedure for them.

- The design curve provides only the total thickness of the pavement and did not specify the thickness of sub base, base and surface separately.
- The design permits the equivalency factor of up to 2 for flexible pavement. it is not the suitable design of various bases and each one need to be evaluated.

13. What are the tests available to evaluate the soil strength?

1. CBR test
2. CRV test
3. Tri-axial compression test
4. Plate-bearing test.

14. What are the factors considered in design of pavement?

- Design wheel load
- Sub grade soil
- Climatic factors
- Pavement component materials
- Environmental factors
- Special factors in the design of different types of pavements.

15. Define critical load positions.

Since the pavement slab has finite length and width, either the character or the intensity of maximum stress induced by the application of a given traffic load is dependent on the location of the load on the pavement surface.

16. What are the types of loading?

Interior loading--- When load is applied in the interior of the slab surface
Edge loading-- when load is applied in an edge of the slab
Corner loading-- when the centre of the load application is located on the bisector of the corner angle formed by two intersecting edges of the slab.

17. What types of join provided in cement concrete pavement?

- Expansion joint
- Contraction joint
- Warping joint

18. Write the importance of California bearing ratio?

- It is the best suitable method for evaluating the stability of soil sub grade and other flexible pavement materials.
- The test results have been correlated, for highways and sir fields.

19. Define Embankment.

It is required to raise the grade line of a highway above the existing ground level it becomes necessary to construct embankments.

The design elements in embankment are

- Height
- Fill material
- Settlement
- Stability of foundation
- Stability of slopes

20. Discuss about the temperature and warping stresses.

Temperature stresses are developed in cement concrete pavement due to variation in slab temperature. During the day, the top of the pavement slab gets heated under the sunlight when the bottom of slab still remains colder.

Warping stresses, whenever the top and bottom surface of a concrete pavement possess different temperature, the slab tends to wrap downward or upward including warping stresses.

UNIT-IV
HIGHWAY CONSTRUCTION MATERIALS AND PRACTICE

1. What are the desirable properties of soil?

- Stability
- Incompressibility
- Permanency of strength
- Minimum changes in volume and stability
- Good drainage
- Ease of compaction

2. What is the use of plate bearing test?

- The plate bearing test is used to evaluate the supporting power of sub grade for use in pavement design by using relatively large diameter plates.
- The plate bearing test was originally devised to find the modulus of sub grade reaction in the westergaards analysis for wheel load stress in cement concrete pavements.

3. What are the desirable properties of aggregates?

- Strength
- Hardness
- Toughness
- Durability
- Shape of aggregates
- Adhesion with bitumen

4. What are the important functions of pavement?

- To distribute the traffic load over the sub-grade soil.
- To provide good riding surface.
- To protect the sub-grade from climatic effects.

5. What are the limitations of C.B.R test?

- It cannot be used to evaluate the soil properties like cohesion or angle of internal friction or shearing resistance.
- Materials passing through 20mm sieve can only be used for this test.
- If the test sample consists of coarse grained particles, then obtained results are not so suitable for proper designing of pavements.

6. Define 'Flakiness Index'.

Flakiness index is defined as the percentage by weight of particles whose least dimension/thickness is less than $3/5^{th}$ or 0.6 of their mean dimension. It can be measured by using thickness gauge.

7. Define 'Elongation Index'.

Elongation index is defined as the percentage by weight of particles whose greatest dimension or length is greater than $1\ 4/5^{th}$ or 1.8 times their mean dimension. It can be calculated by using length gauge.

8. Define flaky aggregates.

Angular aggregates and their thickness are small, when compared to their width or

length is called Flaky aggregates.
Eg: Laminate rocks.

11. Differentiate between prime coat and tack coat in bituminous construction.

Prime Coat	Tack Coat
Applied to create bonding between base layer and bitumen layer	Applied to create bonding between bitumen layers.
Application of low viscosity cut backs as primer on existing base layer	Application of low viscosity liquid bitumen to an existing bituminous layer
Sprayed at an uniform rate of 7.3kg to 14.6 kg per 10 sq.m	Sprayed at an uniform rate of 5kg to 10kg per sq.m
Rate of spraying depends on porosity of the surface	Rate of spraying depends on the type of the surface

12. What is the purpose of applying prime coat?

- To plug the capillary voids and to act as a water proofing agent for existing base.
- To provide best bonding between existing granular layer and new bitumen layer.

13. Why joints are provided in rigid pavements?

- To absorb the expansion and contraction due to change of temperature.
- To avoid warping of concrete slab at edges.
- To provide continuity for concrete laying.

14. What are the requirements of ideal joints?

- Should be easy to maintain
- Moves freely without stress development
- Should not allow infiltration of water
- Should be convenient to road users.
- Should be in level with the surface

15. Differentiate between tar and bitumen

Factors	Tar	Bitumen
Source	Obtained from destructive distillation of coal or wood	Derived from naturally occurring petroleum
Solubility	Soluble in carbon-disulphide and carbon tetrachloride	Soluble only in toluene
Colour	Black	Black or brownish black

16. What is cutback bitumen?

Cutback is the materials in which the viscosity of bitumen is reduced by volatile diluents. The distillates used for preparation of cutback bitumen are naphtha, kerosene, diesel oil, and furnace oil. There are different types of cutback bitumen like rapid curing (RC), medium curing (MC), and slow curing (SC).

17. Define emulsion.

Emulsion is when bitumen is suspended in a finely divided condition in an aqueous medium and stabilized with an emulsifier. The bitumen content in the emulsion is around 60% and the

remaining is water.

18. Write short notes on Modified bitumen.

Certain additives or blend of additives called as bitumen modifiers can improve properties of bitumen and bituminous mixers. Bitumen treated with these modifiers is known as modified bitumen. Polymer modified bitumen should be used only in wearing course depending upon the requirements of extreme climatic variations.

19. Define highway drainage and its types.

Highway drainage is the process of removing and controlling excess surface and subsoil water within the right of way.

Types:

- Surface drainage
- Sub surface drainage

20. What materials used as joint filler?

- Soft wood
- Impregnated fiber board
- Cork or Cork bound with bitumen
- Coir fiber

UNIT V
EVALUATION AND MAINTENANCE OF PAVEMENTS

1. What are the reasons for the pavement defects?

- Increase in traffic
- Environmental changes
- Design and construction deficiencies
- Maintenance deficiencies

2. What are the reasons for development of edge cracks in flexible pavements?

- Poor drainage
- Inadequate lateral support
- In-sufficient pavement width

3. Define plastic deformation

If applied stress is excessive than the stability of sub grade and if the plastic flow takes place, then it is called plastic deformation.

4. Define Warping

Warping is the bending of the concrete slab due to uneven expansion or contraction of top and bottom slab surfaces. It is caused by any differences in temperature above and below the slab or caused by moisture differences.

5. What are the reasons for disintegration of flexible pavement?

Improper mix design

Heavy rainfall or moisture content

Poor construction and poor materials

Poor compaction

Insufficient binder

6. What is unevenness index?

Unevenness index is defined as the cumulative measure of vertical undulations of the pavement surface, recorded per unit length of the road. It can be measured by using Bump Integerator.

7. What is mud pumping?

- Mud pumping is the rigid pavement failure
- It happens when water is infiltrated through the cracks, joints and edges of the rigid pavement.
- The water will form soil slurry and it gets ejected when heavy load passes through the cracks or joints.

8. What is spalling in rigid pavement?

Spalling is the breakdown or disintegration of slab edges at joints or at cracks or directly over the reinforcing steel and generally due to the breakdown of pavement joint edges from traffic action.

9. What are the causes of scaling?

- Over vibration of concrete
- Presence of chemical impurities

10. What is mud-jacking?

Mud-jacking is the repairing method of c.c or rigid pavements, in which the raising of settled cement concrete slab or filling a void beneath the slab is done with cement grout.

10. State the remedial measures in rigid pavement for edge cracks.

Application of sealants

Application of epoxy resin

Proper designing method

11. What are the general problems in earthern roads?

Formation of ruts in longitudinal direction along the wheel path of slow moving vehicles.

Formation of dust in dry weather.

12. What is Alligator crack?

Alligator cracks are caused by the repeated application of heavy wheel loads resulting in fatigue failure or due to the moisture variations resulting in swelling and shrinkage of sub grade and other pavement materials.

13. Mention the types of skidding.

- Straight skidding
- Impending skidding
- Sideway skidding

14. Define pavement roughness index.

Pavement roughness index is defined as the grading of irregularities in the pavement surface that adversely affect the riding quality of a vehicle. It is used to prepare the guidelines for measuring roughness on a standard scale.

15. What is pavement serviceability?

It is defined as the evaluation of pavement in terms of surface unevenness, patching and cracking etc., It is used to analyze the riding quality of pavement.

16. Differentiate Pumping and Raveling.

Pumping	Raveling
The ejection of water and fine materials under pressure through cracks under moving loads.	The wearing away of the pavement surface caused by the loss of binder or the dislodging of aggregate particle or both.

17. What are the failures in rigid pavement?

- Scalling of cement concrete
- Shrinkage cracks
- Spalling of joints
- Warping cracks
- Mud pumping
- Structural cracks

18. Give some typical flexible pavement failures?

- Alligator cracking
- Consolidation of pavement layers
- Shear failure
- Longitudinal cracking
- Frost heaving
- Lack of binding
- Reflection cracking
- Formation of waves and corrugation

19. What is FWD and state its use?

A falling weight deflectometer (FWD) is a testing device used to evaluate the physical properties of pavement. FWD data is primilarily used to estimate pavement structural capacity for overlay design and to determine if a pavement is being overload. FWD is used in highways, local roads, airport pavements, harbor areas and railway tracks.

CE6504-HIGHWAY ENGINEERING
PART 'B' & 'C' QUESTION BANK

UNIT 1
HIGHWAY PLANNING AND ALIGNMENT

1. History of highway development in India. **(16mark)(University repeated questions)**
2. Soil suitability analysis. **(8 mark)**
3. National level institution in highway (IRC, CRRI,MORTH,NHAI,HRB) **(8 mark)(University repeated questions)**
4. Factors influencing in highway alignment. **(8 mark)**
5. Modal limitations towards sustainability. **(8 mark)**
6. Conventional methods (old method) and non- conventional methods (modern method) **(16mark)(University repeated questions)**
7. Ideal alignment and requirements. **(8 mark) (University repeated questions)**
8. Classification of highways. **(8mark)**

UNIT 2
GEOMETRIC DESIGN OF HIGHWAY

1. TypicalCross sectional elements. **(8mark) (University repeated questions)**
2. Super elevation derivation**. (8 mark) (University repeated questions)**
3**.** Sight distance and types. **(8 mark) (University repeated questions)**
4. Super elevation problem. **(8 mark)**
5. Overtaking sight distance problem (OSD)**(8 mark) (University repeated questions)**
6. Stopping sight distance problem (SSD). **(8 mark)**
7. Extra Widening (Mechanical and psychological widening) **(8 mark)**
8. Length of valley curve. **(8 mark) (University repeated questions)**
9.Consideration for hill roads – Hairpin bends. **(8 mark) (University repeated questions)**
10.Lateral and vertical clearance at underpasses. **(8 mark)**

UNIT 3
DESIGN OF FLEXIBLE AND RIGID PAVEMENTS

1. Design factors. (8mark)**(University repeated questions)**
2. Design of flexible pavement. **(8mark)(University repeated questions)**
3. Design of rigid pavement. **(8mark)(University repeated questions)**
4. ESWL (Equivalent single wheel load).**(8mark)(University repeated questions)**
5. Critical load point and problems (Interior, edge, corner problem)**(8mark)(University repeated questions)**

UNIT 4
HIGHWAY CONSTRUCTION MATERIALS AND PRACTICE

1. Soil and test. **(8mark)**
2. Aggregates and tests**. (16 mark)(University repeated questions)**
3. Bitumen and tests. **(16 mark)(University repeated questions)**
4. Abrasion test, flash and fire point test, softening test. **(8mark)(University repeated questions)**
5. Constructionprocedure of bituminous and cement concrete. **(8mark)(University repeated questions)**
6. Modern Materials (glass, fiber, Geo-Membrane, geotextiles and plastics) **(8mark)(University repeated questions)**
7. Quality control measure. **(8mark)**
8. Highway drainage and types. **(8mark)(University repeated questions)**
9. Construction machineries. **(8mark)(University repeated questions)**

UNIT 5
EVALUATION AND MAINTENANCE OF PAVEMENTS

1. Failures of flexible pavements. **(16mark)(University repeated questions)**
2. Failures of rigid pavements. **(16mark)(University repeated questions)**
3. Pavement evaluation and strengthening.**(8mark)(University repeated questions)**
4. Benkelman beam method.**(8mark)(University repeated questions)**
5. Maintenance and repairs. **(16mark)(University repeated questions)**
6. Maintenance of bituminous road**. (8mark)(University repeated questions)**
7. Maintenance of cement concrete road.**(8mark)(University repeated questions)**
8. Highway project formulation.**(16mark)**

V.S.B. ENGINEERING COLLEGE, KARUR
DEPARTMENT OF CIVIL ENGINEERING

Year/Semester : III / V – 'A' & 'B' Section
Subject Code & Name : CE 6504 – Design of Reinforced Concrete Elements

PART 'A' QUESTIONS BANK
UNIT I
METHODS OF DESIGN OF CONCRETE STRUCTURES

1. **What are the advantages of elastic method? (Nov/Dec 2014)**
   - The design usually results in relatively large sections of structural members, compared to ultimate load. Due to this, structures designed by working stress method give better serviceability performance under working loads.
   - This method is the only method available when one has to investigate reinforced concrete section for service stresses and for the serviceability state of deflection and cracking.
   - Working stress method or elastic method of design is used for the design of retaining walls, water tanks, bridge piers where strength of materials affected due to water or soil conditions.
2. **Write any two assumptions of limit state method. (Nov/Dec 2011) (Nov/Dec 2014)**
   - Plane sections normal to the axis remain plane after bending.
   - The maximum stain in concrete at the outermost compression fiber is taken as 0.0035 in bending.
   - For design purpose, the compressive strength of concrete in the structure shall be assumed to be 0.67 times the characteristic strength. The partial safety factor, (γ_m) = 1.5 shall be applied in addition to this.
3. **State the important factors to be considered while designing structural elements.**
   The important factors to be considered while designing structural elements are
   - Strength
   - Serviceability
   - Durability
   - Fire Resistance
4. **What are the different types of loads that have to be considered in the design of a building?**
   - Dead Load
   - Live Load
   - Wind Load
   - Snow Load
   - Earthquake Load
5. **What are the different methods of design used in the design of RC structures?**
   - Working Stress Method or Modular Ratio Method.
   - Ultimate Load Method or Load Factor Method
   - Limit State Method

6. **What is meant by Working Stress Method?**
   Working Stress Method is based on elastic theory in which the materials (concrete and steel), are assumed to be stressed well below the elastic limit under the design loads.

7. **What are the assumptions in Working Stress Method?**

The fundamental assumptions involved in the method based on elastic theory are:

- At any cross-section, plane sections before bending remain plane after bending.
- All tensile stresses are taken up by the reinforcements and none by concrete.
- The stress-strain relationship of steel and concrete under working load is linear.
- There is proper bond between steel and concrete.
- The factor of safety for concrete in bending compression is 3.
- The factor of safety for steel in bending tension is 1.8
- The modular ratio 'm' has the value $280/3\sigma cbc$
  Where σcbc is the maximum permissible stress due to bending in concrete in N/mm^2

8. **What is modular ratio?**

- The ratio of modulus of elasticity of steel (Es) to the modulus of elasticity of concrete (Ec) is called as modular ratio and it is denoted by the symbol m.
- According to IS code the modular ration 'm' has the value of $280/3\sigma cbc$

9. **What is equal area section?**

The area of concrete plus modular ratio times area of steel whether tension or compression, is called as Equivalent area of section.

10. **State the advantages of Limit State Method over other methods.**

- In the Limit State Method of analysis, the principles of both elastic as well as plastic theories used and hence suitable for concrete structures.
- The structure designed by limit state method is safe and serviceable under design loads and at the same time it is ensured that the structure does not collapse even under the worst possible loading condition.
- The process of stress redistribution, moment redistribution etc is considered in the analysis and more realistic factor of safety values are used in the design. Hence the design by limit state method is found to be more economical.
- The overall size of flexural members (depth requirements) arrived by limit state method are less and hence they provide better appearance to the structure.
- Because of the modified assumptions regarding the maximum compressive strains in concrete and steel, the design of compressive reinforcement for double reinforced beams and eccentrically loaded columns by limit state method gives realistic valued which is not so in other methods

11. **State the different limit states.**

- Limit State of Collapse
  - Flexure
  - Compression
  - Shear and Torsion
- Limit State of Serviceability
  - Deflection
  - Cracking
- Limit State of Durability
  - Fire Resistance
  - Environmental and chemical actions

12. **List out the disadvantages of working stress method?**

- This method deals with only the elastic behavior of the structure. It will not show its real strength or the true factor of safety against failure.
- The modular ratio itself is an imaginary quantity. It will give larger design, thus resulting in uneconomical sections with compression members when compression steel is used in bending members.
- Due to creep and non-linear stress- strain relationship concrete does not have a fixed young's modulus as in steel.
- The working stress method fails to discriminate between different types of loads that act simultaneously but have different uncertainties.

13. Define factor of safety.

The factor of safety is defined as the factor by which the yield stress of the material is divided to give the working stress (permission stress) in the material.

14. Define Ultimate Load design method. (Nov/Dec 2013)

This method is based on the ultimate strength, when the design member would fail. It is otherwise called as load factor method or ultimate strength method. The structure is designed to resist the desired loads. In this method factor of safety is taken into account only on loads. And is called load factor. This method gives more economical design of beam and columns by comparing elastic method.

15. Differentiate between WSD and LSD.

Working Stress Method.

- The stresses in an element is obtained from the working loads and compared with permissible stresses.
- The method follows linear stress-strain behavior of both the materials.
- Modular ratio can be used to determine allowable stresses.
- Material capabilities are under estimated to large extent. Factor of safety are used in working stress method.
- Ultimate load carrying capacity cannot be predicted accurately.
- The main drawback of this method is uneconomical.

Limit State Method

- The stresses are obtained from design loads and compared with design strength.
- In this method, it follows linear strain relationship but not linear stress relationship.
- The ultimate stresses of materials itself are used as allowable stresses.
- The material capabilities are not under estimated as much as they are in working stress method. Partial safety factors are used in limit state method.
- It shall also satisfy the serviceability requirements, such as limitations on deflection and cracking.

16. What are the expression recommended by the IS 456-2000 for Modulus of Elasticity and flexural strength? (May/June 2009)

i. From clause 6.2.3.1 of IS 456-2000,
   - Modulus of elasticity of concrete, E_c (N/mm^2) = $5000\sqrt{fck}$

ii. From clause 6.2.2, of IS 456-2000,
   - Flexural strength of concrete, f_{cr} (N/mm^2) = $0.7\sqrt{fck}$

17. What are the classifications available in serviceability limit state? (Nov/Dec 2011)

- Limit State of serviceability includes,
  - Deflection
  - Cracking

18. Working stress method is unrealistic in many ways. Justify with any two points. (Nov/Dec 2013)

- In working stress method, factor of safety is taken into account only on stress in materials, not on loads.
- Material capabilities are under estimated to large extent.
- Working stress method only deals with serviceability such as deflection, crack and vibration
- The main drawback of this method is uneconomical.

19. Write down the value of partial safety factor for a) concrete b) steel. (Nov/Dec 2007)

Partial safety factor for concrete (γ_c) = 1.5

Partial safety factor for steel (γ_s) = 1.15

20. Define Partial safety factor. (May/June 2007)

It is the ratio between design load and characteristic load.

Partial safety factor (γ_f) = Design Load / Characteristic Load

20. What are the imposed loads on buildings?

Examples of imposed loads on buildings are: the weights of its occupants, furniture, machinery, wind pressure, weight of snow, retained earth or water and the forces caused by thermal expansion or shrinkage of concrete.

21. Write the formula for the neutral axis depth factor 'k' in working stress design.

Neutral axis depth factor, $k = \dfrac{1}{\left(\dfrac{\sigma st}{m\ \sigma cbc}\right)+1}$

Where σ_{st} = Permissible stress in steel in tension

σ_{cbc} = Permissible stress in concrete in bending compression

22. Write the formula for the lever arm depth factor 'j' in working stress design.

Lever arm factor, j = 1 – k/3

Where k = neutral axis depth factor.

23. What are the factors considered limit state of serviceability?

Limit State of serviceability includes,

- Deflection
- Cracking
- Durability
- Vibration
- Fatigue
- Fire resistance

24. What is SP-34, SP-24 and SP16?

- SP-34 – 1987 – "Handbook on concrete reinforcement and detailing"
- SP-24 – "Explanary handbook on IS456-2000"
- SP-16 – 1980 - "Design aids for reinforced concrete to IS456-1978"

25. What are the factors considered in limit state of collapse?

The limit states of collapse includes,

- Flexure
- Compression
- Shear
- Torsion

26. Define design load.

The partial safety factor for loads is a load factor which is multiplied to characteristic load, gives the design load.

Design load = γ_f x Characteristic load

UNIT II

LIMIT STATE DESIGN FOR FLEXURE

1. What are the rules to be followed in the design of slabs as per IS 456-2000? (Nov/Dec 2011)

- As per IS 456 -2000, continuous solid slabs are designed for maximum bending moment due to design loads based on bending moment coefficients given in Table 12.
- After thickness and area of steel calculation, the slabs are checked for shear based on shear force due to design loads (Table 13) and design shear strength of concrete (Table 19)
- Finally slab has to be checked for deflection based on basic values (clause 23.2.1) and modification factor (fig 4).

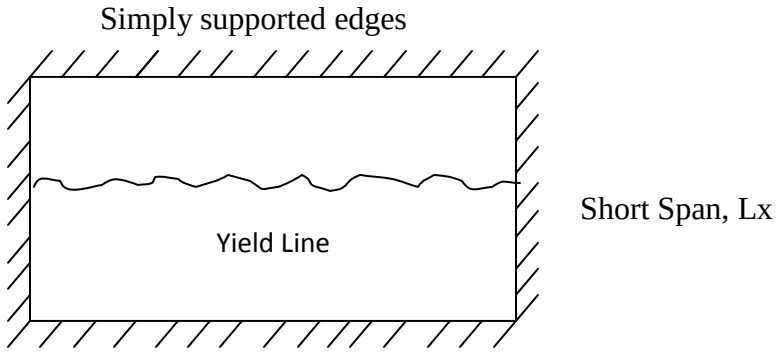
2. Enumerate corner reinforcements for two-way slabs. (Nov/Dec 2011)

- Torsional reinforcement is required for the situation, "two way slab corners are held down" (or) "corners are not free to lift up"

Design parameters of torsional reinforcement in two way slab:

- Torsional reinforcement consists of top and bottom mesh.
- Covering area of each mesh = (Short span, l_x / 5)(Long span, l_y / 5)
- Area of torsional reinforcement per m width = ¾ * short span area of steel, Ast

3. Draw a yield line pattern for a one way slab with simply supported edge conditions. (Nov/Dec 2013)



Long Span, Ly

4. What is the advantage of two way slab over one way slab? (Nov/Dec 2014)

Two way slab is supported in all the four sides and load will be distributed in both the directions. So, main reinforcement is provided in both directions for two way slabs. In two way slab, main reinforcement along long span takes temperature stresses.

5. Enumerate doubly reinforced section. (Nov/Dec 2014)

Reinforcements are provided at both tension and compression zones of flexural members are called doubly reinforced section.

6. What are the codal provisions for minimum reinforcement to be provided as main and secondary reinforcement in slab and their maximum spacing? (Nov/Dec 2007)

a) Minimum Reinforcement:

For Mild Steel

Ast min =0.15% of total cross sectional area =0.15/100 x bD

For HYSD bars

Ast min =0.12% of total cross sectional area =0.12/100 x bD

b) Spacing:

For main reinforcement,

Spacing = 3d or 300mm whichever is smaller

For Secondary reinforcement

Spacing = 5d or 450mm whichever is smaller

Where d - effective depth of slab.

7. When the flexural members are designed as T or L beams?

T-beam and L-beam which may forms part of a concrete beam and slab floor. When the beams are resisting sagging moments, parts of the slab acts as a compression flange and the members may be designed as T or L beam.

All intermediate beams with part of the slab acts as a compression flange are designed to be T-beam.

All edge beams with part of the slab acts as a compression flange are designed to be L-beam.

8. What is the difference between one way slab and two way slab? (Nov/Dec 2008)

Two Way Slab:

When the ratio of Effective Long Span to the Effective Short Span is less than or equal to 2 then it is set to be two way slab.

Effective Long span (Ly) / Effective Short span (Lx) $\leq$ 2

One Way Slab:

When the ratio of Effective Long Span to the Effective Short Span is greater than 2 then it is set to be one way slab.

Effective Long span (Ly) / Effective Short span (Lx) >2

9. Under what circumstances doubly reinforced beams resorted to. (May / June 2008)

Compression reinforcement is provided in addition to tension reinforcement in beams, are termed as doubly reinforced sections.

Doubly reinforcement is provided for the following circumstances

- To increase the moment of resistance of a beam section of limited dimensions.
- The external live loads may be changed. That is, load may be acting on either face of the member.
- The loading may be eccentric and the eccentricity of the load may change from one side of the axis to another side.
- The member may be subjected to a shock or impact or accidental lateral force.

10. Why is secondary reinforcement provided in one way RC slab? (May / June 2008)

Secondary reinforcements are provided running at the perpendicular to the main reinforcements, in order to take the temperature and shrinkage stresses. It is otherwise called as distribution reinforcement or temperature reinforcements.

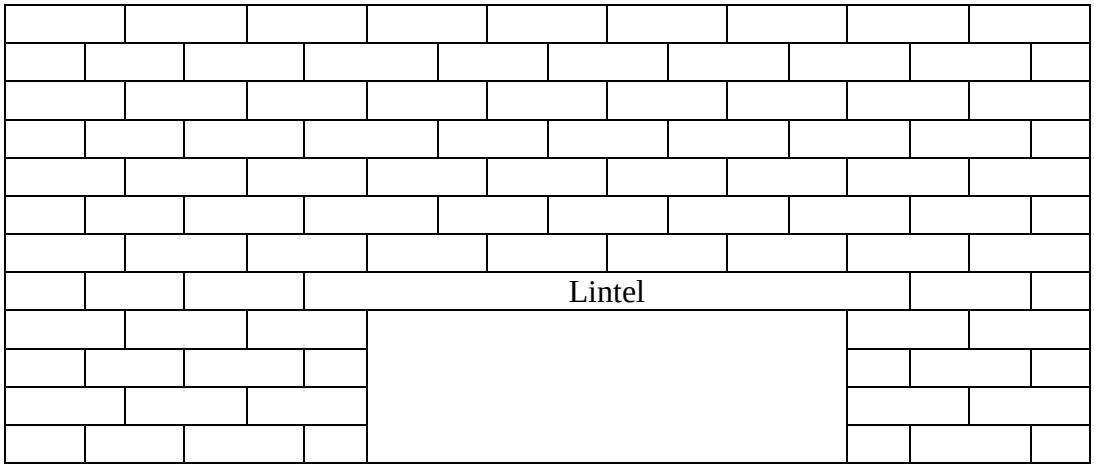
11. Write down the basic values of span to effective depth ratios for different types of beam.

Based on clause no 23.2.1, IS456-2000, basic values of span to effective depth ratios for spans upto 10m are,

Type of Beam	Basic Value
Cantilever	7
Simply Supported	20
Continuous	26

12. Explain the purpose of lintel beams in buildings. (May / June 2007)

Lintels are provided over the openings in walls for doors and windows. A lintel takes the masonry load over the openings and distributes to the masonry located sides of opening.



13. Give the codal specification for the limiting neutral axis depth in limit state method.

Based on clause no. 38.1 of IS 456-2000,

f_y in N/mm^2	$X_{u,max}$ / d
250	0.53
415	0.48
500	0.46

14. What are the basic assumptions in limit state of flexure?

- Plane sections normal to the axis remain plane after bending.
- The maximum strain in concrete at the outermost compression fiber is taken as 0.0035 in bending.
- For design purpose, the compressive strength of concrete in the structures shall be assumed to be 0.67 times the characteristic strength. The partial safety factor, (γ_m) = 1.5 shall be applied in addition to this.
- Tensile strength of concrete is ignored, since concrete is weak in tension.

15. What is the minimum and maximum area of tension reinforcement for beams?

a) Minimum reinforcement:

The minimum area of tension reinforcement shall not be less than that given by the following:

$$\frac{As}{bd} = \frac{0.85}{\text{fy}}$$

Where, As = minimum area of tension reinforcement

b = breadth of beam or breadth of the web of T beam

d = effective depth

f_y= characteristic strength of reinforcement in N / mm^2

b) Maximum reinforcement:

The maximum area of tension reinforcement shall not exceed 0.04bD

16. Give the important assumptions made in the design of doubly reinforced beam as per Limit State Design.

- Reinforced concrete sections in bending fail when the compressive strain in the concrete reaches the strain value of 0.0035.
- Plane sections remain plane even after bending.
- The stress at any point on the material (steel or concrete) can be considered as equal to the stress corresponding to the strain at that point of the stress-strain relationship for the material.

17. What is steel beam theory?

The behavior of RCC beams with compression steel for ultimate load designs sometimes referred as the steel beam theory.

The real beam is considered to be of two beams.

- A single reinforced beam which reaches its ultimate strength by failure of concrete in compression.
- A steel beam without concrete but only compression and tension steel.

Thus the moment of resistance (M_u) of the doubly reinforced beam will be the sum of the resistance of two beams, viz., maximum moment on the beam which can carry (M_{u1}) and the moment capacity of the steel beam (M_{u2})

$$M_u = M_{u1} + M_{u2}$$

18. Why high strength deformed bars are preferred when compared to mild steel bars?

The reasons for preferring deformed bars are

- Bond will be more because of roughness of bars.
- Yield strength is high resulting in less quantity of steel.

19. Calculate the limiting value of tensile stress in an uncracked section of a flexural member made with M20 grade concrete. (May/June 2012)

Tensile strength (i.e. flexural strength) of a concrete can be estimated from the formula.

Flexural strength = $0.7\sqrt{fck}$

Where fck is the characteristic compressive strength of concrete. Hence for M20 concrete,

Flexural strength = $0.7\sqrt{20}$ = 3.13N/mm^2

20. Differentiate shear failure and bending failure. (Nov/Dec 2013)

Shear failure observed in reinforced concrete structures are: diagonal tension failure, flexural shear failure, shear compression failure and shear bond failure.

Flexure or bending failure is commonly encountered in structural elements of reinforced cement concrete, e.g., beams and slabs, which are transversely loaded. Flexure usually occurs in combination with transverse shear and sometimes with axial compression or shear.

UNIT III

LIMIT STATE DESIGN FOR BOND, ANCHORAGE SHEAR & TORSION

1. What are the types of reinforcements used to resist shear in beams? (Nov/Dec 2007)

- Vertical stirrups
- Tension reinforcement bent up near supports.
- Inclined Stirrups.

2. Why minimum shear reinforcement is provided in beams?

Code recommends providing minimum shear reinforcements to safeguard local cracking and nominal safety requirements; even the design shear strength of concrete (τ_c) exceeds the nominal shear stress (τ_v).

Minimum shear reinforcement is obtained from the expression.

$$\frac{\text{Asv}}{b\ sv} \geq \frac{0.40}{0.87fy}$$

Provision of nominal shear reinforcement safe guards spalling of concrete.

3. Define bond. (April/May 2011)

Bond in reinforced cement concrete refers to the adhesion between the embedded steel and the surrounding concrete. This is the bond which makes the composite materials and provides strain compatibility. The assumption that plane sections remain plane even after bending is ensured by the bond between the concrete and steel without slip.

4. Distinguish between flexural bond and development bond. (April/May 2008, Nov/Dec 2011, Nov/Dec 2014)

Flexural bond or Local bond

Flexural bond or local bond at a point in a R.C.C member is the rate of change of tension in the steel at the stipulated section.

Anchorage bond or Development bond

Average bond stress developed, over the full length at the interface of concrete and steel bars is defined as the anchorage bond or development bond.

5. What do you understand by the term Anchorage? (Nov/Dec 2013)

With modern high bond bars the mechanism of reinforcement anchorage is due to

- Adhesion of concrete and steel
- Shear strength of concrete and
- Interlocking of ribs with concrete

Codes specify that, with high bond bars, the condition to be satisfied is that the average resistance called the average bond stress, developed along the full length of the bar surface embedded in the concrete, should be safe at ultimate loads.

6. Define: Development length (April/May 2011)

Development length, Ld is defined as the length of bar necessary to develop the full bond strength of the bar.

$$\mathbf{Ld} = \frac{\boldsymbol{\varphi\sigma s}}{\boldsymbol{4\tau bd}}$$

7. Why is bond stress more in compression bars than that in tension bars? (Nov/Dec 2012)

The intensity of the adhsion force at the junction of steel and concrete is called the bond stress. The surface of contact of steel bar and concrete gets improved under compression whereas under tension it leads to seperation. Accordingly the bond stress is more in compression bars than that in tension bars.

8. Write down the effects of torsion on R.C. beams. (May/June 2013, May/June 2014)

Many types of loadings produce torsion in reinforced concrete members. The resultant torsion may be classified as (i) Primary or equilibrium torsion and (ii) Secondary or compatibility torsion.

The first type if that which is required to maintain basic static equilibrium and the second is the one required maintaining and compatibility condition between members. In general that torsion in statically determinate structures, loads are distributed in more than one path, hence torsional effect is minor. But in structures where the major load is applied unsymmetrical torsion has to be considered carefully.

9. Write about local bond and anchorage length. (May/June 2013, May/June 2014)

Local or Flexural bond at a point in a RCC member is the rate of change of tension in the steel at the stipulated section. Adhesion and friction are the main components of local bond in a mild steel smooth bar.

Anchorage length is defined as the length of bar necessary to develop the full strength of the bar.

10. Define flexural bond.

Because of certain loading situations two types of bonds are identified. Viz., Flexural bond and Anchorage or development bond

Flexural bond occurs in flexural members due to shear or a variation in bending moment. Flexural bond is critical at points where the shear force is significiant.

11. How to overcome torsion on beams?

When torsion is present, different methods to overcome torsion is done by proper design as per Indian Standard Code. When torsion is present along with the bending shear, is recommends the use of equivalent shear for which the shear steels are calculated. Again in Indian Standards when torsion is present as combined with bending, an equivalent bending moment is calculated and reinforcement for this equivalent bending moment is provided as longitudinal steel.

12. When will you provide side reinforcement in a beam? Why?

When the depth of web in a beam exceeds 750mm, side reinforcement should be provided along the two side faces to prevent the buckling of the beam. Area of side face reinforcement should not be less than 0.1% bD and it shall be distributed equally on two faces. The spacing on each face should not be greater than 300mm.

The actual length is taken as the length from centre-centre of intersections with the supporting members.

` **13. Distinguish between L-beam and T-beam?**

A slab cast integrally with a beam acts as compression flange for the beam. The monolithic construction of the beam and the slab are termed as Tee beam.

Beams which are cast monolithic with slab on one side of the rib only are called as L-beams.

14. How will you provide reinforcement to resist torsion in slabs?

Torsion reinforcement shall be provided at corners where the slabs are simply supported on both edges meeting at the corner. It consists of top and bottom reinforcement each with layers of bars placed parallel to the sides of the slab and extending from the edges. The area of reinforcement in each of these four layers shall be three quarter of the area required for the maximum in the slab.

15. State the minimum reinforcement required in one way RC slab.

The reinforcement should not be less than 0.15% of the total cross-sectional area. Cross sectional area for mild steel bars is 0.15% and for deformed bars or welded wire fabrics is 0.12% cross sectional area.

16. What are the functions of distribution bars in slabs?

- It prevents opening of cracks in the slab on account of shortening of length in transfers' direction caused by shrinkage or fall of temperature.
- It keeps the main reinforcement in position
- It also helps in distributing a concentrated load on the slab to the adjacent areas in the lateral directions.

17. Why is the Span/effective depth ratio of slab greater than for beams?

For a given type of support condition the Span/depth basis rules are applicable both for beam and slab. However, as the percentage of reinforcement in the slab is generally low, the effective span-depth ratio can be much larger than the basis ratio of beam.

18. Reinforced concrete slabs are generally safe in shears and they do not require shear reinforcement why?

Slabs subjected to normal distributed loads satisfy the requirement $\tau_v < k\tau_c$ (where k is the multiplying factor) and hence do not need shear reinforcement. This is mainly attributed to the fact that the thickness of the slab (controlled by limiting deflection criteria) is usually adequate in terms of shear capacity.

19. What are the factors that influence moments in two-way slabs?

- Short span length (L_x) and Long span length (L_y)
- Type of surrounding edges such as free, fixed, continuous, etc.
- Type of load such as concentrated, uniformly distributed, etc.
- Magnitude of the load.

20. What is the importance of two-way slab over one way slabs?

One-way slabs are those supported continuously on two opposite sides. One way slabs span in the shorter direction such that the bending moment and shear forces are the least.

Two way slabs are those which are supported continuously on all four sides. Here the loads are carried on to the supports along both the directions. In case of multi-storied buildings with column and beam construction the floor and roof are supported on all four sides. In order to allow significant development of bending in mutually perpendicular directions, the longer span should not exceed two times the shorter span.

UNIT IV

LIMIT STATE DESIGN OF COLUMNS

1. Write any two code requirements on slenderness limits. (May/June 2012)

- Slenderness ratio is a general property of a column which is related to the ratio of its effective length to its lateral dimension. This ratio is called slenderness ratio.
- A column is classified as short column when the slenderness ratio is less than 12. If the ratio is greater than 12 then it is long column or slender column.
- Slenderness ratio has to be checked on both the directions of a column

2. Distinguish between braced and unbraced column? (May/June 2012)

- In certain situations columns may be subjected to lateral loads like wind or earthquake forces. Thus the columns have to be planned to sustain the later loads. This is done by joining the columns by a structure called bracings or by providing a shear wall.
- In columns where in provision is made to take the lateral load by bracings or by shear walls are called braced columns. Whereas unbraced columns are ones which are to resist the lateral load in addition to vertical load.

3. Distinguish between unsupported length and effective length. (May/June 2012)

Effective length is defined as the distance between the points of inflection in the buckled configuration of the column in that plane. It depends on the unsupported length l and the effective length ratio, k, which depends on the end condition. That is Le = kl.

Unsupported length is the clear distance between the floor and the slab over beam framing into the columns in each direction at the next higher floor level.

4. According to I.S. code "All columns should be designed for minimum eccentricity" Justify the statement. (Nov/Dec 2007)

All columns shall be designed for minimum eccentricity equal to the un-supported length of the column/50 plus lateral dimension/30, subject to a minimum of 20mm. In the design equations recommended by Code, this minimum eccentricity is considered.

5. What is failure by elastic instability?

Very long columns may loose stability even under small loads well before the materials reach yield stress. Under such conditions the member fails by lateral 'elastic buckling'.

Under practical conditions this failure mode is not acceptable. Thus code has made specific recommendations regarding the acceptable limit for slenderness ratio (30 for unbraced columns) which should not be allowed in structures.

6. Write the assumptions made for limit state design of columns failing in pure compression.

(Nov/Dec 2011)

- Plane sections normal to the axis remain plane after bending.
- The maximum compressive strain in concrete in axial compression is taken as 0.002.
- The stress-strain curve of steel in compression is taken to be the same as in tension.

7. Write any two functions of lateral ties in a RC column. (April/May 2008)

- To prevent the buckling of individual bars.
- To confine the concrete.
- To keep the main bars in position while concreting.

8. Define member stability effect in braced columns? (May/June 2012)

Braced columns are subjected to primary moments M_1 and M_2 at the ends of the column. The possible amplification in bending moment (over the primary moment M_2) on account of lateral displacements (relative to the chord joining the column ends) is termed as member stability effect.

9. What is pedestal? (May/June 2013)

A column is a compression member, the effective length of which exceeds three times the least lateral dimension. The term pedestal is used to describe the vertical compression member whose effective length is less than three times its least lateral dimension.

10. Write any two support conditions of columns. (May/June 2014)

Effective length of a column (L_0) is the height of the column which is dependent on the bracing and end or support conditions. Seven types of end or support conditions may be visualized. Two of the support conditions are given below.

i. Effectively held in position and restrained against rotation in both ends. Theoretical value of Effective length = $0.5L_0$

ii. Effectively held in position at both ends, restrained against rotation at one end. Theoretical value of Effective length = $0.7L_0$

11. Enumerate axially loaded column. (May/June 2014)

Loadings made along the centroidal axis is called axially loaded column. Depending on the slenderness ratio an axially loaded column may fail in one of the three following modes. Pure compression failure (Mode1), combined compression and Vending Failure (Mode 2) and Failure of Elastic Instability (Mode3).

- Failure of column under Mode1 takes place under axial load without any lateral deformation. The collapse of the column is due to material failure.
- Failure of column under Mode 2, Slender or Long columns undergo deflection along the length even loaded axially and such deflections produce additional moment.

- Failure of column under Mode 3, very long columns may loose stability even under small loads well before the materials reach yield stresses. Under such conditions the member fails by lateral elastic buckling.

12. On what condition intermediate column is more suitable. (Nov/Dec 2014)

Column with lengths that are between the short and long column is defined as intermediate column. Intermediate columns fail both by yielding and buckling. Hence, in situations where yielding and buckling are predominate, the column should be designed as an intermediate column.

13. What is the formula used in the Bresler's Load contour method of approach for short columns subjected to axial load and biaxial bending? (Nov/Dec 2013)

This method is based on the concept of a failure surface which is the envelope of a number of interaction curves for different axes of bending of a column. The design interaction equation is expressed as:

$$\left[\frac{Mux}{Mux\,1}\right] \wedge \propto_n + \left[\frac{Muy}{Muy\,1}\right] \wedge \propto_n \quad \leq 1.0$$

Where Mux and Muy are moments about x and y axes due to design loads.

M_{ux1} and M_{uy1} are maximum uniaxial moment capacity for an axial load of Pu bending about x and y axes respectively.

$\propto$n is an exponent whose value depends on the ratio (Pu/Puz)

Where Puz = [0.45fckAc+0.75fyAsc]

14. What is the minimum and maximum percentage of reinforcement can be provided for a column?

The cross sectional area of longitudinal reinforcement, shall be not less than 0.8% not more than 6% of the cross sectional area of the column.

15. Define Slenderness Ratio.

Slenderness Ratio (λ) = Effective Length / Least lateral dimensions.

16. What is spiral column?

For a circular column, longitudinal reinforcements tied with closely spaced helix are called as spiral column.

17. Define Column.

It transmits load coming from beam or slab and distributes to the foundation. Usually columns are square, rectangle, circular and L-shaped in cross section. It is reinforced with longitudinal and lateral ties. Load carrying capacity of column is depending upon longitudinal steel and cross sectional size of the column. Lateral ties

are giving lateral support to the longitudinal steel. The columns are analyzed for axial force and moments.

18. Differentiate between uniaxial and biaxial bending.

Uniaxial eccentrically loaded column:

Axial load and bending moment along one direction (Mx or My) are applied simultaneously on the column.

Biaxial eccentrically loaded column

Axial load and bending moment along two directions (Mx or My) are applied simultaneously on the column.

19. What are the specifications for pitch of lateral ties in columns? (Nov/Dec 2008)

As per IS456-2000, Clause 26.5.3.2,

The pitch of transverse reinforcement shall be not more than the least of the following

distances.

i. The least lateral dimension of the compression members.
ii. Sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied.
iii. 300 mm

20. Write any two functions of lateral ties in a RC column. (May 2008)

- Lateral ties hold the main or longitudinal steel bars in position.
- It provides lateral support to main reinforcements, so that the main bars can not buckle outwards.

UNIT V

LIMIT STATE DESIGN OF FOOTING

1. What is the major role of foundations?

The foundation is a very important part of a structure, which is located below the ground level. The foundations transfer and spread the loads from column or wall into the ground soil evenly. It is otherwise called as sub structures.

2. What are the purposes of providing foundations?

- The functions of foundations are as follows.
- Foundation transfers live load and dead loads of the structure to the ground soil over a large area uniformly.
- It resists lateral forces such as wind, seismic etc.
- It resists uplift force due to ground water.
- It provides good support for walls and columns.

- To stable in sliding and overturning for retaining wall foundations.
- It should not settle in the downward direction due to loads and soil condition.
- To prevent differential settlement of building.
- To provide a plane surface for the convenience of construction.

3. What is pad foundation?

Isolated or Pad foundations are provided under a single column. Shape of isolated footing may be square, rectangle or circular in plan depending upon shape of the column and loads.

4. Under what circumstances combined footing is necessary. (Nov/Dec 2008)

- The columns are spaced too closely:
  When two columns are close together, causing overlap of adjacent isolated footings.
- Foundation on boundary or property line:
  If isolated footing is provided on boundary or property line, the footing has to be extended beyond the property line. In such cases, two or more columns can be supported on a single rectangular foundation.

5. Define safe bearing capacity of soil. (May/June 2007)

It is the maximum intensity of load or pressure developed under the foundation without causing failure of soil. Unit for safe bearing capacity of soil is kN/m^2. Safe bearing capacity of soil is determined by plate load test at the site.

6. What is punching shear? (May/June 2009)

Punching shear is a type of shear failure occurs in reinforced concrete footings due to axial load from the column and upward soil thrust from the ground.

7. What are the advantages of providing pedestals to columns?

Pedestals are provided to connect column and footing for the following purposes.

i. Where pedestals are provided, and full force is transferred to the footing without additional reinforcements.
ii. Pedestal provides a plane surface for the convenience of column construction.

8. What is the situation in which trapezoidal shape is preferred to a rectangular shape for a two column combined footing?

If one of the columns is carrying much larger load than the other one, trapezoidal combined footing is provided.

9. What is spread footing?

Wide base slab is provided continuously under load bearing masonry walls of the building is called spread or strip footing.

10. What is meant by eccentric loading on a footing, and under what situation does this

occur?

- In eccentric loading, resultant of the acting forces does not coincide with the centroid of footing which creates non uniform bearing pressure.
- Eccentricity may be caused by a moment at the column base or by an unsymmetrical footing base.

11. Define strap footing.

- The strap footing is used instead of a rectangular or trapezoidal combined footing if the distance between columns is large.
- Also it is used to connect an eccentrically loaded column footing to an interior column footing by a strap or beam. The strap is used to transmit the moment caused from an eccentricity to the interior column footing so that a uniform soil pressure is generated under both footings.

12. What is mat foundation? Under what circumstances mat footing is required.

One common footing is provided to connect all columns in a structure is called as mat or raft foundation. This type of foundation is more expensive than other types.

- Raft foundation is provided for the following circumstances.
- Structures like chimneys, silos, cooling towers, buildings with basements where continuous water proofing is needed.
- For foundations where differential settlement can be a major problem.
- Construction site contains soft or weak soils strata such as silt, black cotton soil, shrinkable or expansible clay etc.

13. What is foundation? How the foundation is classified?

The foundation is a very important part of a structure, which is located below the ground level. The foundations transfer and spread the loads from column or wall into the ground soil evenly. It is otherwise called as sub structures.

Depending on the dimension such as depth, width and load transfer, foundation can be broadly classified into two types.

- Shallow foundation
- Deep foundation

14. What is shallow foundation?

Depth of the foundation is less than or equal to width of footing is called as shallow foundation.

15. List out the types of shallow foundation?

- Isolated footing
- Spread or Strip footing
- Combined footing
- Strap footing
- Mat or raft footing

16. What is deep foundation? List out the types of deep foundation?

Depth of the foundation is more than width of footing is called as deep foundations.

Types of deep foundations are

- Pile foundation
- Well foundation or caisson foundation

17. What are the governing factors to decide the depth of location of R.C. footings? (Nov/Dec 2007)

- Footings should be carried well below the top soil, miscellaneous fill, abandoned foundation, debris or muck.
- Footings should be carried below the depth of weathering.
- Footing is sloping ground should have sufficient edge distance as protection against erosion.
- Difference in elevation of footings, should not be so great as to introduce undesirable overlapping of stresses in soil.

18. What are the sections at which the moments are to be computed for the design of a footing?

As per Code (IS: 456-2000) the bending moment to be taken for design of footings is the moment of the reaction forces due to the applied forces (excluding the self-weight of the footing) at the following sections.

- At the face of the column, pedestal or wall, for footing supporting a concrete column, pedestal or wall.
- Half-way between the centre line and the edge of the wall, for footings under masonry walls, and
- Half-way between the face of the column or pedestal and the edge of the gusseted base for footings under gusseted bases.

CE 6504 – Design of Reinforced Concrete Elements
PART 'B' & 'C' QUESTION BANK

UNIT I
METHODS OF DESIGN OF CONCRETE STRUCTURES

1. A singly reinforced concrete beam is of width 450mm and effective depth 715mm. It is reinforced with 8Nos.20mm mild steel bars. Assuming M20 concrete, determine its moment of resistance according to the working stress method. Determine also the stress in steel when the beam is subjected to the above moment.
2. Determine the reinforcement for a T beam with flange width = 1500mm, web width = 300mm, thickness of slab = 100mm, effective depth 735mm, to carry a moment of 380kNm due to characteristic loads. Use M25 concrete and Fe 415 steel. Using Working Stress Design.
3. A singly reinforced concrete beam is of width 400mm and effective depth 615mm. It is reinforced with 8Nos.20mm mild steel bars. Assuming M25 concrete, determine its moment of resistance according to the working stress method. Determine also the stress in steel when the beam is subjected to the above moment.
4. Design a rectangular slab supported on its all four edges (600mm thick) over a classroom of size 4.8m x6.2m. Two adjacent edges of the slab are discontinuous and the remaining two edges are continuous. A finishing surface of cement concrete of 20mm shall be provided over the slab. The slab shall be used as classroom. M20 grade of concrete and HYSD bars shall be used. The unit weight of finishing surface concrete is 24KN/m3.
5. Design a rectangular beam section subjected to an ultimate moment of 120kNm. Use concrete M20 and steel Fe415. Adopt limit state method.

UNIT II
LIMIT STATE DESIGN FOR FLEXURE

1. A rectangular beam has b=200mm, d=400mm if steel used is Fe 415 and grade of concrete is M25. Find the steel required to carry a factored moment of 12kNm.
2. Design of roof slab for an interior panel of size 5mx6m. Live load is 5.0KN/m^2. Use M30 Concrete and Fe 415 Steel.
3. Design a simply supported R.C.C.SLAB for a roof of a hall 4mx10m (inside dimensions) with 230mm walls all around. Assume a live load of 4kN/m^2 and finish 1KN/m^2.Use grade 25 concrete and Fe 415 steel.
4. A T beam continuous over several supports has to carry a factored negative support moment of 1000kNm. Determine the area of steel at supports if b_W = 400MM, b_{fy} =1600mm, D_f = 100mm, D=610mm, $d^{'}$ = 60mm, f_{ck} = 30N/mm^2, f = 415 N/mm^2.

5. A doubly reinforced concrete beam is 250mm wide and 510mm depth the center of tensile steel reinforcement. The compression reinforcement consists of 4 Nos. of 18mm dia bars placed at an effective cover of 40mm from the compression edge of the beam. The tensile reinforcement consists of 4Nos. of 20mm diameter bar. If the beam section is subjected to a BM of 85kNm, calculate the stresses in concrete and tension steel.
6. Design a smallest concrete section of a RC beam to resist an ultimate moment of 62kNm, assuming width 230mm, concrete grade M20 and HYSD bars of grade Fe415.
7. A rectangular beam of width 300mm and effective depth 500mm reinforced with 4 bars of 12mm diameter. Find the moment of resistance and stresses in the top compression fiber of concrete and tension steel. Use concrete M20 and steel Fe415. Adopt Limit State method.
8. Design the interior span of a continuous one way slab for an office

floor continuous over tee beams spaced at 3 meters. Live load = 4kN/m, Floor finish = 1kN/m^2.Use concrete M20 and steel Fe415. Adopt limit state method. Sketch the steel reinforcement.

UNIT III

LIMIT STATE DESIGN FOR BOND, ANCHORAGE SHEAR & TORSION

1. A rectangular beam width b=350mm and d=550mm has a factored shear of 400kN at the critical section near the support. The steel at the tension side of the section consists of four 32mm bars which are continued to support. Assuming f_{ck}=25 and f_y=415(N/mm^2) design vertical stirrups for the section.
2. A reinforced concrete rectangular beam has a breadth of 350mm and effective depth of 800mm. It has a factored shear of 105kN at section XX. Assuming that f_{ck}=25, f_y=415(N/mm^2) and percentage of tensile steel at that section is 0.5percent, determine the torsional moment the section can resist if no additional reinforcement for torsion is provided. Workout the problem according to IS456 principles of design for torsion.
3. A simply supported beam is 5m in span and carries a characteristic load at 75kN/m. If 6 Nos. of 20mm bras are continued into the supports. Check the development length at the supports assuming grade M20 concrete and Fe415steel.
4. A rectangular RCC beam is 400x900mm in size. Assuming the use of grade M25 concrete and Fe415 steel, determine the maximum ultimate torsional moment at the section can take it. No torsion reinforcement is provided and Maximum torsion reinforcement is provided.
5. A rectangular beam width b = 250mm and effective depth 500mm reinforced with 4 bars of 20mm diameter. Determine the shear reinforcement required to resist a shear force of 150kN. Use concrete M20 and steel Fe415.

6. Design a rectangular beam section of width 250mm and effective depth 500mm, subjected to an ultimate moment of 160kNm, ultimate shear force of 30kN and ultimate torsional moment of 10kNm. Use concrete M20 and steel 415.
7. A RC beam 300x450mm in cross section in reinforced with 3 Nos. 20mm diameter of grade Fe250, with an effective cover of 50mm. The ultimate shear at the section of 138kn.Design the shear reinforcement (i)Using only vertical strips without bending any bar for resisting. (ii) Bending 1 bar dia 20mm at 45 degree to resist shear at the section. Assume concrete of grade M20.
8. A reinforced concrete beam 500mm deep and 230mm wide is reinforced with 8Nos.20mm diameter bars at mid span to carry a UDL of 22.5kn/m (inclusive of its own weight) over simple span of 8m. Assuming concrete grade M20, steel grade Fe415, load factor 1.5 and width of support 230mm (i) determine the minimum development length required for 20mm diameter bar to develop full strength (ii) apply check for flexural development length at support assuming all bar to continue at support (iii) determine the minimum number of bars required at support for development length of flexure.

UNIT IV

LIMIT STATE DESIGN OF COLUMNS

1. A rectangular column of effective height of 4m is subjected to a characteristics axial load of 800kN and bending moment of 100kNm about the major axis of the n. Design a suitable section for the column so that the width should not exceed 400mm. Use the minimum percentage of longitudinal steel. Assume f_y=415N/mm^2 and f_{ck}=20N/mm^2.
2. An R.C.Column 500x400mm is subjected to an axial ultimate load of 2500kN and bent in single curvature about the minor axis with $M_{y(top)}$=90knm and $M_{y(bottom)}$=120knm as ultimate moments. If L_0=7.2m and L_e=5.75m on both axes, calculate the design moments for the column.
3. Design the reinforcement in a spiral column of 400mm diameter subjected to a factored load of 1500kN.The column has an supported length of 3.4m and is braced against side way. Use M20 concrete and Fe415 steel.
4. A column 300x400mm has an unsupported length of 3m and effective length of 3.6m.If it is subjected to pu=1100kNm and Mu=230kNm about the major axis, determine the longitudinal steel using fck=25N/mm^2. Calculate the ultimate strength in axial compression of column 400mm in diameter and reinforced with 8Nos. of 20mm dia. of grade Fe250 when the column in helically reinforced by 8mm dia at (i) 60mm pitch, (ii) 30mm pitch. Assume concrete of grade M20. Assume clear cover equal to 40mm.
5. Design an axially loaded tied column 400mmx400mm pinned at both ends with an unsupported length of 3m for carrying a factored load of 2300kN.Use M20 concrete and Fe415 steel.

6. Design a circular column with helical reinforcement of 400mm diameter and 4m in length to carry factored load of 1000kN.The column is hinged at both ends. Use concrete M25 and steel Fe415. A column 300mmx400mm has an unsupported length of 4m and fixed at both ends. It is subjected to a factored load of 1000KN and an ultimate moment of 200kNm about the major axis. Determine the longitudinal reinforcement and lateral ties. Use concrete M25 and steel Fe415 d'=60mm.

UNIT V

LIMIT STATE DESIGN OF FOOTING

1. A rectangular column 300mmx400mm reinforced with 20mm diameter bars carries a load of 1400kN. Design a suitable footing for the column. The safe bearing capacity of the soil is 200kN/m^2.Use concrete M20 and steel Fe415.
2. Design a combined rectangular footing for two columns spaced at 5 centers. The first column 400mmx400mm carries a load of 1200kN and the second column 450mmx450mm carries a load of 1800kn at service state. Weight of Soil = 20kN/m^2, angle of repose=30^0 and safe bearing capacity of soil = 150kN/m^2. Use concrete M20 and steel Fe415.
3. A solid footing has to transfer a dead load of 1000kn and an imposed load of 400kn from a square column 400mmx400mm. Assuming fck=20N/mm^2 and f_y=415N/mm^2 and safe bearing capacity to be 200KN/m^2, Design the footing.
4. Design a combined rectangular footing for two columns spaced at 500cm centers. The first column 300mmx300mm carried load of 1000 kN and second column 300mmx300mm carries a load of 1500kn at service state. Weight of Soil = 20kN/m^2, angle of repose=30^0 and safe bearing capacity of soil = 150kN/m^2. Use concrete M25 and steel Fe415.
5. A solid footing has to transfer a dead load of 1000kN and an imposed load of 400kN from a square column 400x400mm (with16mm bars.) Assuming f_y=415 and f_{ck}=20N/mm^2 and safe bearing capacity to be 200kN/m^2. Design the footing.
6. Design a plain concrete footing for a 450mm wall carrying 300kN per meter length. Assume grade 20 concrete and the bearing capacity of soil to be 200kN/m^2.

V.S.B. ENGINEERING COLLEGE, KARUR
DEPARTMENT OF CIVIL ENGINEERING

Year/Semester : III / V – 'A' & 'B' Section
Subject Code & Name : CE 6506 CONSTRUCTION TECHNIQUES, EQUIPMENTS AND PRACTICES

PART 'A' QUESTIONS BANK

UNIT 1
CONCRETE TECHNOLOGY

1. **State the importance of 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 make the mix difficult to work with and form. Workability can be resolved with the use of plasticizers or super-plasticizers.

2. **What are the tests to be conducted on fresh concrete?**

   1. Slump test 2.Compaction factor test 3.Flow test 4.Key ball test 5.Vee Bee test

3. **What is the use of chemicals as retarders in concrete?**

   Retarding admixtures are used to slow the rate of setting of concrete. By slowing the initial setting time, the concrete mixture can stay in its fresh mix state longer before it gets to its hardened form.

4. **Why is curing done for concrete?**

   Curing plays an important role on strength development and durability of concrete. Curing takes place immediately after concrete placing and finishing, and involves maintenance of desired moisture and temperature conditions, both at depth and near the surface, for extended periods of time.

5. **What does the grade of cement denote?**

   The grades are classified depending upon the compressive strength of the cement.1) Grade 33 2) Grade 43 3) Grade 53.

6. **What are the raw materials used in the manufacture of cement?**

   1. Lime 2.Silica 3.Alumina 4.CalciumSulphate 5.Iron Oxide 6.Magnesia 7.Sulphur

7. **List the various processes involved in the manufacture of concrete.**

   1. Batching of ingredients 2.Mixing of materials 3. Transporting 4.Placing 5.Compacting
   6. Finishing 7.Curing.

8. **Define hydration of cement.**

   The chemical reaction takes place between cement and water is called hydration of cement. When water is added to the cement, various ingredients of cement react chemically with various complicated chemical compounds.

9. **Write the ASTM classification of cement.**

   1) Type **I** Normal cement 2) Type **IA** Normal + air entrained agents 3) Type **II** Moderate sulphate resistant cement 4) Type **IIA** Moderate sulphate resistant cement + air entrained agents 5) Type **III** High early strength cement 6) Type **IIIA** High

early strength cement + air entrained agents 7) Type **IV** Low heat cement 8) Type **V** High sulphate resistant cement

10. Differentiate dry and wet process of manufacturing of cement.

1) Wet process -grinding and mixing of the raw materials in the existence of water. The percentage of the moisture in the raw materials is high.

2) Dry process -grinding and mixing of the raw materials in their dry state. The raw materials is so hard (solid) that they do not disintegrate by water

11. Define batching. What are the methods of batching?

It is the process of measuring concrete mix ingredients either by volume or by mass and introducing them into the mixture. Traditionally batching is done by volume but most specifications require that batching be done by mass rather than volume.

1) Weight Batching 2) Volume Batching

12. What is meant by workability of concrete?

Workability is that property of concrete which determines the amount of internal work necessary to produce full compaction. It is a measure with which concrete can be handled from the mixer stage to its final fully compacted stage.

13. Define RMC.

Concrete prepared at plant or in trick mixers and transported and delivered to the construction site is called Ready Mix Concrete or Pre-Mixed Concrete. It has low cost and high durability.

14. What are methods of compacting concrete?

1) Compaction by hand 2) Compaction by vibration 3) Compaction by pressure

15. What is the use of accelerators in concrete?

A cement accelerator is an admixture for the use in concrete, mortar, rendering or screeds. The addition of an accelerator speeds the setting time and thus cure time starts earlier. This allows concrete to be placed in winter with reduced risk of frost damage.

16. Discuss on mix design concept as per BIS.

The BIS, recommends procedure for designing the mix for concrete. The mix design procedures are given in IS: 10262:1982. The procedure given in the BIS standards are based on various researches carried out at national laboratories.

17. List the various methods of concrete mix design.

Old method- 1) Fineness modulus 2) Minimum voids 3) Trial mixes 4) Arbitrary method

New method- 1) British method 2) ACI method

18. Define non destructive testing.

Non destructive test is a method of testing existing concrete structures to assess the strength and durability of concrete structure. In the non destructive method of testing, without loading the specimen to failure (i.e. without destructing the concrete) we can measure strength of concrete.

19. Mention any four destructive methods of testing concrete.

1) Compression test 2) Split cylinder test 3) Tensile strength test 4) Modulus of rupture test

20. List out the types of non-destructive testing of concrete.

These non-destructive methods may be categorized as 1) penetration tests, 2) rebound tests, 3) pull-out techniques, 4) dynamic tests, 5) radioactive tests, 6) maturity concept.

UNIT – 2
CONSTRUCTION PRACTICES

2. **Mention the significance of bond in masonry structures.**
   Masonry is defined as the construction of building units bonded together with mortar. The building units may be stones, bricks or precast blocks of concrete. Depending upon the type of building units used, masonry may be of the following types
   - Stone masonry
   - Brick masonry
   - Hollow concrete blocks masonry
   - Reinforced brick masonry
   - Composite masonry
3. **How are bond stones placed in stone masonry?**
   One of the important features of rubble masonry is bond stones. These are long selected stones placed from front to back of thin walls or from outside to the interior of the thick walls. They hold together the masonry walls transversely.
4. **What is rubble masonry and ashlar masonry?**
   Rubble Masonry: It is a stone work wherein blocks of stones are either undressed or roughly dressed and have wider joints.
   Ashlar Masonry: It is a stone work wherein blocks of stones are accurately dressed with very fine joints of 3mm thick.
5. **Define slip form.**
   Slip form construction is a construction method in which concrete is poured into a continuously moving form. Slip forming is used for tall structures (such as bridges, towers, buildings, and dams), as well as horizontal structures, such as roadways.
6. **Define scaffolding.**
   Scaffolding, also called staging, is the basis of most construction projects it is a temporary structure used to support a work crew and materials to aid in the construction, maintenance and repair of buildings, bridges and all other manmade structures.

7. **List out the types of scaffoldings.**
   1) Single Scaffolding 2) Double Scaffolding 3) Cantilever Scaffolding 4) Suspended Scaffolding 5) Steel Scaffolding 6) Patented Scaffolding.
8. **What is the necessity of providing construction joints?**
   The construction joints may be vertical, horizontal or inclined depending on the type of structure. In the case of inclined or curved members the joint should be perpendicular to the axis of the structural member.
9. **Write short notes on Expansion joints.**
   These joints are provided to allow the expansion of the slab due to rise in slab temperature. Expansion joints also permit construction of the slab and help to reduce the warping stresses. The gap width for this type of joint is 20mm to 25mm
10. **How are steel trusses fabricated and grouped?**
    Preparation of steel work for erection is called as fabrication. It includes all work necessary to layout, cut, drill, rivet or weld the steel section. The fabrication plan has to be properly planned such that the work at the site of erection should be reduced as much as possible.

11. State the purposes of providing DPC in buildings.

Damp proofing courses of suitable materials are provided at appropriate locations for their effective use. i) DPC should cover the full thickness of the walls. ii) DPC course should be continuous and should form as a bearer from the entry of moisture. iii) DPC should not be exposed in total.

12. What are the types of damp proofing courses?

i) Damp proof membrane ii) Integral damp proofing iii) Surface coating iv) Cavity wall construction.

13. What are the advantages of hollow concrete block masonry?

- Concrete blocks are regular in size, requiring no dressing work. Hence construction is very rapid.
- Blocks are light and therefore easy to handle.
- There is great saving in the material.
- Hollow blocks are structurally stronger than bricks

14. Differentiate English bond and Flemish bond.

- English bond is stronger than Flemish bond for walls thicker than 11/5 brick
- Flemish bond gives more pleasing appearance than the English bond
- Broken bricks can be used in the form of bats in Flemish bond. However, more mortar is required
- Construction with Flemish bond requires greater skill to comparison to English bond

15. What are the causes of dampness?

Dampness in a structure may be caused due to a) Natural cause b) Structural cause

Natural Causes- 1) Penetration of rain 2) Rise of moisture from ground 3) Moisture condensation.

Structural Causes – 1) Faculty design of structure 2) Faculty construction of structure.

16. What are the steps involved in site clearance?

- Removing trees, stumps, roots and surface vegetations.
- Disposing of the vegetation by stacking and ultimately burning.
- Knocking all vegetation stumps and roots, chopping or crushing them and later burning.

17. What are the advantages of precast concrete?

- Concrete of superior quality can be produced as it is possible to have the best quality control.
- Smooth surface can be produced and there is no need for plastering.
- Precast units can be given the desired shape.
- Precast units can be prepared in all weather conditions.

18. Define Flooring.

Flooring is the general term for a permanent covering of a floor, or for the work of installing such a floor covering. Floor covering or paving or simply as flooring is the one constructed over the sub-floor and is intended to provide a hard, smooth, durable and impressive surface to the floor.

19. What is meant by centering or shuttering?

Concrete is in a plastic state initially and has to keep within an enclosure of a desired shape by proper supporting till it gains adequate strength. This temporary enclosure is known as centering or shuttering

20. What are the acoustic materials?

Common building materials are absorbents of different levels. Such materials called as absorbent materials or acoustical materials. Examples- 1) Acoustic Plaster 2) Acoustic Tiles 3) Porous Boards 4) Perforated Boards 5) Quilt and Mats.

21. Write short notes on fire resisting properties of building materials.

The building materials have varying fire resistant properties which are discussed below i) Using suitable materials ii) Taking precautions in building construction iii) By providing fire alarm systems and fire extinguishers. **Examples** – 1) Brick 2) Terra-cotta 3) Stone 4) Concrete 5) Mortar 6) Asbestos Cement.

UNIT – 3
SUBSTRUCTURE CONSTRUCTION

6. State the use of Box jacking.

Box jacking also known as Tunnel jacking, involves the advancement of a site cast rectangular or other shaped sections using high capacity hydraulic jacks. Uses are

- It is non-intrusive method beneath the existing surface.
- It enables the traffic flow without disruption.
- It is more often used when a subway or a aqueduct or a underground structure is to be constructed.

7. What is meant by pipe jacking?

It is generally referred as 'Micro Tunneling". Pipes are pushed through the ground behind the shield using powerful jacks. Simultaneously excavation takes place within the shield. This process is continued until the pipeline is completed.

8. Write about under water construction of diaphragm walls.

Diaphragm walls are structure elements, which are constructed underground to prevent the seepage into the excavated area. It is a continuous wall constructed in ground in to facilitate certain construction activities. Common uses of diaphragm walls are

- To provide structural support for the construction
- To provide retaining wall
- To provide deep diaphragms

9. Give any 4 types of piling techniques.

A Pile driver is a mechanical device used to drive piles into soil to provide foundation support for buildings or other structures. Some of the piles driving equipments are 1) Diesel hammer 2) Vertical travel lead systems 3) Hydraulic hammer 4) Vibratory pile driver.

10. What are the techniques adopted for tunneling?

The choice of a particular method of tunneling depends on the type ground. The types of ground met with generally are 1) Full face method 2) Top heading and benching method 3) Tunneling with liner plates 4) Needle beam method 5) Drift method

11. Define caissons. Mention its types.

Caisson has come to mean a box like structure, round or rectangular, which is suck from the surface of either land or water to some desired depth. Caissons are of three types:

1) Box caisson 2) Open caisson 3) Pneumatic caissons.

12. What is box caisson? Where do we use it?

A box caisson is open at top and closed at the bottom and is made of timber, reinforced concrete or steel. This caisson is built on land, then launched and floated to pier site where is suck in position. Such a type of caisson is used where bearing stratum is available at shallow depth, and where loads are not very heavy.

13. What is meant by cofferdam?

Cofferdam is a watertight enclosure placed or constructed in waterlogged soil or under water and pumped dry so that construction or repairs can proceed under normal conditions.

14. Mention the different types of coffer dams.

1) Cantilever sheet pile cofferdam 2) Braced cofferdam 3) Embankment protected cofferdam

4) Double wall cofferdam 5) Cellular cofferdam.

15. Write a note on sinking cofferdam.

An open caisson is a box without top or bottom, made of timber, metal, or concrete. An open caisson has heavy walls and sharp wedge like edges which allow it to sink with the aid of additional temporary loads and jets of water while the inside material is dragged out. The sinking of an open caisson proceeds at atmospheric pressure, and theoretically, there is no limit to the depths of sinking. This is called sinking coffer dam.

16. Differentiate cofferdam from caisson.

- Cofferdam is a watertight enclosure placed or constructed in waterlogged soil or under water and pumped dry so that construction or repairs can proceed under normal conditions.
- Caisson has come to mean a box like structure, round or rectangular, which is suck from the surface of either land or water to some desired depth.

17. What is meant by cable anchoring?

An anchor is a device, normally made of metal, used to connect a vessel to the bed of a body of water to prevent the craft from drifting due to wind or current. The vessel is attached to the anchor by the rode (commonly called the anchor cable or anchor chain in larger vessels), which is made of chain, cable, rope, or a combination of these. The process of connecting a vessel to the bed of a body of water using cable or chain or rope is called cable anchoring.

18. What are the two types of anchoring system for the cable incase suspension bridge?

A suspension bridge with light load does not require stiffening. Under heavy loads the cables have to be stiffened so that they may not be put to large changes in shape

- Unstiffened suspension bridge
- Stiffened suspension bridge

19. What is grouting?

Grouting is a process whereby stabilizers, either in the form of a suspension or solution, are injected into sub-surface soil or rocks for control of ground water during construction or strengthening adjacent foundation soils to protect them against damage during excavation, pile driving etc.

20. What are sheet piles?

Sheet piles are thin piles, made of plates of concrete, timber or steel, driven into the ground for either separating members or for stopping seepage of water. They are not meant for carrying any vertical load. They are driven into ground with help of suitable pile driving equipment, and their height is increased while driving, by means of addition of successive installments of sheets.

21. Define well point.

Well points are small well screens of size 50 to 80 mm in diameter and 0.3 to 1 m length. Well points are made of brass or stainless steel screens and of closed ends or self jetting types.

22. Define shoring for deep excavation.

Shoring is the process of supporting a building, vessel, structure, or trench with shores when in danger of collapse or during repairs or alterations. During excavation, shoring systems provide safety for workers in a trench and speeds up excavation.

23. Define dewatering.

Dewatering is the removal of water from solid material or soil by wet classification, centrifugation, filtration, or similar solid-liquid separation processes, such as removal of residual liquid from a filter cake by a filter press as part of various industrial processes

24. Enlist different dewatering techniques.

1) From open sumps and ditches 2) From well-point systems 3) From deep well drainage 4) Electro-osmosis 5) Cement grouting 6) Freezing

25. Name some equipments used for underground open excavation.

1) Excavators 2) Shovels 3) Bulldozers 4) Tractors 5) Motor Graders 5) Scrapers 6) loaders

UNIT – 4
SUPER STRUCTURE CONSTRUCTION

6. Define bridge decks.

Bridges are designed for carrying moving loads and personnel. They need a flat surface for movement. This flat surface is called the surface. They deck may consist of a slab, a beam and a slab, a grillage, a box girder, multi-beam, etc.

7. What is an offshore platform?

The comparatively flat region of submerged land extending seaward from beyond the region where breakers form to the edge of the continental shelf.

8. Mention the reasons for using special forms for shells.

A shell structure is a curved surface structure. It is a relatively thin slab which is curved in one or both directions. It is often stiffened along its edges to maintain its curvature. Based on the geometry of the middle surface, shells may be classified as a) Dome shells b) Shell barrel vault c) Translation shells d) Ruled surface shells

9. What are the precautions to be taken while erecting light weight components on tall structures?

- Excellent co-ordination and site organization have to be maintained.
- All heavy equipments like generators, lighting systems, twists, etc are to be in working condition.
- Effective measures have to be taken to work even in unsuitable weather conditions.

10. What are the major techniques adopted for heavy decks?

Heavy decks are launched by two methods viz , space by space construction and cantilever construction. In the space by space construction bridge deck with precast 'I' girders and cast-in-siter RCC slab are used. In the cantilever construction, segmental construction is adopted using cast-in-situ or precast techniques.

11. Mention the light weight components of tall structures.

The cranes used for erecting light weight components on tall structures are

1) Tower cranes are used mainly in the erection of apartment, and high-rise industrial buildings.
2) Pillar cranes are used for light load up to 20 tonnes. These cranes may be stationary or mobile type.

12. Define support structures.

It may be defined as the structure which is used to support some other structure i.e., to give assistance or to bear a structure or building. Examples: Retaining wall, Dams, Framework, skeletal frame, foundation, etc.

13. What are pre-stressed concrete and its types?

Pre-stressed concrete is a modified or improved form of reinforced concrete. It takes the full advantage of compressive strength of concrete and at the same time eliminates the weakness of concrete in tension. Two methods commonly used for pre-stressing are i) Pre-tensioning method and ii) Post tensioning method.

14. What are erection stresses?

Depending on the types of structure, additional stresses are induced. Such stresses may be caused while dragging a structure to a particular point of installation. Example piles ar while lifting the unit for erection (a prefabricated roof unit).

15. Define articulated structures.

Articulated structure means the separation of a structure into two or more elements and joins the entire structural elements such that it functions as a single monolithic structure. The structural elements are prefabricated, assembled and erected.

16. What are the situations in which articulated structures can be used?

The stresses caused by construction loads and by the weight of components while they are being lifted into position.

17. Define braced domes.

A dome is a type of roof of semi-spherical or semi-elliptical shape. The materials used for construction of domes are stone, brick or concrete. They are supported or circulated or polygon shaped well.

18. What is the necessity of space decks?

Space decks are those which are used for launching of space vehicles and as decks on off-shore structures. Space decks are to be designed for dynamic stresses also in addition to static stresses.

19. Distinguish between space decks and bridge decks.

- Bridges are designed for carrying moving loads and personnel. They need a flat surface for movement. This flat surface is called the surface. They deck may consist of a slab, a beam and a slab, a grillage, a box girder, multi-beam, etc.

- Space decks are those which are used for launching of space vehicles and as decks on off-shore structures. Space decks are to be designed for dynamic stresses also in addition to static stresses.

20. Define sky scrapers.

A skyscraper is a tall, continuously habitable building. There is no official definition or height above which a building may clearly be classified as a skyscraper

21. What are conveyors?

Conveyors are transportation devices which function adopting the friction between the materials being transported and the base of the conveyor called the belt. These are suitable if the path for the flow of material is fixed.

22. Explain the construction sequence of launching girders.

The construction sequences of launching girders are **i) Span by Span Construction-**In this type of construction bridge deck with precast 'I' girders and cast-in-situ RCC slab are used.

ii) Cantilever Construction-Cantilever segmental construction by launching girder are done in phased manner.

23. What are the methods employed for launching heavy decks?

- Balanced cantilever erection method
- Progressive placing method
- Span by span (or) Steeping form work method
- Incremental launching method

24. What are the precautions to be taken in tall building construction?

Tall buildings are invariably of frame structures. Framed structures are comprised of series of frames. These framed structures comprise of columns and beams. Columns are connected by beams at floor and roof levels.

25. List out the types of domes?

- Ribbed domes
- Schwedler domes
- Three way grid domes
- Parallel lamella domes
- Geodesic domes

UNIT – 5
CONSTRUCTION EQUIPMENT

Part –A

11. Name the equipments used for earth moving operations.

Excavators- 1) Loaders 2) Wheel excavator 3) Cable excavator

Shovels- 1) Dipper shovel 2) Dragline 3) Clamshell 4) Drag shovel or Hoe

Bull dozers- 1) Tractors 2) Motor graders 3) Scrapers 4) Loaders

12. What is pile driving?

Construction of pile foundations involves two separate steps, namely, the installation of piles and the making of pile caps. Installation of precast concrete piles, steel piles, timber piles and sheet-piles are driven with the help of pile driving equipment.

13. Give a list of equipments needed in the construction of tall structures.

The cranes used for erecting light weight components on tall structures are discussed below

- Tower cranes are used mainly in the erection of apartment, and high-rise industrial buildings.
- Pillar cranes are used for light load up to 20 tonnes. These cranes may be stationary or mobile type.

14. What are the equipments used for compacting concrete?

The following equipments are used for compaction of concrete: 1) Hand compaction 2) Vibration 3) Internal or immersion vibrators.

15. List out the equipments used for dredging and trenching.

Equipments for dredger - 1) Ladder dredger 2) Cutter dredger 3) Grab dredger 4) Dipper dredger. **Equipments for trenching-** 1) Trencher excavator 2) Self-propelled tractor 3) Wheel type trencher.

16. Define dredging.

Dredgers are used for excavation from riverbed, lake or sea for purpose of deepening them. Dredging is an important operation in navigation canals, harbours, dams etc. The mechanically equipment used for this purposes is called as dredger.

17. What are the operations performed by motor grader?

Motor graders are used for leveling and smoothening the earthwork, spreading and leveling the base courses in the construction of roads and airfield. It can be used for land reclamation, snow clearance, gravel road repairing, mixing of stabilizing materials such as tar, asphalt, cement and lime, maintaining quarry roads etc.

18. What do you understand about truck agitators?

Concrete produced from a mixer is required to be transported to the forms for placing. This handling tends to produce segregation and loss of slump if the distance is long. An agitator truck is one of the vehicle which is used for mixing and transporting of concrete together to long distances.

19. What is mucking?

Mucking is the operation of loading the broken rock pieces, particularly from a tunnel. Different methods of mucking are 1) In small tunnels hand cuts or wheel barrows are used 2) Special power shovels are used in medium size tunnels 3) Specially made mucking machine are equipped with dippers.

20. Write short notes on material handling equipment.

Material handling devices are expected to satisfy one or more of the following functions

- Construction materials are to be moved and positioned.
- Lifting of a load and placing it at a particular place.
- Loading of materials into transportation equipment.

21. What are the scrapers used?

Scrapers are the device to scrap the ground and load it simultaneously, transport it over the required distance, dump at desired place and then spread the dumped material over the required area in required thickness level, and return to the pit for the next cycle.

22. List out the factors affecting of earthwork equipment.

Some of the factors which affect the output of and earthwork equipments are 1) Physical job conditions 2) Type of soil 3) Specification of machine 4) Condition of the machine 5) Method of operation

23. Differentiate between single acting hammer and double acting hammer.

- The functioning of single acting hammer differs from drop hammer only in the manner of lifting of the ram after each blow
- The functioning of double acting hammer, the motive fluid acts on both sides of the piston.

24. What are the various forms of earth movers?

Excavators- 1) Loaders 2) Wheel excavator 3) Cable excavator
Shovels- 1) Dipper shovel 2) Dragline 3) Clamshell 4) Drag shovel or Hoe
Bull dozers- 1) Tractors 2) Motor graders 3) Scrapers 4) Loaders

25. What is TBM?

Tunnel boring machine as mole recent developments in the tunnel driving technique. The function of TBM is to loosen the earth or break the rock continuously in the entire section of the tunnel, into cuttings and convey to the rear of the machine.

26. Write short notes on earth movers.

Earth mover is defined as a vehicle of machine designed for excavating, pushing or transporting large quantities of soil.

27. What are the equipments needed for tunneling and trenching.

Equipments for tunneling- 1) Drill jambos 2) Mechanical Moles 3) Mucking 4) Mechanical vibration 5) Dust control. **Equipments for trenching-** 1) Trencher excavator 2) Self-propelled tractor 3) Wheel type trencher.

28. What are the operations conducted with the help of a tractor?

A tractor is a multi-purpose machine. This comes in varied types as light model to heavy model. The light model is used for agricultural or small haulage purposes. Heavy model equipped with several special rigs are used for earth moving work.

29. Write about pile driving equipment.

Pile driving equipment comprise of the following i) Driving rig ii) Guiding leaders iii) Pile hammer with accessories iv) Additional aids for pre-boring, jetting v) Boiler for steam raising or air compressor.

30. How can scrapers help in increasing speed of construction?

The operations of a conventional scraper are 1) **Digging or loading** 2) **Transporting** 3) **Unloading.**

CE 6506 CONSTRUCTION TECHNIQUES, EQUIPMENTS AND PRACTICES
PART 'B' & 'C' QUESTION BANK
UNIT 1
CONCRETE TECHNOLOGY

1. Explain the various steps involved in the manufacture of concrete.
2. Explain any two tests for testing of fresh concrete.
3. What is meant by Non destructive Testing? Explain any one method in detail.
4. What are the factors to be considered for mix design? Explain the step by step procedure for IS method?
5. What are concrete chemicals? Explain in detail and discuss their uses.
6. Describe the processes in the manufacture of Ordinary Portland Cement.
7. Explain ACI method of mix design.
8. Explain the procedure for compression test on concrete.
9. Explain in detail the different types of curing of concrete.
10. Write in detail about RMC?

UNIT – 2
CONSTRUCTION PRACTICES

3. Explain the different types of stone masonry with neat sketches.
4. Describe in detail the construction practices to be followed for acoustics and fire protection.
5. What are the methods of providing DPC? What are the requirements of an ideal material for Damp proofing?
6. Describe the different types of bonds in brick masonry with sketches.
7. Explain the different types of joints in buildings with sketches.
8. Write notes on DPC and requirements and conditions of good acoustics.
9. What is scaffolding? Mention its various components and types.
10. Explain the various types of flooring with neat sketches.
11. Explain the various types of trusses with neat sketches.
12. Explain the various types of roof finishes with neat sketches.

UNIT – 3
SUBSTRUCTURE CONSTRUCTION

6. Describe the procedure involved in underwater construction of diaphragm walls and basement.
7. What are caissons and cofferdams? Explain the method of sinking cofferdams with neat sketches.
8. What is a coffer dam? With the help of sketches explain the types of coffer dams.
9. Explain the the types of shores in detail.
10. Explain the procedure involved in tunneling techniques.
11. Explain the process of dewatering and the uses of standby equipment for underground

open excavation.

12. Explain with sketches about sheet piles and well points.
13. Explain the methods of piling.
14. Explain the various types of sheet piles.
15. Write the operation procedure for caissons.

UNIT – 4
SUPER STRUCTURE CONSTRUCTION

8. Discuss the various techniques used for construction of heavy decks.
9. Explain about the support structures required for heavy equipments and conveyors.
10. Explain special forms for shells in detail.
11. Discuss the process of in-situ pre-stressing in high rise structures.
12. Explain the procedure involved in erection of braced domes and space decks.
13. What are the advantages of using belt conveyors for transporting materials? Describe the construction of a typical belt conveyor installation.
14. Explain the general requirements in launching girders.
15. Explain about shell roof structures.
16. Write about material handling in detail.
17. Write the procedure for erecting heavy decks.

UNIT – 5
CONSTRUCTION EQUIPMENT

1. Explain in detail the various equipment used for compaction, batching and mixing of concrete.
2. Explain about Earth movers and equipment used for erection of structures.
3. Explain the various equipment for pile driving.
4. Explain the equipment used for tunneling.
5. Explain pile driving in detail.
6. Explain the factors involved in selection of equipment for earthwork.
7. Mention the various types of earthwork equipment. Mention their uses.
8. Discuss the role of tractors in earth moving. What considerations govern the selection of wheel type or crawler type tractor on a job? Compare their applications.
9. Describe the working principle of diesel hammer and state its limitations.
10. Write notes on equipment for erection of structures.