V.S.B. College of Engineering Technical Campus, Coimbatore

Department of Civil Engineering

SUBJECT CODE /NAME: CE 6601/DESIGN OF REINFORCED CONCRETE AND BRICK MASONARY STRUCTURES

UNIT I – RETAINING WALLS

Design of Cantilever and Counterfort retaining walls.

PART - A (2 marks)

1. What are the types of retaining walls? (AUC Nov/Dec-2011)

Gravity retaining wall
Cantilever retaining wall
Counterfort retaining wall
Buttress retaining wall
Basement or foundation wall

Name the two important stability aspects? (AUC Nov/Dec-2011, 12, 13)(May/Jun-2012)

Stability against overturning
Stability against sliding
Stability of foundation base

3. What is gravity retaining wall? (AUC Nov/Dec-2012)

A gravity wall made of plain concrete or brick masonry. The stability of the wall is maintained by its weight. It is generally made up to a height of 3m of wall.

4. How the vertical stem of a counterfort retaining wall is designed? (AUC May/Jun-2012)

The stem is designed as a continuous slab with span equal to the spacing of counterforts. The spacing of counterforts may vary from 2.5m to 4m.maximum load on stem is at its lowest portion due to maximum horizontal earth pressure.

Consider one meter height of vertical slab and design for maximum moments. The maximum negative moment at the end support may be taken as $wl^2/10$ and that at intermediate supports as $wl^2/12$, where l is the span and w is the earth pressure intensity at the lowest portion of vertical slab. The reinforcement curtailed towards the top. The section is checked for shear and end anchorage.

5. What is the structural action between cantilever and counterfort type retaining wall? (AUC May/Jun-2013)

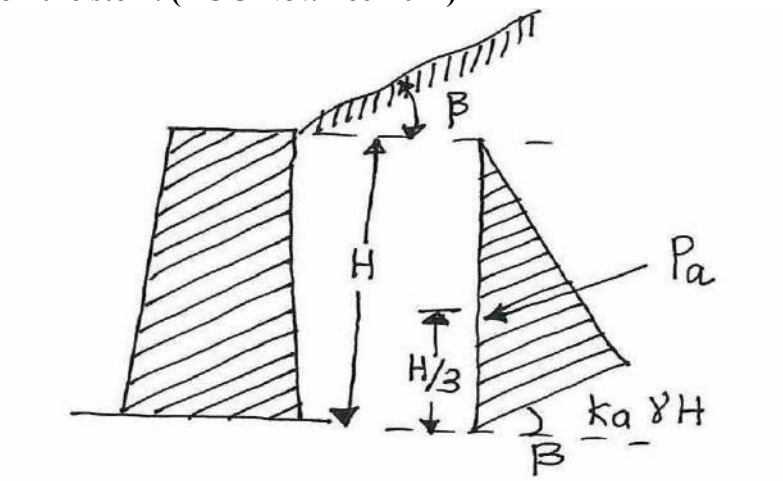
In cantilever retaining wall the pressure and other forces are withstand by the stem of the retaining wall and base slab. In counterfort retaining wall is provided the height of retaining wall is more than 6m.the walls also provided perpendicular to stem wall. The counterfort act as support to stem and heel slab.

0 What is the function of weep hole in retaining wall construction?(AUC May/Jun-2013)

0 The weep hole is provided in the retaining wall for the purpose of water distribution through the hole from the back fill materials.

1 The weep hole is act as drainage in the hilly side retaining walls due to the rain water.

1 A cantilever retaining wall supports an inclined backfill. Sketch the distribution of active earth pressure on the stem. (AUC Nov/Dec-2011)



8. What is a Retaining wall?

Retaining walls are generally used to retain earth or such materials to maintain unequal levels on its two faces. The soil on the back face is at a higher level and is called back fill. Retaining walls are extensively used in the construction of basements below ground level, wing walls of bridge and to retain slopes in hilly terrain roads.

9. What are the forces acting on retaining wall?

Self-weight of retaining wall
Weight of soil above the foundation base
Earth pressure on retaining wall
Surcharge
Soil reaction on the footing
Frictional force on the footing due to sliding.

10. What are the disadvantages of gravity retaining walls?

Gravity walls of stone masonry were generally used in the earlier days to the height of the earth fill. The advent of reinforced concrete has resulted in thinner retaining walls.

11. What are the types of retaining walls?

Retaining wall can be classified structurally as
Cantilever retaining wall,
Counter fort retaining wall

12. What is a cantilever retaining wall?

The most common and widely used retaining wall is of cantilever type. Vertical stem resisting earth pressure one side and the slab bends like a cantilever. The thickness of the vertical slab is large at the bottom and decreases towards the top in proportion to the varying soil pressure.

13. What is a counter fort retaining wall?

Counter fort retaining walls are used for large heights exceeding 5 mts of earth fill. In counterfort retaining wall the vertical stem is designed as a continuous slab spanning between the counterforts. Counter forts are designed as cantilever beams from the base slab.

14. What are the forces acting on a retaining wall?

Forces acting on a retaining wall are

0 Lateral earth pressure due to the back fill

1 Vertical forces including weight of soil, stem, heel, toe, and soil fill above the toe.

2 The soil pressure developed to resist the earth pressure and other vertical forces acting on the heel and toe slab.

1 Define Active Earth pressure.

If the soil exerts a push against the wall by virtue of its tendency to slip laterally and seek its natural slope (angle of repose) thus making the wall to move slightly away from the back filled soil mass. This kind of pressure is known active earth pressure.

16. Define Passive earth pressure.

The pressure or resistance which soil develops in response to movement of the structure towards it is called the Passive Earth Pressure.

17. What are the stability conditions should be checked for the retaining walls?

The stability of retaining walls should be checked against the following conditions The wall should be stable

23 The wall should be stable against Overturning

24 The wall should be stable against bearing capacity failure.

18. What is meant by backfill?

The material retained or supported by a retaining wall is called backfill.

19. What is meant by surcharge?

The position of the backfill lying above the horizontal plane at the elevation of the top of a wall is called the surcharge.

20. What is a gravity retaining wall?

A gravity retaining wall is the one in which the earth pressure exerted by the backfill is resisted by dead weight of the wall, which is either made of masonry or mass concrete.

21. What is meant by submerged backfill?

The sand fill behind the retaining wall saturated with water is called submerged backfill.

22. What is the function of counterforts in a retaining wall?

The stem of the counterfort retaining wall acts as a continuous slab supported on counterforts. The counterforts take reactions both from the stem as well as the heel slab. Since. the active earth pressure on stem acts outwards and net pressure heel slab acts downwards, the counterforts are subjected to tensile stresses along the outer face of the counterforts.

23. What is meant by back anchoring of retaining wall?

When the height of retaining wall is much more, it becomes uneconomical to provide counterforts. In order to reduce the section of stem etc. in the high retaining walls, the stem may be anchored at its back. The anchor practically takes all the earth pressure and B.M and S.F. in the stem are greatly reduced. When the wall is unsafe in sliding, shear key will have to be provided.

24. When is the design of shear key necessary?

When the wall is unsafe in sliding, shear key will have to be provided.

UNIT II – WATER TANKS

Underground rectangular tanks-Domes-Overhead circular and rectangular tanks-Design of staging and foundation.

PART - A (2 marks)

23 Water is the types of reinforced concrete water tanks?(AUC May/Jun-2012)(AUC Nov/Dec-2011)

- Tanks resting on ground
- Underground tanks
- Elevated water tanks.

\2. What are the forces acting on the dome? **(AUC May/Jun-2013)**

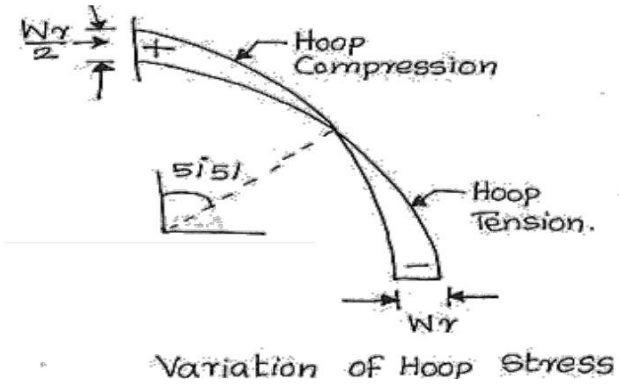
Self-weight of the dome.
Live load
Floor finishing load

23 What are the conditions to be considered for the cylindrical tank situated underground? (AUC May/Jun-2013)

When a water tank is built underground, the wall should be investigated for both internal water pressure and external earth pressure. The external pressure may be due to dry earth or due to a combination of earth and ground water.

The design principles for such tanks are same as that for tanks resting on ground. In such case of tank built below ground with earth covering the roof will be a trapezoidal lateral pressure on the wall.

24 Sketch the variation of hoop stress between the crown and base of a hemispherical top cover dome carrying uniformly distributed load per unit surface area. (AUC Nov/Dec-2013)



Variation of Hoop Stress

23 Mention various critical load combinations that are to be considered in the analysis of walls of an underground rectangular water tank, when there is a possibility of ground water table to rise above the base slab. (AUC Nov/Dec-2013)

When there is a possibility of ground water table to rise above the base slab, not only walls are to be designed for saturated soil up to the extent of water above the base slab, but also the base slab is to be designed for the net uplift pressure of water. In addition check has to be applied for stability of the as a whole against uplift.

24 For what conditions the underground water tanks are designed and checked? (AUC May/Jun-2012) (AUC Nov/Dec-2011)

- The wall to be designed for both internal water pressure and external earth pressure.
- The external pressure may be due to dry earth or due to a combination of earth and ground water.
- The design principles for such tanks are same as that for tanks resting on ground. In such case of tank built below ground with earth covering the roof will be a trapezoidal lateral pressure on the wall.

7. Name the types of movement joints. **(AUC Nov/Dec-2012)**

Construction joints

Expansion joints

Sliding joints

8. What theory is used to design? (AUC Nov/Dec-2012) A. the members under direct tension

The members are designed by Dr.Reissners Method and Carpenter's Method.

B. the members under bending tension

The members are designed by I.S Code method.

9. Mention the grade of concrete which is used in the construction of water tank.

Richer concrete mix of grades M20 to M30 are commonly used in the construction of water tanks. High quality concrete, in addition to providing water tightness, also has higher resistance to tensile stresses developed in the tank walls.

23 Mention the three factors that must be considered while designing a RCC tank.

- Strength
- Water tightness
- Overall stability

23 Mention the reinforcement details that should be provided in a water tanks.

Minimum area of steel is 0.3 percent of gross area of section up to 100mm thick, reduced to 0.2 percent in section up to 450mm thick. For sections above 225mm thick, provide two layers of reinforcement. The percentage of reinforcement in base or floor slab resisting directly on ground must be not less than 0.15% of the concrete section.

The minimum cover to all reinforcement should be not less than 25mm or the diameter of the bar whichever is greater.

12. Define the term: Dome

A Dome is defined as a thin shell generated by the revolution of a regular curve about one of its axes.

23Define the following terms:

Latitude

The circle of each ring in a dome is called Latitude.

Meridian circle : The circle drawn through two diametrically opposite points on a horizontal diameter and the crown is known as meridian circle.

23 Define the following terms

i. Radial

The joint between successive horizontal rings is called radial.

ii. Meridian thrust:

The reaction between the rings is tangential to the curved surface giving rise to compression along the medians. The compressive stress is called meridional thrust or meridional compression.

15. Mention the thickness and steel requirement of dome.

A minimum thickness of 7.5cm is provided to protect steel. Minimum steel requirements 0.15% for mild steel bars and 0.12% for HYSD bars of the sectional area in each direction meridionally as well as along the

23 What are the three types of joints in water tank?

- Movement joints
- Construction joints
- Temporary open joints

24 What is the foundation specification for small capacity tanks?

For small capacity tanks individual footings for columns can be provided. Infect, the type of footing will depend upon the nature of soil and type of staging. In case of low lying areas of low safe bearing capacity with high ground water table, pile footings are provided.

In any case of foundation slab, lean mix of 1:4:8, 150mm thick may be provided as leveling course.

23 What are the methods available for the analysis of circular tank?

- IS code method
- Reissners method
- **Carpenter"s method**
- Approximate method

19. What are movement joints in water tanks?

These joints require the incorporation of special materials in order to maintain water-tightness while accommodating relative movement between the sides of the joints. All movement joints are essentially flexible

20. What is contraction joint in water tanks?

A contraction joint is a typical movement joint which accommodates the contraction of the concrete.

21. What is meant by expansion joint in water tanks?

It is a movement joint with complete discontinuity in both reinforcement and concrete, and is intended to accommodate either expansion or contraction of the structure.

22. What are underground water tanks?

Underground water tanks are used for storage of water received from water supply mains operating at low pressures, or received from other source.

23 What are conditions under which the walls of underground water tanks designed?

- Tank full with water, with no earth fill outside.
- Tank empty, with full earth pressure due to saturated earth fill.

24 What are the four components of design of underground water tanks?

- Design of long walls
- Design of short walls
- Design of base slab

23 What are two methods of analysis of rectangular tanks?

- Approximate analysis
- Exact analysis based on elastic theory

24 Where are the places domes are used?

- Roof of circular areas
- Circular tanks
- Exhibition halls, auditoriums and planetariums and
- Bottoms of tanks, bins and bunkers

UNIT III – SELECTED TOPICS

Design of staircases (ordinary and doglegged staircase)-Design of flat slabs-Design of reinforced concrete walls-principles of design of mat foundation, box culverts and road bridges.

PART - A (2 marks)

1. What are the types of staircases? (AUC May/Jun-2012) (AUC Nov/Dec-2012) (AUC Nov/Dec-2011)

They are broadly classified as

- Quarter turn stair
- Half turn stair
- Dog legged stair
- Open newer stair with quarter space landing
- Geometrical stairs such as circular stair, spiral stair, etc.

2. Define flat slab.(AUC May/Jun-2013)

A flat slab is a typical type of construction in which a reinforced slab is built monolithically with the supporting columns and is reinforced in two or more directions, without any provision of beams.

23 What is the thickness of flat slab with drops and without drops?(AUC May/Jun-2013)

- The thickness of the drop shall be 1.25 to 1.5 times the thickness of the slab.
- The thickness of the flat slab without drop is less than 125mm.

24 Distinguish between one way shear and punching shear in flat slabs.(AUC Nov/Dec-2013)

- The one way shear is located near the column head due to the shear force on the joint.
- Punching shear is located the panels for the shear is created by the loads.

25 What are the load cases for which a box culvert should be designed to remain safe? AUC

Nov/Dec-2013)

-

The box culvert is subjected to soil load from outside and water load from inside.

No water flowing in the drain. The box culvert will be dry from inside, and the sidewalls will be subjected to earth pressure from outside.

- Water in box, which will be subjected to earth pressure from outside and water pressure from inside.

6. What are the limitations of direct design method of flat slabs?

- There must be at least three continuous spans in each direction.
- The panels should be rectangular and the ratio of longer span to shorter span within a panel shall not be greater than 2.0.

  The successive span length in each direction shall not differ by more than one third of the longer span. The end spans may be shorter but not longer than the interior spans. The design live load should not exceed three times the design dead load.

0 **Write the different types of flat slabs?**

- Slabs without drops
- Slab with drops and column with column head

1 What do you mean by column strip and middle strip in flat slab?

Column strip is a design strip having a width of $0.25L_2$ but not greater than $0.25\ L_1$ on each side of the column center line where L_1 is the span in the direction, moments are being determined, measured center to center of supports and L_2 is the span traverse to L_1 measured center to center of the support.

Middle strip is a design strip bounded on each of its opposite sides by the column strip.

9. What is a stair case?

A staircase consists of a number of steps arranged in a series, with landings at appropriate locations, for the purposes of giving access to different floors of a building.

10. Define tread

The horizontal portion of a step was the foot rests is referred to, as tread.250 to 300 mm is the typical dimensions of a tread. Riser is the vertical distance between the adjacent treads or the vertical projection of the step with value of 150 to 190 mm depending upon the type of building.

11. Define Going

Going is the horizontal projection of an inclined flight of steps between the first and last riser.

12. What is a flight?

A flight is the length of the staircase situated between two landings. The number of steps in a flight may vary between 3 to 12.

13. What is the minimum rise and tread in residential buildings?

In residential buildings, the rise may vary between 150mm to 180mm tread between200mm to 250mm.

14. What is the minimum rise and tread in public buildings?

In public buildings, the rise may vary between 120mm to 150mm tread between200mm to 300mm.

15. Mention the places where the following staircase can be used

Single flight staircase is used in cellars or attics where the height between floors is small and the frequency of its use is less. Quarter turn staircase flight generally runs adjoining the walls and provides uninterrupted space at the center of the room.

Generally used in domestic houses where floor heights are limited to 3m. Dog legged staircase is generally adopted in economical utilization of available space.

Open well staircases are provided in public buildings where large spaces are available. In congested locations, where space availability is small, Spiral stairs are provided.

What are all the components of flat slab?

- Drop of flat slab
- Capital or column head

17. Define drop of flat slab.

Drop is that part of the slab around the column, which is of greater thickness than the rest of the slab.

18. Define capital or column head.

Sometimes the diameter of a supporting column is increased below the slab. This part of column with increased diameter is called column head.

19. Define panel of flat slab.

It is the area enclosed between the center lines connecting adjacent columns in two direction sand the outline of the column heads.

0 **What are the methods of analysis of flat slab?**

- The direct design method
- The equivalent frame method

21. What are all the assumptions made in equivalent frame method?

- The structure is considered to be made of equivalent frames longitudinally and transversely.
- Each frame is analyzed by any established method like moment distribution method.
- Iii The relative stiffness is computed by assuming gross cross section of the concrete alone in the
- Any variation of moment of inertia along the axis of the slab on account of provision of drops
- Slabs without drops and column heads calculation of the moment of inertia should be considered.

22. What are all the assumptions made in direct design method?

- There shall be minimum of three continuous spans in each direction.
- The panel shall be rectangular, and the ratio of the longer span to the shorter span within a panel shall not be greater than 2.0.

23. Explain about box culvert shortly.

Slabs are cast monolithic. A box culvert is used where a small drain crosses a high embankment of a road or a railway or a canal- especially when bearing capacity of soil is low. A box culvert is continuous rigid frame of rectangular section in which the abutment and the top and bottom.

0 Give the names of various types of bridges.

- Solid Slab Bridge or deck slab bridge.
- Deck Girder Bridge or T-beam Bridge.
- Balanced cantilever bridge
- Rigid frame culvert.
- Bowstring Girder Bridge.
- Continuous girder or arch bridge.

UNIT IV – YIELD LINE THEORY

Application of virtual work method to square, rectangular, circular and triangular slabs.

PART - A (2 marks)

0 List the assumptions made in yield line analysis of slabs.(May/Jun-2013) (Nov/Dec-2011) (May/Jun-2012)

- The reinforcing bars are fully yielded across the yield lines at failure.
- The yield lines divide the slab into various segments who in turn behave classically.
- The entire deformation take place only in the yield lines and the individual segments of the slab are plane segments in the collapse condition.
- The bending and twisting moments have the maximum values and are uniformly distributed along the yield lines.
- The yield lines are straight at in intersection of individual inclined segments.

2. Define yield line theory. (May/Jun-2013)

The yield line theory is largely based upon the yield lines that develop in any reinforced concrete slab (rectangular, circular, square or any other geometrical shape in plan) before its final collapse. This stage reaches under loads approaching collapse load or ultimate load that the slab can carry.

The collapse loads, movements and shears can be calculated from the crack pattern developed in slab, under idealized support conditions and only uniformly distributed loads.

5888 What are the characteristic features of yield lines?(Nov/Dec-2011)(May/Jun-2012)

- Yield lines end at the supporting edges of the slab
- Yield lines are straight
- A yield line or yield line produced passes through the intersection of the axes of rotation of adjacent slab
- Axes of rotation generally lie along lines of supports and pass over any columns.

4. What is meant by yield lines?

The failure of reinforced concrete slabs of different shapes such as square, rectangular, circular with different types of edge conditions is preceded by a characteristic pattern of cracks, which are generally referred to as yield lines.

5. State the principle of virtual work. (Nov/Dec-2013)

If a deformable structure in equilibrium under the action of a system of external forces is subjected to a virtual deformation compatible with its condition of support, the work done by these forces on the displacements associated with the virtual deformation is equal to the work done by the internal stresses on the strains associated with this deformation.

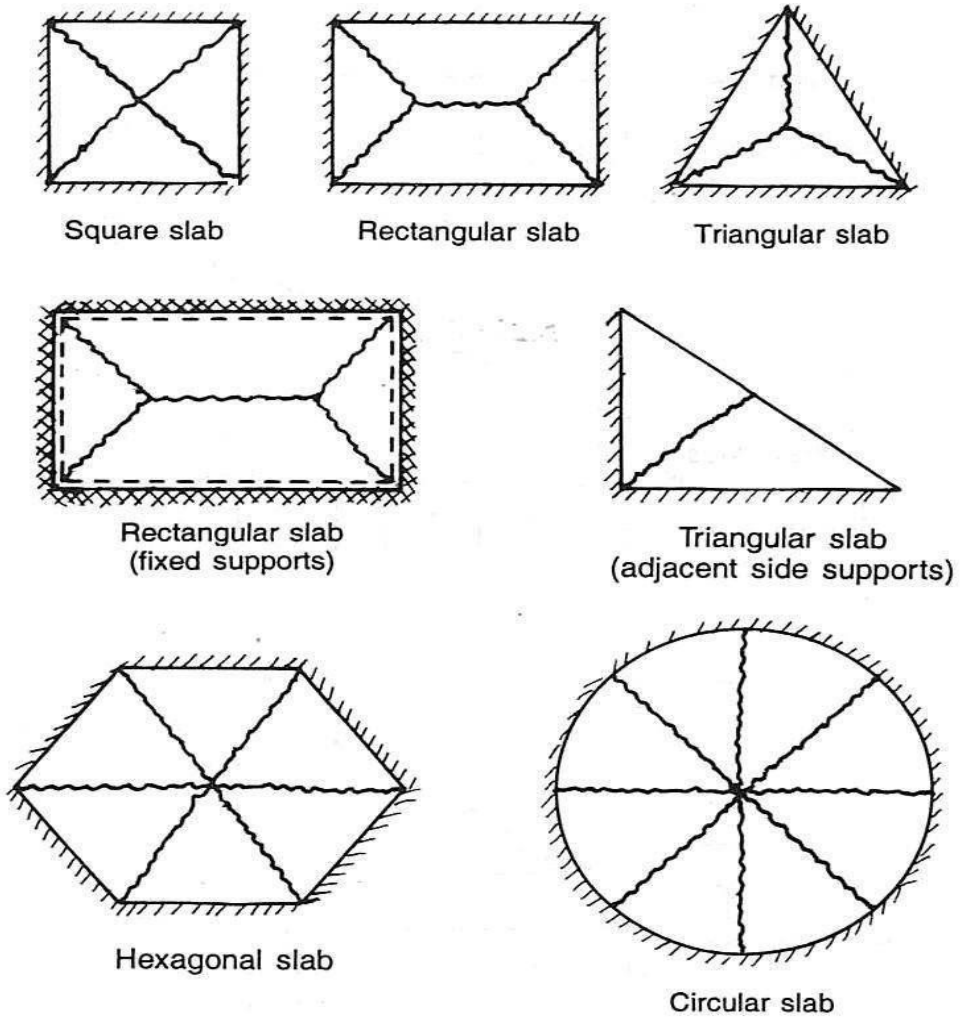
6. What is meant by an orthotropically reinforced slab? (Nov/Dec-2012)

If the reinforcement in the two directions is not the same, it is said to be orthotropically reinforced slab.

7. What is meant by an isotropically reinforced slab? (Nov/Dec-2012)

The ultimate moment of resistance in an isotropically reinforced slab, in any direction, is the same.

8. Draw the typical yield line pattern for different slabs. (Nov/Dec-2012) (Nov/Dec-2013)



Typical yield line patterns in reinforced concrete slabs.

0 What are the two methods of determining the ultimate load capacity of reinforced concrete slabs?

- Virtual work method
- Equilibrium method

10. What is the direction of yield line in one way slab?

In one way slab, the direction of yield line is perpendicular to the direction of steel.

11. What is the direction of yield line in two way slab?

In two way slab, the direction of yield line is not perpendicular to the direction of steel.

0 What is the concept of yield line method?In the yield line method, the computation of ultimate load is based on the pattern of yield lines that are developed in the slabs under conditions approaching collapse.

25. Who innovated yield line theory?

This method was innovated by Ingerslav (1923) and was greatly extended and advanced by Johanssen.

14. What is a yield line?

A yield line is defined as a line in the plane of the slab across which reinforcing bars have yielded and about which excessive deformation under constant limit moment continues to yield leading to failure.

15. Define static indeterminacy of a structure.

If the conditions of statics i.e.,ΣH=0,ΣV=0 and ΣM=0 alone are not sufficient to find either external reactions or internal forces in a structure, the structure is called a statically indeterminate structure.

16. Define: Unit load method.

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

0.0 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 .Mmax max = wl / 8

0.1 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.

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.

0 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 tendency to change the nature of stresses is called reversal of stresses.

0 **What is the moment at a hinged end of a simple beam?**

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

1 Define similitude.

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

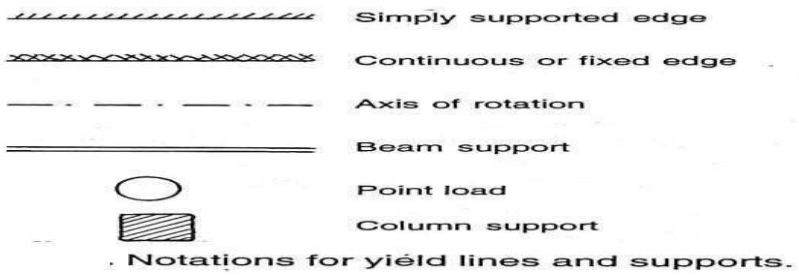
Geometric similitude is similarity of form

- Kinematic similitude is similarity of motion Dynamic and/or mechanical similitude is similarity of masses

23. Define: Trussed Beam.

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

24. Draw the notations for yield lines and supports.



. Notations for yield lines and supports.

UNIT V – BRICK MASONRY

Introduction, classifications of walls, lateral supports and stability, effective height of walls and columns, effective length of walls, design loads, load dispersion, permissible stresses, design of axially and eccentrically loaded brick walls.

PART - A (2 marks)

0 What is effective length of brick wall when the wall is continuous? (AUC May/Jun 2013)

The effective length of the wall is continuous=0.8L

1 What is the allowable compressive stress in brick masonry?

Permissible compressive stress in masonry shall be based on the value of basic compressive stress as given in table 8 and multiplying this value by factor known as

0 Stress reduction factor

0 Area reduction factor

Shape modification factor

0 How the brick masonry walls are classified?

0 Load bearing wall

- Non load bearing wall

4. How will you determine the permissible stress in masonry?

Permissible compressive stress in masonry shall be based on the value of basic compressive stress as given in **table 8 (IS: 1905-1987)** and multiplying this value by factor known as stress reduction factor (k_s),area reduction factor (k_a) and shape modification factor (k_p) as detailed in 5.4.1.1 to 5.4.1.3.

5. What is mean by slenderness ratio of a masonry wall? (AUC Nov/Dec 2012)

The slenderness ratio of a masonry wall is defined as the effective height divided by the effective thickness or its effective length divided by the effective thickness, whichever is less.

23 Name the various types of masonry walls used in building construction.(AUC Nov/Dec 2012) (AUC May/Jun 2012)

- o Partition walls
- o Party walls
- a. Separating walls

24 Obtain the stress reduction factor for an eccentrically loaded masonry member with Slenderness ratio of 12 and eccentricity to thickness ratio of 1/12. (AUC Nov/Dec 2013)

From table 9 (IS: 1905-1987) stress reduction factor for slenderness ratio and eccentricity. The stress reduction factor for slenderness ratio is 12 and eccentricity is 1/12 is **0.81**.

5888 Why is it intended to limit the slenderness of the load bearing masonry wall?(AUC Nov/Dec 2013)

Load bearing masonry walls the slenderness ratio is the important design criteria, so to limit we limit the slenderness of the load bearing wall.

5889 What is cross sectional area of Masonry unit?

Net cross sectional area of a masonry unit shall be taken as the gross cross sectional area minus the area of cellular space. Gross cross sectional area of cored units shall be determined to the outside of the coring but cross sectional area of groves shall not be deducted from the gross cross sectional area to obtain the net cross sectional area.

10. What is bond in brick masonry?

Arrangements of masonry units in successive courses to tie the masonry together both longitudinally and transversely the arrangement is usually worked out to ensure that no vertical joint of one course is exactly over the one in the next course above or below it, and there is maximum possible amount of lap.

11. How will you calculating effective length, effective height and effective thickness?

The height of a wall to be column to be considered slenderness ratio. The length of a wall to be column to be considered slenderness ratio. The thickness of a wall or column to be considered for calculating slenderness ratio.

12. What meant by lateral support?

A support which enables a masonry element to resist lateral and/or restrains lateral deflection of a masonry element at the point of support.

13. What is the slenderness ratio for walls?

For a wall, Slenderness ration shall be effective height divided by effective thickness or effective length divided by the effective thickness is less.

14. What is the slenderness ratio for walls and columns?

For column slenderness ration shall be taken to be the greater of the ratios of effective heights to the respective effective thickness in the two principal directions. Slenderness ratio for a load-bearing column shall not exceed 12.

15. What is slenderness ratio in brick masonry structures?

In brick masonry structures, for a wall slenderness ratio shall be the effective height divided by the effective thickness or effective length divided by the effective thickness whichever is less.

16. What is slenderness ratio in brick column masonry structures?

For a column slenderness ratio shall be taken to be the greater of the ratios of effective height s to the respective effective thickness in the two principal directions. Slenderness ratio of a load-bearing column shall not exceed 12.

17. What is reinforced brick work?

Reinforced brickwork is a typical type of construction in which the compressive strength of bricks is utilized to bear the compressive stress and steel bars are used to bear the tensile stresses in the slab.

23 What is the thickness adopted for reinforced brick slab?

The thickness of slab may be kept as 100mm to 200mm.

24 What are reinforced Masonry Walls?

A wall can be defined as an upright member, the width of which exceeds four times its thickness. If the ratio is less than four the wall is considered as column.

5888 What are the factors affecting design of masonry walls?

5888 Strength
5889 Materials used
5890 Loads acting on walls
5891 Weight of the members.

UNIT I (16 Marks)

23 Explain the steps to be followed in proportioning and design of retaining walls.

24 Design a reinforced concrete cantilever retaining wall to retain earth level with the top of the wall to a height of 5.5 m above ground level. The density of soil at site is 17 KN/Cu.mts with a safe bearing capacity of 120 KN/sq.mts. Assume the angle of shearing resistance of the soil as 35degrees. Further assume a coefficient of friction between soil and concrete as 0.55. Adopt M20grade concrete and Fe415 HYSD bars.

25 A Cantilever type retaining wall is to be designed to support a bank of earth 4m above the ground level on the toe side of the wall. The backfill surface is inclined at an angle of 15 degrees with the horizontal. Assume that good soil is available for foundations at a depth of 1.25m below the ground level with a safe bearing capacity of 160KN/m and an angle

of shearing resistance of 30degrees .Assume co-efficient of friction between soil and concrete as 0.5,Adopt M-20 grade concrete and Fe-415 HYSD reinforcement. Assume the unit weight of soil as 16kN/m3

.4. Design a counter fort type retaining wall to support an earth fill of 7.5m above ground level. The foundation depth may be taken as 1.5m below the ground level. The safe bearing capacity of soil at site is 150KN/m2. .Unit weight of soil may be taken as 16KN/m3 and an angle of shearing resistance of 30 degrees. Assume the value of coefficient of friction as .55.Adopt M-20 grade concrete and Fe-415 HYSD bars. Sketch the details of reinforcements in the retaining wall.

5888 Design a cantilever retaining wall to retain earth with a backfill sloped 20 degrees to the horizontal. The top of the wall is 5.5m above the ground level. Assume the depth of foundation as 1.2 m below the ground level with a safe bearing capacity of capacity of 120Kn/m3.The unit weight of backfill is18KN/m3 and an angle of shearing resistance of 35 degrees .Also assume the coefficient of friction between soil and concrete as 0.55.Adopt M-20 grade concrete and Fe-415HYSD steel bars.

UNIT II

23 An open rectangular tank 4m x 6m x 3m deep rests on firm ground. Design the tank. Use M20mix.

24 Design a circular tank with flexible base for capacity of 400000 liters. The depth of water is to be4m, including a free board of 200mm.Use M20 concrete.

25 Design an underground water tank 4m x 10m x 3m deep. The sub soil consist of sand having angle of repose of 30 degree and saturated unit weight of 17KN/m3.The water table is likely to rise up to ground level. Use M20 concrete and HYSD bars. Take unit weight of water as9.81KN/m3

26 Design the side wall of a circular tank of capacity1.5 lakh litres of water. The depth of the tank is limited to 2.5m. The joint between the wall and base as flexible. The base slab rest on the ground. Use M 20 grade concrete.

27 Design a spherical dome over a circular beam for the following data

23 Inside diameter of room = 12m
24 Rise of dome = 4m
25 Live load due to wind, snow,etc = 1.5 KN/m2

The dome has an opening of 1.6m diameter at its crown. A lantern is provided at its top, which causes a dead load of 22KN acting along the circumference of the opening. Use M20 concrete and Fe415 steel.

5888 Design a conical dome roof for a room with base diameter as 12m. The live load due to wind, snow, etc may be taken as 1000N/mm2.The height of the roof is 4m.

UNIT III

0 Design one of the flights of stairs of a school building spanning between landing beams to suit the following data.

- 0.0 Type of staircase : waist slab type
- 0.1 Number of steps = 12
- 0.2 Tread T =300mm
- 0.3 Riser R =160mm
- 0.4 Width of landing beams = 400mm
- 0.5 Materials: M-20 concrete and Fe-415 HYSD bars.

0 Design a dog-legged stair for a building in which the vertical distance between floors is 3.6m.Thestair hall measures 2.5m x 5m.The live load may be taken as 2500N/mm2.Use M20 concrete, and HYSD bars.

1 Design the interior panel of a flat slab 5.6m x 6.6m in size, for a super imposed load of 7.75kN/m2.Provide two-way reinforcement. Use M20 concrete and Fe 415 steel.

2 Design the interior panel of a flat slab for a warehouse to suit the following data:

- 0 Size of warehouse 24m x 24m divided into panels of 6m x 6m.
- 1 Loading class-5kN/m2
- 2 Materials: M-20 Grade concrete and Fe-415 grade HYSD bars.

3 Design a box culvert having inside dimensions 3.5m x 3.5m.The box culvert is subjected to a superimposed dead load of 12000N/m2 and a live load of 45000N/m2 from the top. Assume unit weight of soil as 18000N/m3 and angle of repose of 30degree.Use M20 concrete and Fe415 steel.

4 Design a solid slab bridge for class A loading for the following data. Clear span = 4.5m
Clear width of road ways = 7m
Average thickness of wearing coat = 80mm
Use M20 mix. Take unit weight of concrete as 24000N/m3

UNIT IV

0 A reinforced concrete square slab, 3.5m X 3.5m is simply supported at the ends and is reinforced with 8mm diameter bars spaced at 150mm centres both ways. Determine the safe service live load if the average effective depth of slab is 100 mm and the total thickness of slab, inclusive of flooring, is 160mm. Use M20 concrete and Fe 415 HYSD bars .

1 A rectangular slab 4m X 5m is simply supported at the ends.Design the slab to carry super – imposed service load of 5 kN / m2, if the slab is to be isotropically reinforced Use M20 concrete and Fe 415 HYSD bars

2 A triangular slab has equal side lengths of 4.5m is supported on two edges and is isotropically reinforced with 8mm dia. bars of Fe 415 grade, spaced at 125mm centres both ways. Determine (i) Ultimate moment capacity (ii) ultimate collapse load. The total thickness of slab may be assumed as 120mm in M20 grade concrete.

3 Design a circular slab of 5m dia, simply supported along the edge,to carry a service live load of 5 kN / m2. Use M20 concrete and Fe 415 HYSD bars.

UNIT V

0 Explain the factors to be considered while designing brick masonry with respect to stability and lateral supports on the structure.

1 What are the factors to be considered while determining the effective height of wall and column sand effective length of walls?

2 Explain the design procedure to design axially and eccentrically loaded brick walls

3 Design an interior panel of a flat slab, 5.5mx5.5m for a live load of 5000 N/m2. Use M20 grade concrete and Fe415 grade steel.

4 Derive from principles the ultimate design moments for a rectangular simply supported slab panel using yield line approach.

5 A square interior panel of an intermediate floor is of effective dimension 5mx5m. The live load on the floor is 2.5 kN/m2. Finishes is 1 kN/m2.. Analyse the slab using yield line approach and design the slab. Use M20 concrete and Fe415 steel.

6 Design a solid square masonry column of height 2000mm, to carry an axial load of 150KN. The column is tied at the top and bottom. Include the self weight of the column for the design.

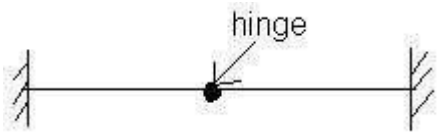
7 Design a solid wall of a single storey mill building that is 3000m in height, securely tied with roof and floor units and supporting two beams on either side of it that exerts reactions of 30KNand 20KN. The thickness of the wall is 230mm. The beam bears on the wall is 115mm. Assume uniform bearing stress. Neglect the load due to self-weight

CE 6602 - STRUCTURALANALYSIS-II

UNIT1-FLEXIBILITY METHOD

PART-A (2 marks)

1.Find degree of indeterminacy of the following. (N/D 2016, Apr/May2011)



Degree of indeterminacy=No. of reactions–No.of condition equations

0 (3+2+ 3) –

3 =5

2.Define kinematic redundancy. (N/D 2016, Apr/May2011)

When a structure is subjected to loads, each joint will undergo displacements in the form of translations and rotations. Kinematic redundancy of a structure means the number of unknown joint displacement in a structure.

3.Give the mathematical expression for the degree of static indeterminacy of rigid jointed plane frames. (AUC Nov/Dec2011)

Degree of static indeterminacy= (No. of closed loopsx3)–No.of releases

4.What are the properties which characterize the structure response by means of force- displacement relationship?(AUC Nov/Dec2011)

0 Each element of a flexibility matrix represents a displacement at a coordinate (i)due to a force at a coordinate (j).

1 If the matrix of the structure is known, we know the behavior of the structure.

5.What are the conditions to be satisfied for determinate structures and how are indeterminate structures identified?(AUC May/June 2012)

Determinate structures can be solving using conditions of equilibrium alone (H=0;V= 0; M=0). No other conditions are required.

Indeterminate structures cannot be solved using conditions of equilibrium because (**H≠0; V ≠ 0; M≠0**). Additional conditions are required for solving such structures.

6.Write down the equation for the degree of static indeterminacy of the pin-jointed frames, explaining the notations used. (AUC May/June 2012)

Total indeterminacy=External indeterminacy+ Internal indeterminacy

External indeterminacy =No. of reactions–No.of equilibrium equations

Internal indeterminacy =m - (2 j - 3)

7.Differentiate pin-jointed planeframe and rigid jointed plane frame. (AUC May/June 2013)

S.No	Pin jointed plane frame	Rigid jointed plane frame
1	The joints permit change of angle between connected members.	The members connected at a rigid joint With maintain the angle between them even under deformation due to loads.
2	The joints are in capable 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 members by developing shear.	Provision of rigid joints normally Increases there redundancy of the structures.

8.Mention any two methods of determining the joint deflection of a perfect frame.

(M/J 2016,May/June 2013)

0 Unit load method

1 Virtual work method

2 Slope deflection method

3 Strain energy method

9.What are the requirements to be satisfied while analyzing a structure?

The three conditions to be satisfied are:

5888 Equilibrium condition

(ii)Compatibility condition

(iii)Force displacement condition

10.What is meant by force method in structural analysis?

A method in which the forces are treated as unknowns is known as force method. The following are the force methods:

23 Flexibility matrix method

24 Consistent deformation method

25 Claypeyron"s 3 moment method

26 Column analogy method

11.Define flexibility coefficient.

It is defined as the displacement at coordinate i due to unit force at coordinate j in a structure. It makes up the elements of a flexibility matrix.

12.Why is flexibility method also called as compatibility method or force method?

Flexibility method begins with the superposition of forces and is hence known as force method. Flexibility method leads to equations of displacement compatibility and is hence known as compatibility method.

13.Define the Force Transformation Matrix.(MAY/JUNE 2016)

The connectivity matrix which relates the internal forces Q and the external forces R is known as the force transformation matrix. Writing it in a matrix form,

$$\{Q\} = [b]\ \{R\}$$

Where, Q = member force matrix/vector;

b= force transformation matrix

R=external force/load matrix/vector.

14.State any two methods of matrix inversion.

5888 Ad joint method

5889 The gauss-jordan method (by linear transformation)

5890 The Choleski method(by factorization)

5891 Partitioning method

15.Define Degree of Freedom and explain its types.(NOV/DEC 2016)

Degree of freedom is defined as the least no of independent displacements required to define the deformed shape of a structure.

There are two types of DOF:(a)Nodal type DOF and (b) Joint type DOF.

a) Nodal type DOF:

This includes the DOF at the point of application of concentrated load or moment, at a section where moment of inertia changes, hinge support, roller support and junction of two or more members.

b) Joint type DOF:

This includes the DOF at the point where moment of inertia changes, hinge and roller support and junction of two or more members.

16.Define a primary structure.(NOV/DEC 2012)

A structure formed by the removing the excess or redundant restraints from an indeterminate structure making it statically determinate is called primary structure. This is required for solving indeterminate structures by flexibility matrix method.

17.Briefly mention the two types of matrix methods of analysis of indeterminate structures.(MAY/JUNE 2016)

Flexibility matrix method:

This method is also called the force method in which the forces in the structure are treated as unknowns. The no of equations involved is equal to the degree of static indeterminacy of the structure.

Stiffness matrix method:

This is also called the displacement method in which the displacements that occurring the structure are treated as unknowns. The no of displacements involved is equal to the no of degrees of freedom of the structure.

18.Find the indeterminacy for the given rigid plane frame.

$$i= (3m+ r)–3j$$

Where, m =3; r =4; j = 4

$$i= (3 \times 3+4)–(3x4) =1$$

External indeterminacy, EI= r –e= 4–3= 1

Internal indeterminacy, II = i–EI =1- 1=0.

19.Define local and global coordinates.(MAY/JUNE 2009)

Local coordinates: Coordinates defined along the individual member axes locally.

Global coordinates: Common coordinate system dealing with the entire structure. Also known as system coordinates.

20.What is the relation between the flexibility matrix and stiffness matrix?(N/D 2016,M/J 2016)

The relation between the flexibility matrix and stiffness matrix is that, one is the inverse of the other, when they both exist.

21. What is meant by indeterminate structures?

Structures that do not satisfy the conditions of equilibrium are called indeterminate structure. These structures cannot be solved by ordinary analysis techniques.

22. What are the conditions of equilibrium?

The three conditions of equilibrium are the sum of horizontal forces,vertical forces and moments at any joint should be equal to zero.

i.e., $\sum H = 0$; $\sum V = 0$; $\sum M = 0$

23. Differentiate between determinate and indeterminate structures.

Determinate structures can be solving using conditions of equilibrium alone **($\sum H = 0$; $\sum V = 0$; $\sum M = 0$).** No other conditions are required.

Indeterminate structures cannot be solved using conditions of equilibrium because **($\sum H \neq 0$; $\sum V \neq 0$; $\sum M \neq 0$).** Additional conditions are required for solving such structures.

24. Define degree of indeterminacy.

The excess number of reactions that make a structure indeterminate is called degree of Indeterminacy. Indeterminacy is also called degree of redundancy.

Indeterminacy consists of internal and external indeterminacies.

It is denoted by the symbol**„i"**

Degree of redundancy(i)= I.I.+ E.I.

Where I.I. = internal indeterminacy and E.I.= external indeterminacy.

25. Define internal and external indeterminacies.

Internal indeterminacy (I.I.) is the excess no of internal forces present in a member that make a structure indeterminate.

External indeterminacy (E.I.) is excess no of external reactions in the member that make the structure indeterminate.

Indeterminacy =I.I.+ E.I.

E.I.= r–e; where r=no of support reactions and e= equilibrium

conditions I.I.= i–EI

e= 3 (plane frames) and e= 6 (space frames)

23 Write the formulae for degree of indeterminacy for:(M/J 2012,A/M 17,NOV/DEC2011&2017)

(a)Two dimensional pin jointed truss (2DTruss)

i= (m+r)– 2j where m= no of members

r= no of reactions; j= no of joints

(b)Two dimensional rigid frames/plane rigid frames(2DFrames)

i= (3m+r)– 3j where m= no of members

r= no of reactions; j= no of joints

(c)Three dimensional space truss(3DTruss)

i= (m+r)– 3j where m= no of members

r= no of reactions; j= no of joints

(d)Three dimensional space frames (3DFrame)

i= (6m+r)– 6j where m= no of members

r= no of reactions; j= no of joints

5888 Find the indeterminacy for the beams given below.

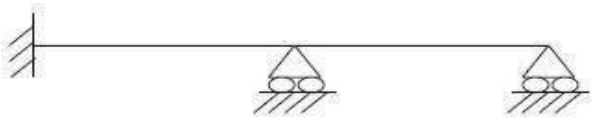
For beams degree of indeterminacy is given by i=r– e

(a)

i= r– e where,r= no of reactions, e= no of equilibrium conditions r= 4 ande= 3

i= 4– 3 =1

(b)



i= r– e where, r= no of reactions, e= no of equilibrium conditions r= 5 ande= 3

i= 5– 3 =2

0 Find the indeterminacy for the given rigid plane frame. i= (3m+ r)– 3j

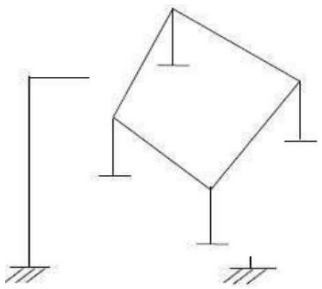
Where, m= 3;r= 4; j= 4

i= (3x 3 + 4)– (3x 4)=1

External indeterminacy EI= r – e= 4– 3 = 1

Internal indeterminacy II= i– EI= 1-1 = 0

0 Find the indeterminacy of the space rigid frame. i= (6m+ r)– 6j



Where, m= 8;r= 24 (i.e. 6 per support x 4)

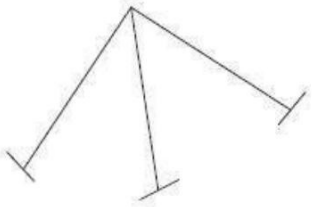
j= 8; e= 6

i= (6x 8 + 24)– (6x 8)=24

External indeterminacy EI= r – e= 24– 6 = 18

Internal indeterminacy II= i– EI= 24-18 =6

30. Find the indeterminacy for the given space truss.



i= m+ r– 3j

Where m= 3

r= 18 (i.e. 6 reactions per supportx 3)

j= 4

i= (3+ 18)– (3x 4)=9

External indeterminacy EI= r – e= 18– 6 = 12

Internal indeterminacy II= i– EI= 9-12 = -3

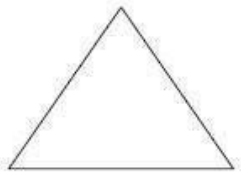
31. What are the different methods of analysis of indeterminate stru ct u res ?

The various methods adopted for the analysis of indeterminate structures include:

0 Flexibility matrix method

1 Stiffness matrix method

2 Finite Element method



23 **for the truss shown below, what is the**

DOF? Pin-jointed plane frame/ truss

DOF/ Dk= 2j– r

Where, r= no of reactions; j= no of joints

33. Define compatibility in force method of analysis. (MAY/JUNE 2015)

Compatibility is defined as the continuity condition on the displacements of the structure after external loads are applied to the structure.

23 Write the element flexibility matrix (f) for a truss member & for a beam element. The element flexibility matrix (f) for a truss member is given by

$$f = \frac{L}{AE}$$

The element flexibility matrix (f) for a beam element is given by

$$f = \frac{L}{6EI}\begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix}$$

UNIT II - STIFFNESS MATRIX METHOD

PART-A (2 marks)

1. Define static indeterminacy. (AUC Apr/May2011)

The excess number of reactions that make a structure indeterminate is called static indeterminacy.

Static indeterminacy=No. of reactions–Equilibrium conditions

23Define flexibility of a structure. (AUCApr/May2011)

This method is also called the force method in which the forces in the structure are treated as unknowns. The no of equations involved is equal to the degree of static indeterminacy of the structure.

3. Write down the equation of element stiffness matrix as applied to 2D plane element.

(NOV/DEC 2017)

(AUC Nov/Dec2011)

The equation of element stiffness matrix for 2D plane element is

$$= \frac{EI}{L}\begin{bmatrix} 4 & 2 \\ 2 & 4 \end{bmatrix}$$

4. Define degree of freedom of the structure with an example. (AUC May/June 2012)
What is degree of kinematic indeterminacy and give an example. (AUC Nov/Dec2011)

Degree of freedom is defined as the least no of independent displacements required to define the deformed shape of a structure.

There are two types of DOF:(a) Nodal type DOF and (b)Joint type DOF.

For example:

i = r –e where, r =no of reactions, e=no of equilibrium conditions

r= 4 and e= 3

i = 4–3= **1.**

5. Write a short note on global stiffness matrices. (AUC May/June 2012)

The size of the global stiffness matrix (GSM)= No: of nodes x Degrees of freedom per node.

6. Write a note on element stiffness matrix. (AUC May/June 2013)

$$= \begin{bmatrix} K_1 & 0 & 0 \\ 0 & K_2 & 0 \\ 0 & 0 & K_3 \end{bmatrix}$$

The element stiffness is K1,K2,K3etc.....

7. List out the properties of rotation matrix. (AUC May/June 2013)

23 Matrix multiplication has no effect on the zero vectors (the coordinates of the origin).

24 It can be used to describe rotations about the origin of the coordinate system.

25 Rotation matrices provide an algebraic description of such rotations.

23 They are used extensively for computations.

24 Rotation matrices are square matrices with real entries.

24What are the basic unknowns in stiffness matrix method?

In the stiffness matrix method nodal displacements are treated as the basic unknowns for the solution of indeterminate structures.

9. Define stiffness coefficient„kij".

Stiffness coefficient „kij" is defined as the force developed at joint **„i" d**ue to unit displacement at joint **„j"** while all other joints are fixed.

10.What is the basic aim of the stiffness method?

The aim of the stiffness method is to evaluate the values of generalized coordinates **„r"** knowing the structure stiffness matrix **„k" a**nd nodal loa**ds „**R**"** through the structure equilibrium equation.

{R}= [K] {r}

11.What is the displacement transformation matrix?

The connectivity matrix which relates the internal displacement **„**q**" a**nd the external displacement **„r"** is known as the displacement transformation matrix **„a"**.

{q}= [a] {r}

12.How are the basic equations of stiffness matrix obtained?

The basic equations of stiffness matrix are obtained as:

23 Equilibrium forces

24 Compatibility of displacements

25 Force displacement relationships.

13.What is meant by generalized coordinates?

For specifying a configuration of a system, a certain minimum no of independent coordinates are necessary. The least no of independent coordinates that are needed to specify the configuration is known as generalized coordinates.

14.Write about the force displacement relationship.

The relationship of each element must satisfy the stress-strain relationship of the element material.

15.Compare flexibility method and stiffness method.(MAY/JUNE 2016)

Flexibility matrix method:

23 The redundant forces are treated as basic unknowns.

24 The number of equations involved is equal to the degree of static indeterminacy of the structure.

25 The method is the generalization of consistent deformation method.

23 Different procedures are used for determinate and indeterminate structures

Stiffness matrix method:

23 The joint displacements are treated as basic unknowns

24 The number of displacements involved is equal to the no of degrees of freedom of the structure

25 The method is the generalization of the slope deflection method.

26 The same procedure is used for both determinate and indeterminate structures.

16.List possible to develop the flexibility matrix for an unstable structure?

In order to develop the flexibility matrix for a structure, it has to be stable and determinate.

17.What is the relation between flexibility and stiffness matrix?

The element stiffness matrix **„k"** is the inverse of the element flexibility matrix **„f"** and is given

By f= 1/k or k= 1/f.

18.List the properties of the stiffness matrix.

23 The properties of the stiffness matrix are:

24 It is a symmetric matrix

25 The sum of elements in any column must be equal to zero.

26 It is an unstable element therefore the determinant is equal to zero.

19.Why the stiffness matrix method is also called equilibrium method or displacement method?

(APR/MAY 2017)

Stiffness method is based on the superposition of displacements and hence is also known as the displacement method. And since it leads to the equilibrium equations the method is also known as equilibrium method.

20.If the flexibility matrix is given as $F = \begin{bmatrix} 2 & -1 \\ -1 & 4 \end{bmatrix}$ **. Write the corresponding stiffness matrix.**

Stiffness matrix=1/ (Flexibility matrix)

23 = [F]-1.

23 What is the equilibrium condition used in the stiffness method?

The external loads and the internal member forces must be in equilibrium at the nodal points.

23 What is the compatibility condition used in the flexibility method? The deformed elements fit together at nodal points.

24 Write the element stiffness for a truss element.

The element stiffness matrix for a truss element is given by

$$k = \frac{AE}{l}$$

23 Write the element stiffness matrix for a beam element.(APR/MAY 2015,MAY/JUN 2016)

The element stiffness matrix for a beam element is given by

$$k = \frac{2EI}{l}\begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$$

24 What are the types of structures that can be solved using stiffness matrix method?

Structures such as simply supported, fixed beams and portal frames can be solved using stiffness matrix method.

26. Give the formula for the size of the Global stiffness matrix.

The size of the global stiffness matrix (GSM)= No:of no des x Degrees of freedom per node.

5888 Write the n stiffness matrix for a 2 D beam element. (APR/MAY 2015,MAY/JUN 2016)

The stiffness matrix for a 2 D beam element is given by

$$[K] = \begin{bmatrix} k11 & k12 & k13 & k14 \\ k21 & k22 & k23 & k24 \\ k31 & k32 & k33 & k34 \\ k41 & k42 & k43 & k44 \end{bmatrix}$$

$$[K] = EI\begin{bmatrix} 12/L^2 & 6/L^2 & -12/L^3 & 6/L^2 \\ 6/L^2 & 4/L & -6/L^2 & 2/L \\ -12/L^3 & -6/L^2 & 12/L^3 & -6/L^2 \\ 6/L^2 & 2/L & -6/L^2 & 4/L \end{bmatrix}$$

UNIT-III

FINITE ELEMENT METHOD

1. What is meant by Finite element method?

Finite element method (FEM) is a numerical technique for solving boundary value problems in which a large domain is divided into smaller pieces or elements. The solution is determined by assuming certain polynomials. The small pieces are called finite element and the polynomials are called shape functions.

0 List out the advantages of FEM.(APR/MAY 2011)

Since the properties of each element are evaluated separately different material properties can be incorporated for each element.

There is no restriction in the shape of the medium.

Any type of boundary condition can be adopted.

1 List out the disadvantages of FEM.

0 The computational cost is high.

1 The solution is approximate and several checks are required.

2 Mention the various coordinates in FEM.

0 Local or element coordinates

1 Natural coordinates

2 Simple natural coordinates

3 Area coordinates or Triangular coordinates

4 Generalized coordinates

3 What are the basic steps inFEM?

Discretization of the structure

Selection of suitable displacement function

Finding the element properties

Assembling the element properties

Applying the boundary conditions

Solving the system of equations

Computing additional results

4 What is meant by discretization?(MAY/JUN 2016 & 2013 & 2014)

Discretization is the process of subdividing the given body into a number of elements which results in a system of equivalent finite elements.

0What are the factors governing the selection of finite elements?

23 The geometry of the body

24 The number of independent space coordinates

25 The nature of stress variation expected.

0 Define displacement function.(NOV/DEC 2012)

Displacement function is defined as simple functions which are assumed to approximate the displacements for each element. They may assume in the form of polynomials, or trigonometrical functions.

9. Briefly explain a few terminology used in FEM.

The various terms used in FEM are explained below.

Finite element: Small elements used for subdividing the given domain to be analyzed are called finite elements. These elements may be 1D, 2D or 3D elements depending on the type of structure.

Nodes and nodal points: The intersection of the different sides of elements are called nodes. Nodes are of two types– external nodes and internal nodes.

- External nodes– The nodal point connecting adjacent elements.
- Internal nodes– The extra nodes used to increase the accuracy of solution.

Nodal lines:Thei nterface between elements are called nodal lines.

Continuum:The domain in which matter exists at every pointis called a continuum. It can be assumed a shaving infinite number of connected particles.

Primary unknowns: The main unknowns involved in the formulation of the element properties are known as primary unknowns.

Secondary unknowns:These unknowns are derived from primary unknowns are known as secondary unknowns. In displacement formulations, displacements are treated as primary unknowns and stress, strain, moments and shear force are treated as secondary unknowns.

10. What are different types of elements used in FEM?(APR/MAY 2017)

The various elements used in FEM are classified as:

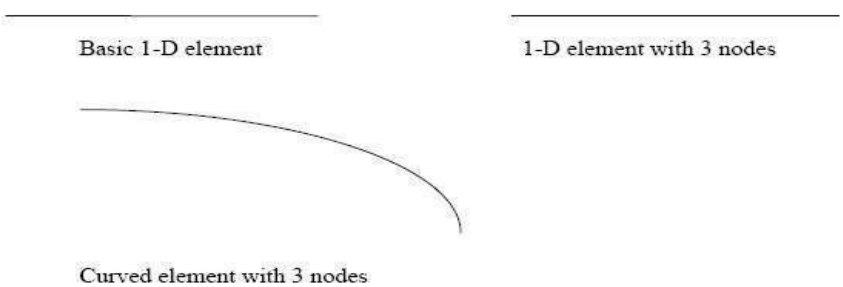
One dimensional elements (1Delements)

Two dimensional elements(2Delements)

Three dimensional elements(3Delements)

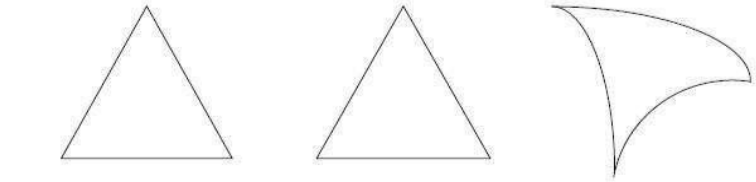
0 Whatare1-Delements? Give examples.

Elements having a minimum of two nodes are called 1D element. Beams are usually approximated with 1Delement. These may be straight or curved. There can be additional nodes within the element.



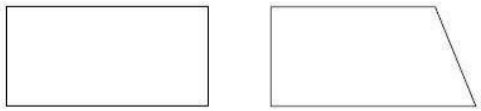
12. What are 2-D elements? Give examples.

A plane wall, plate, diaphragm, slab, shell etc., Can be approximated as an assemblage of 2-D elements. Most commonly used elements are triangular, rectangular and quadrilateral elements.



Triangular elements

Curved triangular element



Rectangular and Quadrilateral elements

13. What are 3-D elements? Give examples.

3-D elements are used for modeling solid bodies and the various 3-D elements are tetrahedron, hexahedron, and curved rectangular solid.

14. Define Shape function.

Shape function is also called an approximate function or an interpolation function whose value is equal to unity at the node considered and zeros at all other nodes. Shape function is represented by Ni where i= no deno.

15. What are the properties of shape functions?(NOV/DEC 2016)

The properties of shape functions are:

0 The no of shape functions will be equal to the no of nodes present in the element.

1 Shape function will have a unit value at the node considered and zero value at other nodes.

2 The sum of all the shape function is equal to 1.

□Ā띋ǰ□Ā□Ā□Ā□Ā□Ā□Ā□ÈÅ ↠ĀÀÅ Ā↠Ā□Ā□Ā□Ā□Ā□Ā□Ā□1 Define aspect ratio.(MAY/JUN 2009,APR/MAY 2010)

Element aspect ratio is defined as the ratio of the largest dimension of the element to its smallest dimension.

17. What are possible locations for nodes?

The possible locations for nodes are:

0 Point of application of concentrated load.

1 Location where there is a change in intensity of loads

2 Locations where there are discontinuities in the geometry of the structure

3 Interfaces between materials of different properties.

18. What are the characteristics of displacement functions?

Displacement functions should have the following characteristics:

À↠ĀÀĀĀĀĀ□Ā□Ā□Ā□Ā□Ā□Ā□Ā□Ā뛵ǰ□Ā□Ā□Ā□Ā□Ā□Ā□Ā0 The displacement field should be continuous.

À↠ĀÀĀĀĀĀ□Ā□Ā□Ā□Ā□Ā□Ā□Ā□Ā뛵ǰ□Ā□Ā□Ā□Ā□Ā□Ā□Ā1 The displacement function should be compatible between adjacent elements

À↠ĀÀĀĀĀĀ□Ā□Ā□Ā□Ā□Ā□Ā□Ā□Ā뛵ǰ□Ā□Ā□Ā□Ā□Ā□Ā□Ā2 The displacement field must represent constant strain states of elements

À↠ĀÀĀĀĀĀ□Ā□Ā□Ā□Ā□Ā□Ā□Ā□Ā뛵ǰ□Ā□Ā□Ā□Ā□Ā□Ā□Ā3 The displacement function must represent rigid body displacements of an element.

1 What is meant by plane strain condition?

À↠ĀÀĀĀĀĀ□Ā□Ā□Ā□Ā□Ā□Ā□Ā□Ā뛵ǰ□Ā□Ā□Ā□Ā□Ā□Ā□Ā0 Plane strain is a state of strain in which normal strain and shear strain directed perpendicular to the plane of body is assumed to be zero.

UNIT IV - PLASTIC ANALYSIS OF STRUCTURES

PART-A (2 marks)

1. What is shape factor? (Nov/Dec 2017) (AUCApr/May2011) (AUC Nov/Dec2011)

The shape factor is defined as the ratio of the plastic moment of a section to the yield moment of the section.

$$S = \frac{Mp}{M} = \frac{Zp}{Z}$$

Where Mp = Plastic moment
M= Yield moment
Zp= Plastic section modulus
Z= Elastic section modulus

2. State upper bound theorem. (Apr/May2011,Apr/May2011, May/June 2013)

Upper bound theorem states that **"**A load computed on the basis of an assumed mechanism

is always greater than or equal to the true ultimate load**"**.

3. Define plastic modulus. (N/D 2017,M/J 2014,M/J 2016,N/D 2011)

The plastic modulus of a section is the first moment of the area above and below the equal area axis. It is the resisting modulus of a fully plasticized section.

Zp= A/2(y1 +y2).

4. What are meant by load factor and collapse load? (AUC Nov/Dec2011&May/June 2012)

Load factor:

Load factor is defined as the ratio of collapse load to working load.

Load factor= collapse load ⁄ working load

$$\lambda = \frac{Wc}{W}$$

Collapse load: The load that causes the (n+ 1)the hinge to form a mechanism is called collapse load where n is the degree of statically indeterminacy. Once the structure becomes a mechanism.

5. Define plastic hinge with an example. (AUC May/June 2012& 2013)

When a section attains full plastic moment Mp, it acts as hinge which is called a plastic hinge. It is defined as the yielded zone due to bending at which large rotations can occur with a constant value of plastic moment Mp.

6. What is difference between plastic hinge and mechanical hinge?

Plastic hinges modify the behavior of structures in the same way as mechanical hinges. The only difference is that plastic hinges permit rotation with a constant resisting moment equal to the plastic moment Mp. At mechanical hinges, the resisting moment is equal to zero.

7. List out the assumptions made for plastic analysis.(M/J 2016, A/M 2015)

The assumptions for plastic analysis are:

0 Plane transverse sections remain plane and normal to the longitudinal axis before and after bending.

1 Effect of shear is neglected.

2 The material is homogeneous and isotropic both in the elastic and plastic state.

3 Modulus of elasticity has the same value both in tension and compression.

4 There is no resultant axial force in the beam.

5 The cross-section of the beam is symmetrical about an axis through its centroid and parallel to the plane of bending.

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1.0.0 Rectangular section, S= 1.5

1.0.1 Triangular section,S= 2.346

1.0.2 Circular section,S= 1.697

1.0.3 Diamond section,S= 2

□Ā뜁ǰ□Ā□Ā□Ā□Ā□Ā□Ā□□ĀÀ↠Ā□Ā뜁ǰ□Ā□Ā□Ā□Ā□Ā□Ā□2 Mention the section having maximum shape factor.

The section having maximum shape factor is a triangular section, S= 2.345.

10.State lower bound theory.(N/D 2016,N/D 2016,M/J 2013,A/M 2015,A/M 2011)

Lower bound theory states that the collapse load is determined by assuming suitable moment distribution diagram. The moment distribution diagram is drawn in such a way that the conditions of equilibrium are satisfied.

11.What are the different types of mechanisms?

The different types of mechanisms are:

Beam mechanism

Column mechanism

Panel or sway mechanism

Cable mechanism

Combined or composite mechanism

12.Mention the types of frames.

Frames are broadly of two types:

0 Symmetric frames

1 Un-symmetric frames

13.What are symmetric frames and how they analyzed?

Symmetric frames are frames having the same support conditions, lengths and loading conditions on the columns and beams of the frame. Symmetric frames can be analyzed by:

0 Beam mechanism

1 Column mechanism

14.What are unsymmetrical frames and how are they analyzed?

Un-symmetric frames have different support conditions, lengths and loading conditions on its columns and beams. These frames can be analyzed by:

0 Beam mechanism

1 Column mechanism

2 Panel or sway mechanism

3 Combined mechanism

15.How is the shape factor of a hollow circular section related to the shape factor of a ordinary circular section?

The shape factor of a hollow circular section =A factor K x shape factor of ordinary circular section. SF of hollow circular section= SF of circular section x $\{(1-c^3)/(1-c^4)\}$.

16.Give the governing equation for bending.

The governing equation for bending is given by

σ M/I= /y

Where M=Bending moment

I =Moment of inertia

0 = Stress

y=C.G.distance

17.Give the theorems for determining the collapse load.

The two theorems for the determination of collapse load are:

Static Method [Lower bound Theorem]

Kinematic Method [Upper bound Theorem]

18.What is a mechanism?

When an-degree indeterminate structure develops n plastic hinges, it becomes determinate and the formation of an additional hinge will reduce the structure to a mechanism. Once a structure becomes a mechanism, it will collapse.

19.What are the assumptions made in fully plastic moment of a section?

0 Plane traverse sections remain plane and normal to the longitudinal axis after bending, the effect of shear being neglected.

1 Modulus of elasticity has the same value in tension and compression.

2 The material is homogeneous and isotropic in both the elastic and plastic state.

3 There is no resultant axial force on the beam. i.e., total compression= total tension.

4 The cross-section of the beam is symmetrical about an axis through its centroid parallel to the plane of bending.

5 Longitudinal fibres are free to expand and contract without affecting the fibres in the lateral dimension.

20.What are the limitations of load factor concept?(APRIL/MAY 2016)

0 The analysis procedure does not give us any clue if a total loadWu/ load factor the structure behaves well.

1 The stresses are within limit, so we have to check the stresses at crucial points by conventional elastic method.

2 This is a peculiar and un realistic assumption.

3 The assumption of monotonic increase in loading is a simplistic.

UNIT V - SPACE AND CABLE STRUCTURES

PART-A (2 marks)

0 **Give any two examples of beams curved in plan. (Apr/May2011& 2016, N/D 2016)**

Curved beams are found in the following structures.

0.0 Beams in a bridge negotiating a curve

0.1 Ring beams supporting a water tank

0.2 Beams supporting corner lintels

0.3 Beams in ramps

0 **What is the nature of forces in the cables? (NOV/DEC 2017,Apr/May2011)** Cables of cable structures have only tension and no compression or bending.

1 Define tension coefficient. For what type of structures tension coefficient method is employed?(AUC Nov/Dec2011)(NOV/DEC 2017)

The tension coefficient for a member of a truss is defined as the pull or tension in the member divided by its length, i.e. the force in the member per unit length.

0 What are the components of forces acting on the beams curved in plan and show the sign conventions of these forces?(AUC Nov/Dec2011)

Beams curved in plan will have the following forces developed in them:

Bending moments

Shear forces

Torsional moments

Define a space frame and what is the nature of joint provided in the space trusses? (AUC May/June 2012)

A space frame is a structure built up of hinged bars in space. It is three dimensional generalization of a truss.

Socket joint is provided in the space trusses.

6. What are the types of stiffening girders? (AUC May/June 2012)

23 Suspension bridges with three hinged stiffening girders

24 Suspension bridges with two hinged stiffening girders

What are the methods available for the analysis of space trusses? (AUC May/June 2013)

Tension co-efficient method is available for the analysis of space trusses.

8. What is the need for cable structures? (AUC May/June 2013)

23 The main load bearing member.

24 Flexible throughout.

25 It can take only direct tension and cannot take any bending moment.

24What are cables structures?(NOV/DEC 2012)

Long span structures subjected to tension and uses suspension cables for supports. Examples of cable structures are suspension bridges, cable stayed roof.

Suspension bridge–

cable structure

10.What is the true shape of cable structures?

Cable structures especially the cable of a suspension bridge is in the form of a catenary. Catenary is the shape assumed by a string/ cable freely suspended between two points.

11.Mention the different types of cable structures.

Cable structures are mainly of two types:

(a)Cable over a guide pulley

(b)Cable over a saddle

12.Briefly explain cable over a guide pulley.

Cable over a guide pulley has the following properties:

23 Tension in the suspension cable =Tension in the anchor cable

24 The supporting tower will be subjected to vertical pressure and bending due to net horizontal cable tension.

13.Briefly explain cable over saddle.

Cable over saddle has the following properties:

11776 Horizontal component of tension in the suspension cable= Horizontal component of tension in the anchor cable

11777 The supporting tower will be subjected to only vertical pressure due to cable tension.

14.What are the main functions of stiffening girders in suspension bridges?OR

Why are stiffening girders is used in suspension bridges?(April/may 2017 & 2015)

Stiffening girders have the following functions.

0 They help in keeping the cables in shape

1 They resist part of shear force and bending moment due to live loads.

Differentiate between plane truss and space truss.(Nov/Dec 2016)

Plane truss:

0 All members lie in one plane

1 All joints are assumed to be hinged.

Space truss:

2 This is a three dimensional truss

0 All joints are assumed to be ball and socketed.

16.What are the significant features of circular beams on equally spaced supports?

0 Slope on either side of any support will be zero.

1 Torsional moment on every support will be zero

17Give the expression for determining the tension T in the cable.

The tension developed in the cable is given by

$= \sqrt{HT^2 + V^2}$

Where, H=horizontal component and V= vertical component.

18.Define tension co-efficient. (Nov/Dec 2017)

The tension co-efficient for a member of a truss is defined as the pull or tension in that member divided by its length.

19.What are cables made of?

0 Cables can be of mild steel, high strength steel, stainless steel, or polyester fibres. Structural cables are made of a series of small strands twisted or bound together to form a much larger cable.

1 Steel cables are either spiral strand, where circular rods are twisted together or locked coil strand, where individual interlocking steel strands form the cable (often with a spiral strand core).

2 Spiral strand is slightly weaker than locked coil strand. Steel spiral strand cables have a Young's modulus, E of 150± 10kN/mm² and come in sizes from 3 to 90 mm diameter. Spiral strand suffers from construction stretch ,where the strands compact when the cable is loaded.

20.Give the types of significant cable structures

Linear structures:

0 Suspension bridges

1 Draped cables

2 Cable-stayed beams or trusses

3 Cable trusses

4 Straight tensioned cables

Three-dimensional structures:

0 Bi-cycle roof

1 3D cable trusses

2 Tensegrity structures

3 Tensairity structures

1 What is a catenary?

Catenary is the shape taken up by a cable or rope freely suspended between two supports and under its own self weight.

0 What is the degree of indeterminacy of a suspension bridge with two hinged stiffening girder?

The two hinged stiffening girder has one degree of indeterminacy.

23. What are the forces developed in beams curved in plan?(May/June 2016)

Beams curved in plan will have the following forces developed in them:

0 Shear forces.

1 Bending moments.

2 Torsional moments.

1 Give the expression for calculating equivalent UDL on a girder. Equivalent UDLon a girder is given by:

$$We = \frac{Total\ load\ on\ girder}{Span\ of\ girder}$$

2 Give the range of central dip of a cable.

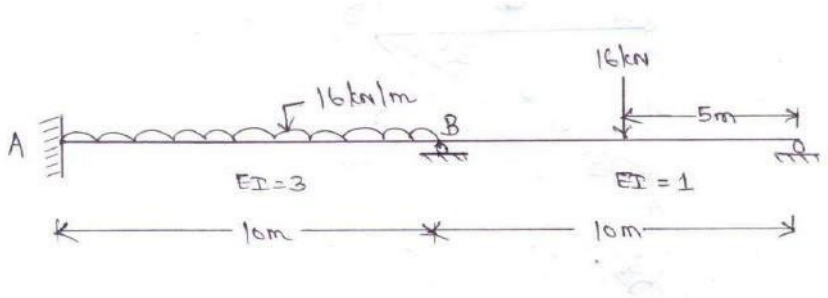
The central dip of a cable ranges from 1/10 to 1/12 of the span.

CE6602-STRUCTURAL ANALYSIS II

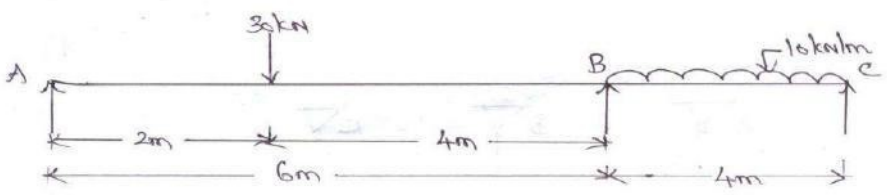
UNIT-I FLEXIBILITY METHOD

PART-B (16 mark questions)

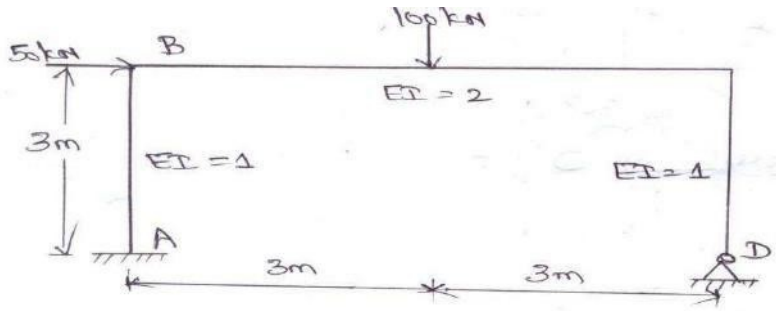
0 Analyse the continuous beam shown in figure by the flexibility method and draw the bending moment diagram.



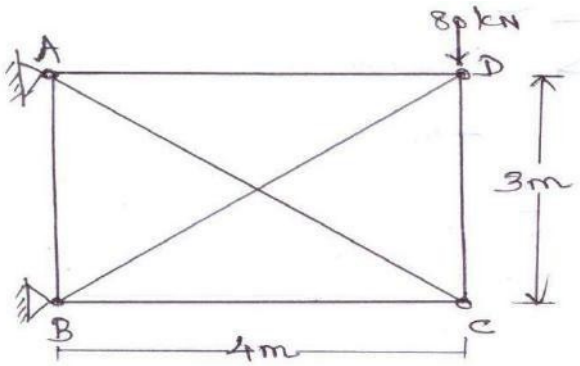
0 Analyse the continuous beam shown in figure by the flexibility method and draw the bending moment diagram.



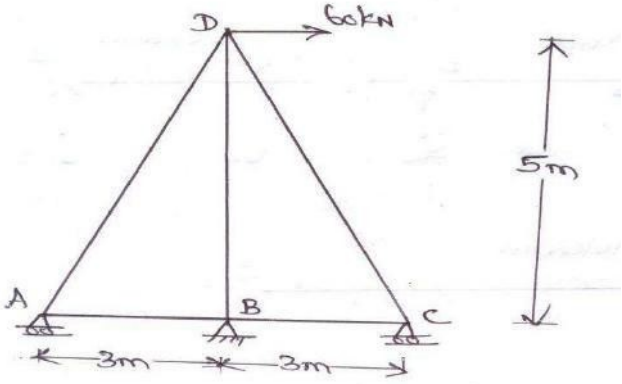
3. Analyse the frame shown in the figure by the matrix flexibility method.



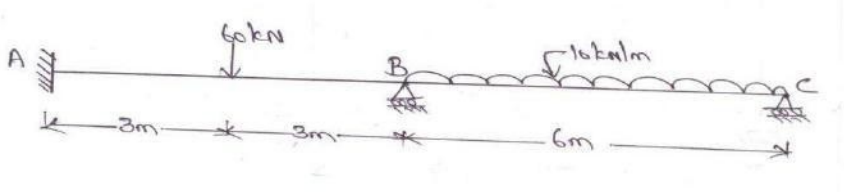
0 A statically indeterminate frame shown in the figure carries a load of 80 kN, Analyze the frame by matrix flexibility method. A and E are same for all members.



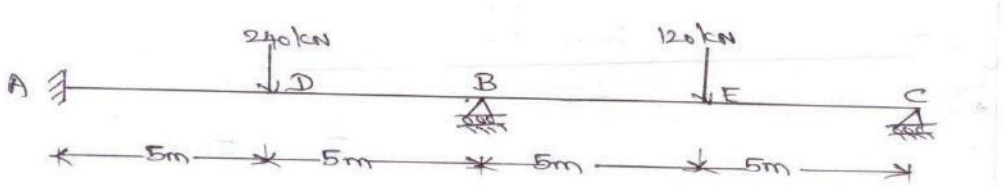
0 Analyse the truss loaded as shown in the figure using matrix flexibility method and find the member forces. A and E are the same for all members.



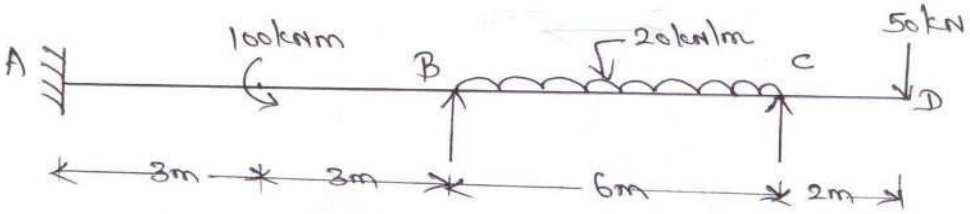
0 Analyse the continuous beam shown in figure using the matrix flexibility method.



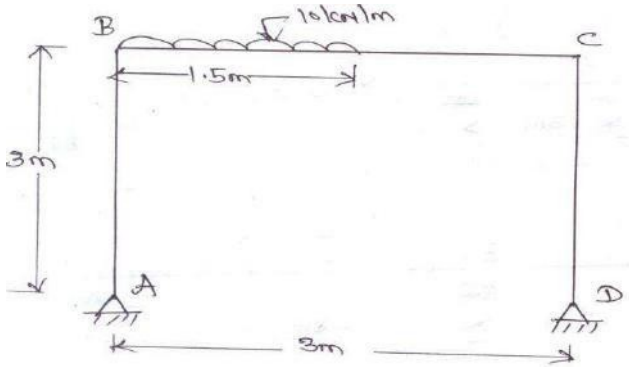
0 Analyse the continuous beam shown in figure .Assume EI as uniform. Use Matrix flexibility method.



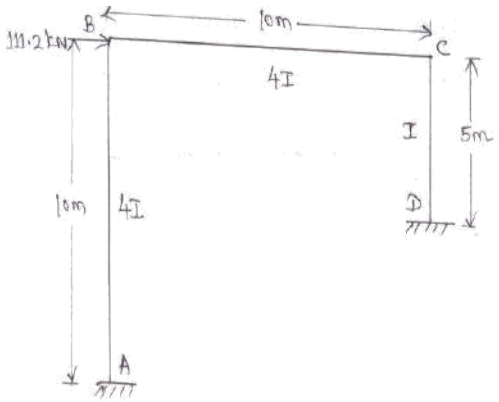
0 Using matrix flexibility method, analyze the continuous beam loaded as shown in the figure



0 Analyse the rigid jointed portal frame shown in the figure by the matrix flexibility method.

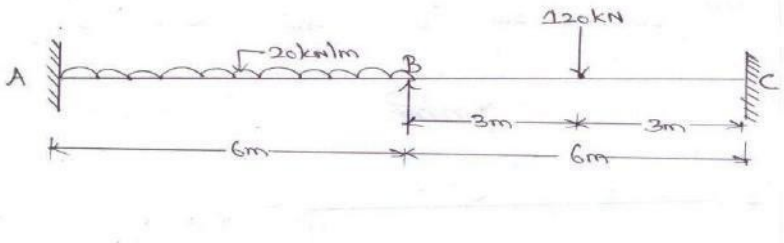


10. Analyse the portal frame shown in figure using matrix flexibility method.

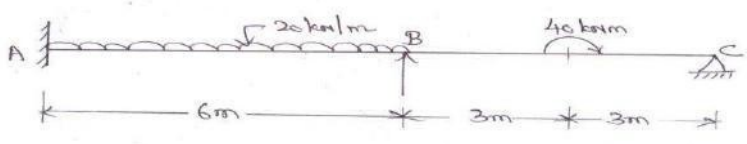


UNIT-II STIFFNESS MATRIX METHOD

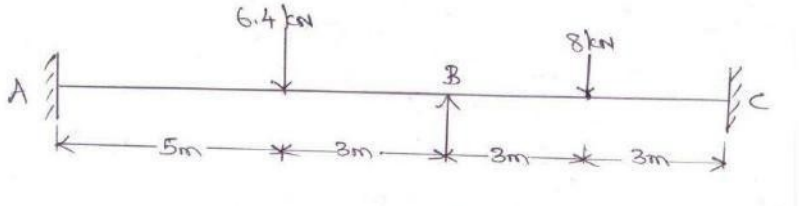
0 Analyse the continuous beam shown in figure by stiffness method. Draw the bending moment diagram.



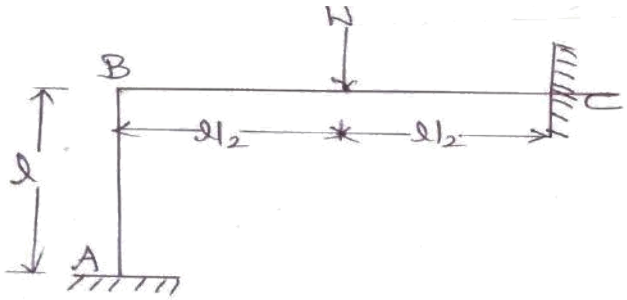
0 A two span continuous beam ABC is fixed at A and simply supported over the supports B and C. AB=6m and BC=6m.The moments of inertia is constant throughout. It is loaded as shown in the diagram. Analyse the beam by matrix stiffness method.



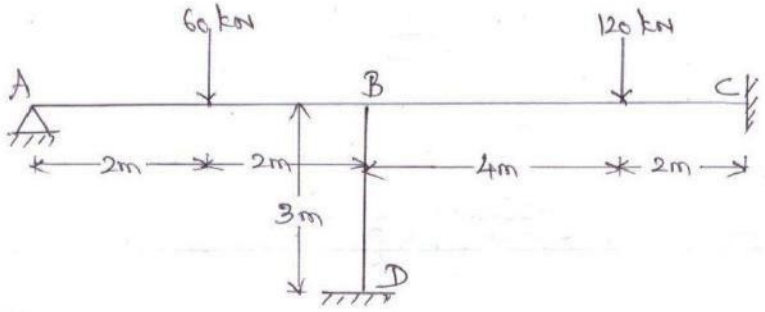
3. Analyse the continuous beam by matrix stiffness method.



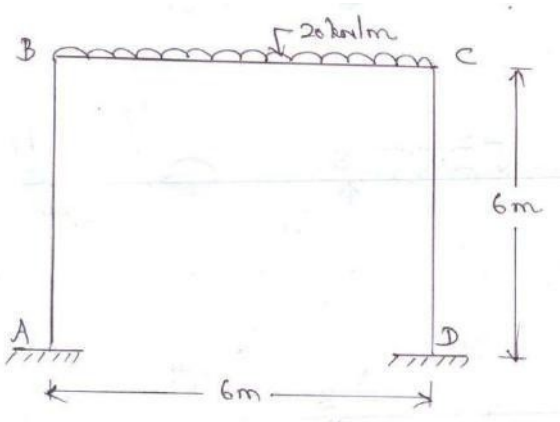
4. Analyse the structure shown in figure by stiffness method.



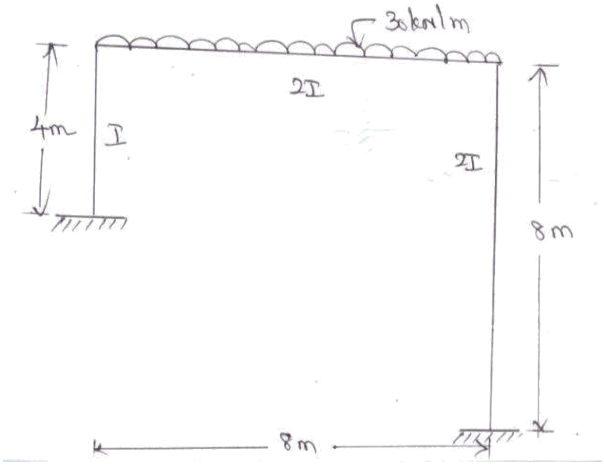
5. Analyse the frame shown in figure by the matrix stiffness method.



6. Analyse the frame shown in figure by stiffness method.

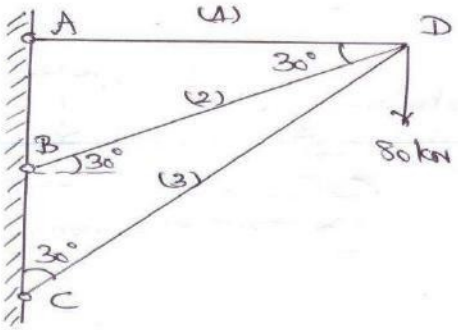


7. Analyse the frame shown in figure by the matrix stiffness method.

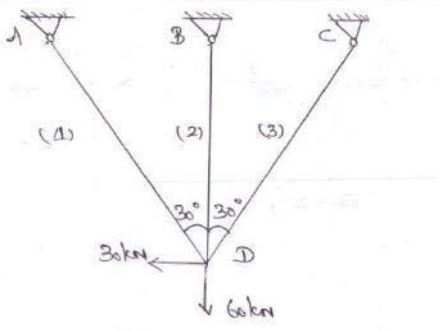


0 Using matrix stiffness method, analyse the truss for the member forces in the truss loaded as shown. AE and L are tabulated below for all the three members.

Member	AE(MN)	L(cm)
AD	400	400
BD	461.9	461.9
CD	800	800



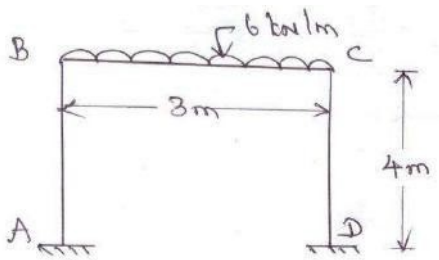
0 Find the bar forces in the truss shown in figure by stiffness method. AE and L for all members are tabulated below.



Member	AE (MN)	L (cm)
AD,CD	300	300
BD	259.8	259.8

0 Analyse the portal frame with fixed base shown in the figure using the matrix stiffness method, given

$I_{AB}=3I\mathbf{S}$; $I_{BC}=2I\mathbf{S}$; $I_{CD}=3I\mathbf{S}$.



UNIT-III FINITE ELEMENT METHOD

0 Explain the procedure of adopting finite element method.

1 Explain the discretisation process
in detail.

2 Compute the nodal loads on each of the 3 elements for a fixed beam AB of span L with a point load W & 2W located at one third span from end A & B respectively.

3 Determine the element load vectors and global load vector for the system in the figure-A.

4 For the beam shown in figure-A, determine the {P} vectors and the {F} vector by equivalent load method.

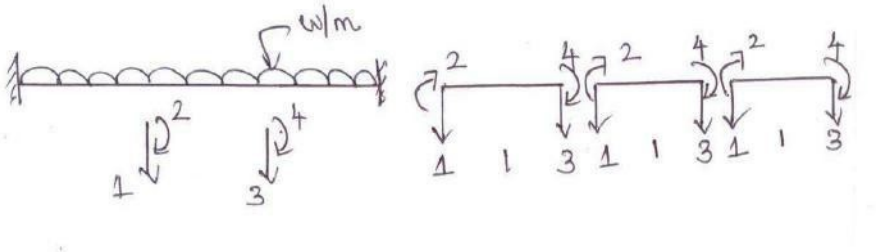


Figure-A

0 Explain the procedure for assembling of force vectors and stiffness matrices.

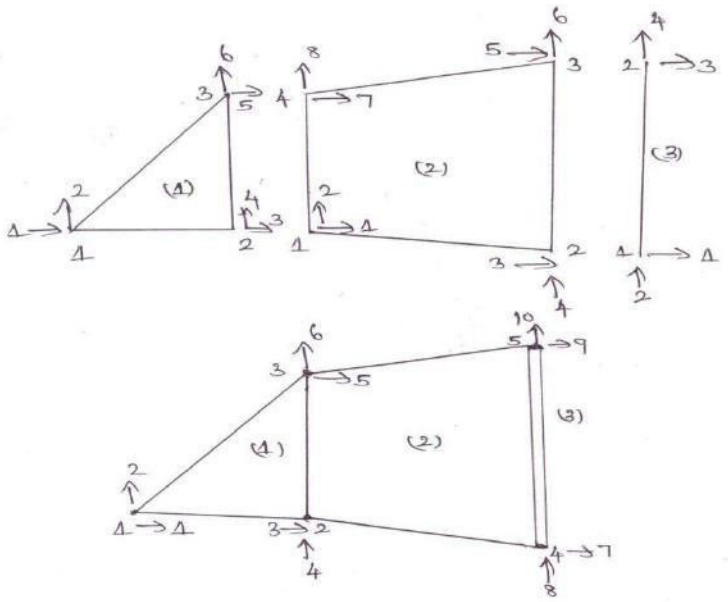
1 Explain the procedure for formulating the stiffness matrix for a constant strain element.

2 Explain the formulation of Pascal Triangle.

3 Assemble the elements 1,2 and 3 in the figure to develop the global load vectors and the global stiffness matrix, given that

$$\{P\mathbf{I}\}^{T} = [8\ \ 0\ \ 6\ \ 0\ \ 20]$$

$\{P\ddot{\imath}\}^T_T = [5\ \ 1\ \ 3\ \ 0\ \ 6\ \ 0\ \ 92]$



0 Solve the matrix equation {f}=[K]{u} where {f}T =[100, 120, -10]and [K] is 12 6 2 { 6 48 4 }

UNIT-IV PLASTIC ANALYSIS OF STRUCTURES

0 Calculate the shape factor for a a) **rectangle section of breadth „b‟ and depth „d‟,**

0 Diamond section of breadth „b‟ and depth „d‟.

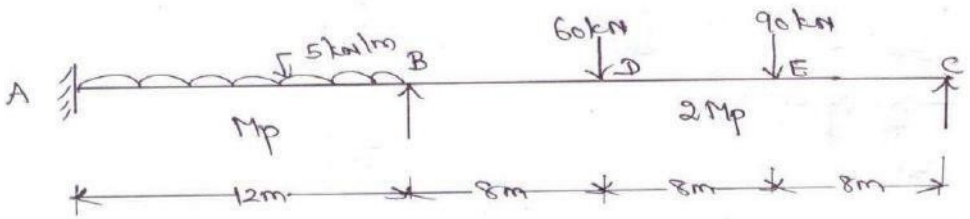
1 Calculate the shape factor for a triangle a) centroid lying at d/3 from the base of **depth„d‟, and breadth „b‟. b) Circular section of dia„D‟.**

2 A mild steel I-section 200mm wide and 250mm deep has a mean flange thickness of 20mm and a web thickness of 10mm.Calculate the S.F. Find the fully plastic **moment if σ_y**=252N/mm².

3 Find the shape factor of the I-section with top flange 100mm wide, bottom flange150mm wide, 20mm t_k and web depth 150mm and web thickness20mm.

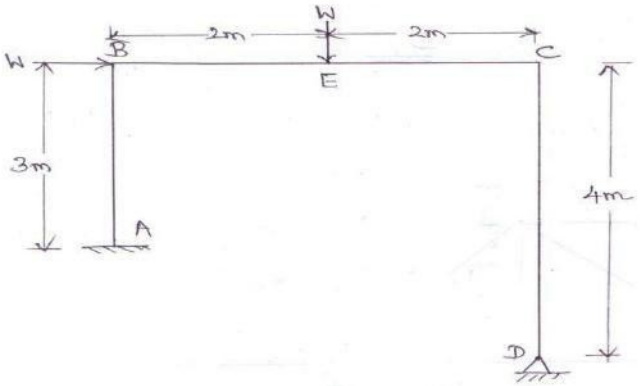
4 Find the shape factor of the T-section of depth 100mm and width of flange 100mm,flange thickness and webthickness10mm.

0 A continuous beam ABC is loaded as shown .Determine the required M_p if the load factoris3.2.

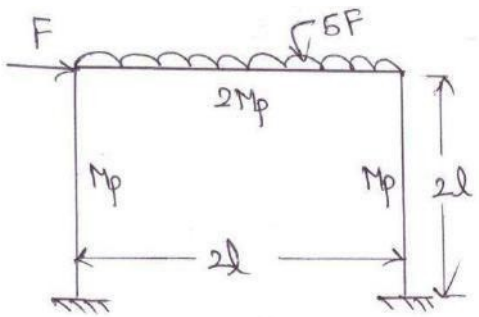


0 A two span continuous beam ABC has span length AB=6m and BC=6m and carries an udl of 30 kN/m completely covering the spans AB and BC.A and C are simple supports. If the load factor is 1.8 and the shape factor is 1.15 for the I-section, find the section modulus; assume yield stress for the material as250N/mm².

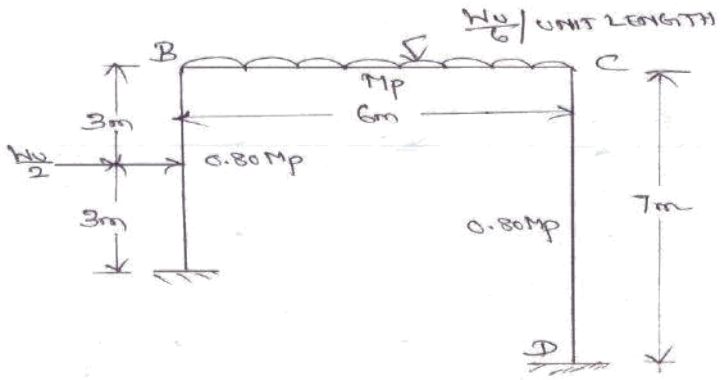
1 Determine the collapse load for the frame shown in the diagram, M_p is the same for all members.



9. Find the collapse load for the portal frame loaded as shown.

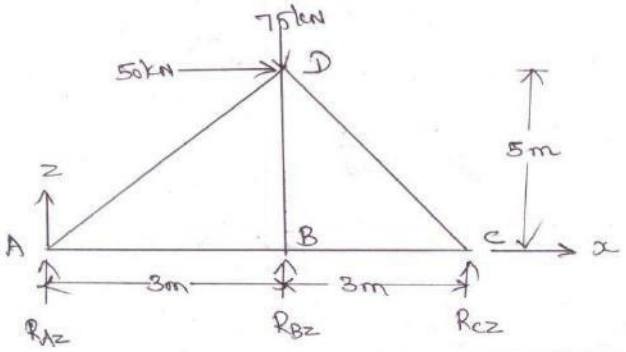


10. Find the collapse load for the loaded frame loaded as shown.

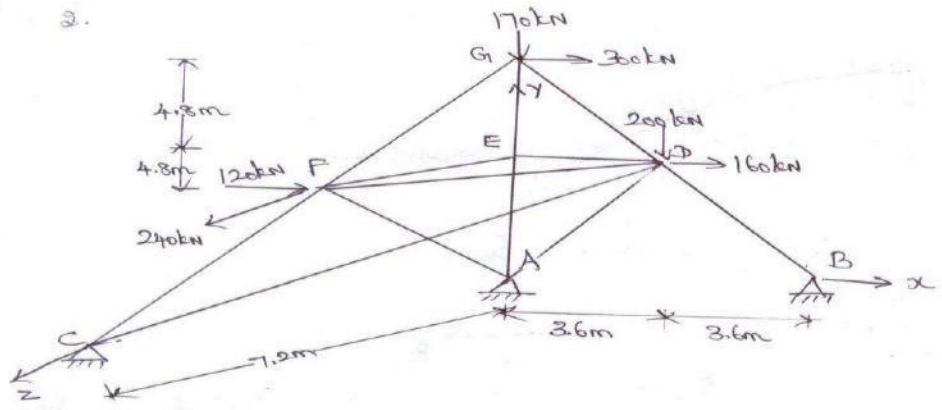


UNIT-V CABLE AND SPACE STRUCTURES

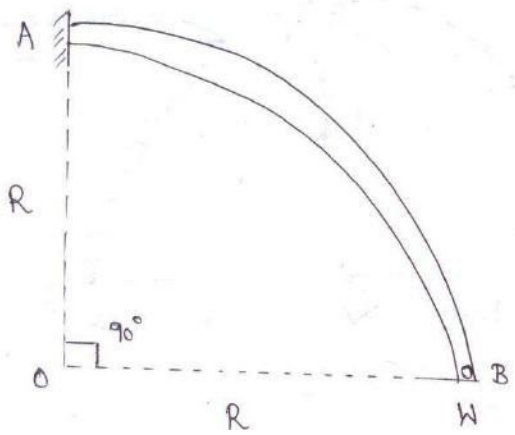
0 Using the method of tension coefficients, analyse the space truss shown in the figure and find the forces in the members of the truss.



0 Analyse the space truss shown in the figure by the method of tension coefficients and determine the member forces.

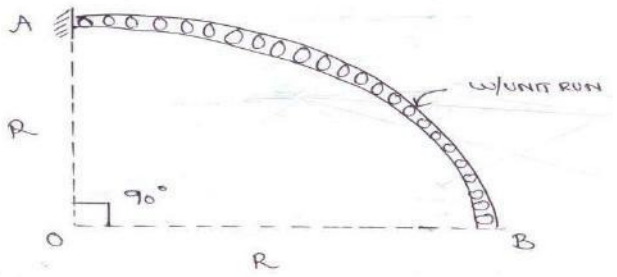


0 A curved beam in the form of a quadrant of a circle of radius R and having a uniform cross section is in a horizontal plane. It is fixed at A and free at B as shown in the figure. It carries a vertical concentrated load W at the free end B. Compute the shear force, bending moment and twisting moment values and sketch variations of the above quantities. Also determine the vertical deflection

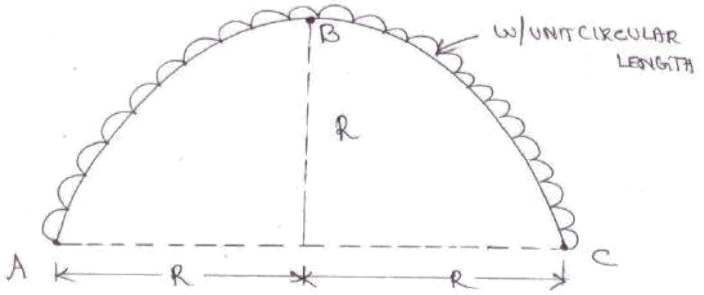


of the free end B.

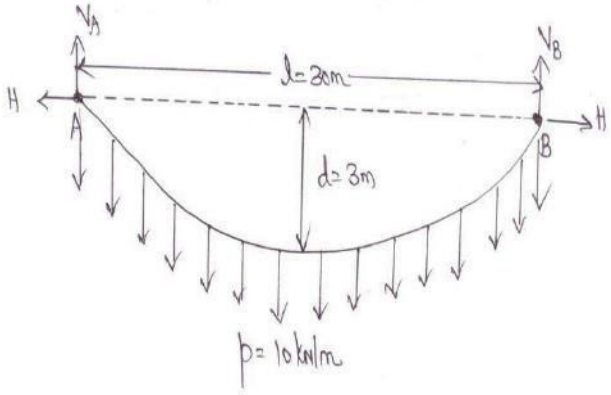
0 A curved beam AB of uniform cross section is horizontal in plan and in the form of a quadrant of a circle of radius R .The beam is fixed at A and free at B. It carries a uniformly distributed load of w/unit run over the entire length of the beam as shown. Calculate the shear forces, bending moment and Twisting moment value at A and B and sketch the variations of the same. Also determine the deflection at the free end B.



0 Diagram shows a curved beam, semi-circular in plan and supported on three equally spaced supports. The beam carries a uniformly distributed load of w/unit of the circular length. Analyse the beam and sketch the bending moment and twisting moment diagrams.



A suspension cable having supports at the same level has a span of 30m and a maximum dip of 3m.The cable is loaded with a udl of 10kN/m throughout its length. Find the maximum tension in the cable.



A suspension bridge of 250m span has two no‟s of three hinged stiffening girdness supported by cables with a central dip of 25m.If 4 point load of 300kN each are placed at the centre line of the roadway at 20, 30, 40 and 50m from the left hand hinge, find the shear force and bending moment in each girder at 62.5m from each end. Calculate also the maximum tension in the cable.

A suspension cable is supported at 2 points 25m apart .The left support is 2.5m above the right support. The cable is loaded with a uniformly distributed load of 10kN/m throughout the span. The maximum dip in the cable from the left support is 4m.Find the maximum and minimum tensions in the cable.

A suspension cable of 75m horizontal span and central dip 6m has a stiffening girder hinged at both ends. The dead load transmitted to the cable including its own weight is 1500kN.The girder carries a live load of 30kN/m uniformly distributed over the left half of the span. Assuming the girder to be rigid, calculate the shear force and bending moment in the girder at 20m from the left support. Also calculate the maximum tension in the cable.

A suspension cable has a span of 120m and a central dip of 10m is suspended from

the same level at both towers. The bridge is stiffened by a stiffening girder hinged at the end supports. The girder carries a single concentrated load of 100kN at a point 30m from left end. Assume equal tension in the suspension hangers. Calculate

The horizontal tension in the cable

The maximum positive bending moment.

CE6605-ENVIRONMENTAL ENGINEERING II

TWO MARKS

UNIT – I

PLANNING FOR SEWARAGE SYSTEMS

What do you mean by time of concentration? State its significance in sewage design.

0. The period after which the entire area will start contributing to the runoff is called time of concentration.

OR

1. It is defined as the longest time without unreasonable delay that will be required for a drop of water to flow from further point of drainage area.
2. It indicates the time of flow, time of entry, exit and the run off times.

State the pollution control board norms for effluent discharge into streams?

0. To render sewage inoffensive.
1. To save the aquatic life.
2. To eliminate the danger of contamination of water supplies.
3. The amount of treatment that should be given to the sewage.

List the factor influencing the fixing of design period?

0. Weather flow condition
1. Rate of water supply
2. Type of area served
3. Population growth

4) Give the design flow value for separate, combined and storm sewers?

TYPE	RIGID	FLEXIBLE

Separate sewers	1.0	0-0.4
Combined sewers	1.0	0
Storm sewers	0.5-0.8	0

5) Distinguish between dry weather flow & wet weather flow?

Dry weather flow	Wet weather flow
It refers to the waste water flow in sewerage system during the period of any weather.	It refers to the waste water flow in sewerage system during the period of wet weather.
It follows minimum infiltration.	It follows maximum infiltration.

State the necessity of waste water characterization?

0 **It"s** indicates the amount of heavy metals and synthesized organic compounds generated by industrial activities.

1 As technological changes takes place in manufacturing. Changes also occur in the compounds discharged and the resulting waste water characteristics.

2 Therefore waste water characterization on becomes a essential pats of an overall water quality management program.

A sewer has to be designed by considering both velocity and maximum velocity of flows-state true or false and justify the answer?

(i) The sewers should be designed to follow minimum velocity also called as self cleaning velocity showed be generated at least once a day because if certain deposition takes place and is not removed it will obstruct free flow.

0 It is necessary to maintain velocity the sewers pipe to prevent scouring of pipe.

What do you understand by sewer appurtenances? Enumerate various appurtenances commonly used?

In order to make the process easy and to have efficient working and maintenance. Sewer system requires various appurtenances for their proper functioning and maintenance.

Manholes
Catch basis
Clean outs
Inlets
Lamp holes
Ventilators

9) Differentiate Sewage & Sewerage?

SEWAGE: It is a waste water coming from sources (or) community it includes sullage, night soil etc...

SEWERAGE: The process of collection & conveyance of sewage from source to treatment plant.

10) What is the role of velocity in a sewage system?

In order to keep the solid particle in suspended form, avoid the solids particle settled down on sewer & to avoid scouring in sewer, minimum & maximum velocity should be maintain.

Name the classification of pumps used sewage pumping?

0 Centrifugal pump
1 Reciprocating pump
2 Pneumatic ejectors (or) Air pressure pumps.

List out the sewer appurtenances?

- Manholes
- Catch basis
- Clean outs
- Inlets
- Lamp holes
- Ventilators
- Oil & gases trap
- Flushing tank
- Inverted siphon

13) Define BOD & COD?

BOD (Bio chemical Oxygen Demand): The amount of oxygen required for survival of micro organism to oxides the organic substances at standard temperature & standard time.

COD (Chemical Oxygen Demand):: The amount of oxygen required to oxides the chemical present in the waste water.

14) Define self cleaning velocity?

The minimum velocity require to keep the solid particles in suspended forms in sewer is called self cleaning velocity (or) minimum velocity.

What are the requirements of the good sewer joints?

- Resistance to corrosion
- Resistance to abrasion
- Strength & durability
- Economical
- Light weight
- Hydraulic efficiency.

16) Define Sullage?

The fresh waste water coming out from bathroom, kitchen except water closets (latrine).

What are the two factors affecting sanitary sewage?

- Types of area to be served
- Rate of water supply
- Population growth
- Infiltration of ground water
- Unaccounted water supply.

18) What are the sewerage systems available?

Combined system:

When the drainage is taken along with the sewage then it is called as combined system.

Separate system:

When the drainage and sewage are taken independently of each through two different sets of sewage is called as separate system.

19) What is drop manhole?

It is a setup which is provided bottom of manhole to transfer the sewage.

When a branch sewer enters a manhole by more than 0.5-0.6m above the main sewer, the sewage is generally not allowed to fall directly into the manhole, but is brought into it through a down pipe taken from the branch of sewer to the bottom of manhole. That setup **is called „drop manhole".**

What is the effect of oxygen demanding waste on water bodies?

- DO level will decrease
- Aquatic life will destroy.

Enumerate the source of waste water?

- Industrial wastes
- Domestic wastes
- Agricultural wastes
- Storm water
- Commercial wastes
- Institutional wastes

Under what circumstances pumping is required for sewerage system?

- The sewage from localized low lying pockets in a city has to be pumped.
- When the area is flat, laying of sewer at their designed gradients may involve deeper and deeper excavation in the forward direction f flow.
- For disposing of the sewage of the basement of large commercial buildings, sewage may be pumped.
- When the out fall of the sewer is lower than the level of the treatment plant.

(v**)** In case a sewer has to go across a high rid.

23) Distinguish between unit operation & unit processes?

Unit operations are the physical operation to remove the impurities present in the water and waste water.

Unit processes are the chemical and biological conversion on the status of the impurities that they will be converted to a form that can be easily separated.

Define design period?

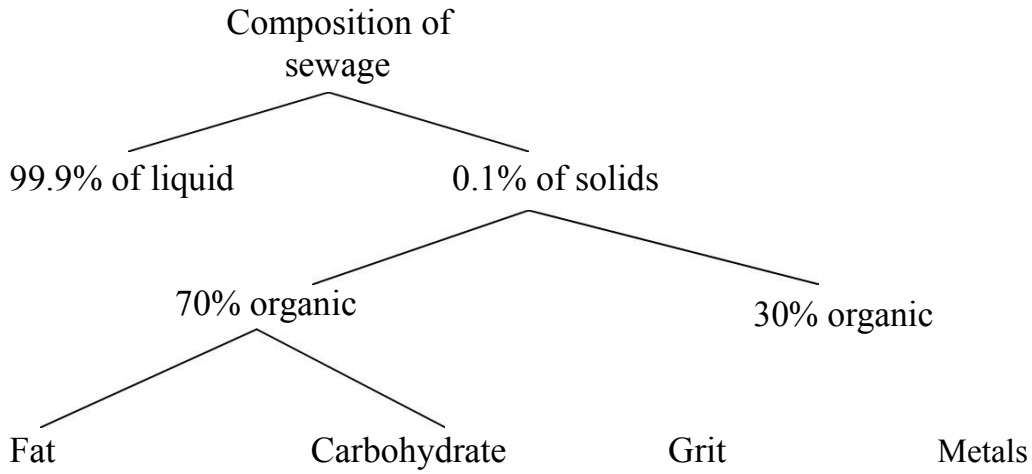
The forecasting period up to which the provision to be made is called design period. Approximately 30-40 years.

Define sewerage system?

- The structural system used to collecting, conveying and disposal waste water from source to treatment plant through sewer.
- It includes the waste water treatment unit.

UNIT-II
SEWER DESIGN

1) Write note on composition of sewage?



2) What is mean by hydraulic gradient of a sewer?

It is defined as the gradient about which the sewer is constructed. It is approximately equal to the ground slope.

(OR)

The head drop between the two points divided by the length in sewer line or network.

State five parameters of effluent standards for sewage disposal in land surface waterbod

Parameter	Permissible limits as per IS 2490-1974
pH	5.5-9.0
5 day BOD @ 20/ºc	30mg/L
COD	250mg/L
Suspended solids	100mg/L
TDS	2100mg/L
Temperature	40/ºc
Oil & grease	10mg/L

State the advantages of egg shaped sewer section?

- Cheap
- Suitable for combined sewer
- Discharge is subjected to great variation
- High velocity flow
- Large sized

What is trap? State its quality requirement?

0 Traps are defined as fittings at the end of soil pipes of water to prevent foul gases coming out of the soil pipe / waste pipe.

1 Quality requirement.

Should provide enough water seal (around 50 mm) with large surface area.
Interiors surface should be smooth so that the flow is not obstructed which enables self cleaning.
An assess door should be provided for cleaning the trap.
(vi)It should be made of non-adsorbent material.

6) Name sewage characteristics with which organic matter concentration is expressed?

ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ0 BOD
ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ1 COD
ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ2 TOC
ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ3 Volatile solids.

What are the typical characteristics of sewage from South Indian Cities?

ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ0 Physical
ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ1 Chemical
ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ2 Biological

State the necessity of legal requirements and effluents disposal sewage?

0 All type of effluent needs to be treated and disposed off safely.
1 Parameter like DO, BOD, COD, suspended solids, other solids content needs to be reduced to the permissible level.
2 Toxicity level must be eliminated to a non-hazardous state and then disposed off.

Enumerate the various steps involved in the layout & construction of sewers?

Prepare primary sewer layout plan based on

- Lower capacity request
- Sewer service
- Authorization for private sewer.

Submit the plan as part a part of a development plan.

On approval of the plan it is implemented.

Reciprocating pumps is not widely used in the sewage pumping-state true or false and justify your answer?

True, because of their

ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ0 Initial cost
ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ1 Difficulty of maintenance
ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ2 Greater wear and tear of their valves.

Why do the analyses BOD & COD usually give different results for the same waste water?

0 Naturally sewage contains bacteria and nutrients almost will initiate bio chemical reactions (BOD).
1 The chemicals are also broken down by using oxidizing agents (COD).
2 Result is oxygen content will be decreased and varies.

What is the effect of suspended solids on water bodies?

0 Effect on sustainability of water bodies by reaction activities.
1 Effect on aquatic defect fines

Water becomes warmer good & oxygen penetration

.

Name any two software"s used in sewer design?

- Source CAD
- Strom CAD
- CADIAS
- Bently sewer
- Sewer

What are the Demerits of chemical precipitation?

- High cost of chemicals
- Large quantity of sludge which offers difficulty of its removal
- Skilled attendance
- Putrescible efficient

What do you mean by chemical precipitation?

When certain chemicals are added to, sewage they produce a precipitate known as flow which in insoluble or slightly soluble in water. The flow attracts small particles to form large size and thus size goes on increasing during the process of settlement.

16) What is do you mean by transitional setting zone?

Grit particles however, generally lie between 0.1mm and 1 mm, and hence undergo settling which lies in between streamline settling and turbulent settling. This settling zone is called the transitional settling zone

What are the users of Baffle?

- Baffler are required to prevent the movement of organic matter and its escape along with the efficient

Distribute the sewage uniformly through the cross section of the tank.

It is used to avoid short circuiting

What are the classifications of biological process?

- Aerobic processes
- Anaerobic processes
- Aerobic – anaerobic processes

List out the aerobic processes?

- Activated sludge processes
- Trickling filters
- Aerobic stabilization pond
- Aerated lagoon

List out the anaerobic process?

- Anaerobic sludge digestion,
- Anaerobic contact processes
- Anaerobic filters
- Anaerobic lagoons or ponds

21) What are the sources of waste water?

- Domestic waste water (i.e sewage)
- Agricultural return waste water
- Industrial waste water

What are the methods involved in the treatment of waste water?

Mainly classified into

Conventional treatment methods

Advanced waste waster treatment

Conventional treatment methods

Preliminary processes

Primary treatment

Secondary treatment

Advanced waste water treatment

Tertiary treatment

23) What are the functions involved in the chemical unit processes

- Chemical precipitation
- Gas transfer
- Adsorption
- Disinfection
- Combustion

What do you understand by waste water treatment?

The waste water treatment or sewage treatment is a broad term that applies to any process/operation or combination of processes and operations that can reduce the objectionable properties of water carried waste and render it less dangerous with the following.

- Removal of suspended and floatable material
- Treatment of biodegradable organics

Elimination of pathogenic organisms

UNIT-3

PRIMARY TREATMENT OF SEWAGE

What are the distinct stages in the sludge digestion processes? Acid fermentation

Acid repression

Alkaline fermentation

Define the term ripened sludge?

This digested sludge (geHong from Alkaline fermentation stage)is collected at the bottom of the digestion tank and is also called repented sludge

What are the factors effecting sludge digestion

0 TemperatureThermopolis Meropholic

1 Pit value

2 Seeding wotu digested sludge

3 Mixing and stirring of the raw sludge with digested sludge.

What are functions of aeration in ASP?

oxygenation of the mixed log wor

Flocculation of the colloid in sewage influent

Suspension of activated sludge

What are the methods employed for the purpose of certain in ASP?

Diffused air aeration air aeration

Mechanical aeration

Combined diff used air and Mechanical aeration

8.1.5 What are the patterns of mechanical aeration?

Haworth paddle or Sheffield aeration system

Hartley paddle or bir Mangham Bio flocure lation system

Simplex aeration system

Link belt aeration system

Kessner Brush aeration system

8.1.6 List out the important aeration processes in the ASP?

Conventional process Tapered
aeration process Ste aeration
process Contact slabolisection
process Completely mixed
process Modified aeration
Extended aeration

What are the advantage of stabilization ponds or cagoins

0 Lower initial lost than required for a mechanical plant.

1 Tower operation costs

2 Regulation of efficient discharge possible their provoelving control of pollection during critical times of the year.

What are the disadvantage of tagoons?

0 Requires extensive land area. Hence the method can be used only on rural area.

1 If used in urban areas, expansion of town and new developments may encroach on the lagoon site.

What do you understand by facultative ponds?

(1)A facultative panel combine the features of the acrobite and anacrobic ponds.
(2)Constructed of intermediate depta (1, to 1.5m)
(3)A facilitative bond consists of three

aerobic Zone - Top
Facilative zone
(iii)Anaerobic zone - bottom

What are remedial measurement for rising bludge problem?

0 Increasing the return sludge age
1 Increasing the speed of the sludge scroper mechanism, where possible
2 Decreasing the mech cell residence come by increasing the sludge write rate

What is meant by sludge bulking?

Sludge with poor setting characteristics is termed bulking sludge. It results on poor influent due to thee presence of excessive suspended solids and also in rapid loss of MISS from tance aeration

What are the advantage of increment 8 and filters?

0 The efficient from intermittent sand filter is of better quality. It is more clean and more stable and hence does not need further treatment before disposal

1 The filter work under acrobic conditions, and hence there is no trouble of odour, files and inserts

(iii)The operation is very simple, requiring no mechanical equipment except for dosing

What are the disadvantages of intermittent sand filters?

ÀrĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀ0 The rate of filtration and hence that of load long is very small per unit surface area of the filter hence they cannot be employed for medium size or bigger plants

1 They requires large area and large quantity of sand due to which their construction is very costly.

15. What do you understand by contact beds?

Confact beds, also called confact filters, are similar to inter mitten sand filters in construction, except that th filtering media is very coarse, consisting of broken stones called ballart of 20 to 50mm gauge.

A contact bed is a water toght take of masonry walls and of rectangular shape. The depth of filtering media is kept b/w 1 to 1.8m

What are the operations involved in the contact beds?

- filling
- Contact
- Emptying
- Oxidation

17.What are the advantage of contact of beds?

Contact beds can work under small heads.

Contact beds can be operated without exposing the sewage efficient to view.

There is no nuisance of filter flows

iv)The problem of odour is much less as compared to trill long filters.

18.What are the disadvantage of contact beds in T.F?

Rate of loading is mech less in comparison to trilling filters.

Large areas of land is required for their installation

Intermittent operation requires continceoces attendance
The cost of contact beds is mech more as compared to trick long filters.

19.What do you mean by tracking filters?

Tricking filters, also as percolating filters or sprinkling filters or sprinkling filters are similar to contact beds in construction, but their operation is confinceous and they allow constant aeration In this system sewage is allowed to sprinkle or trickle over a bed of coarse, rough hard filter media and it is then collected through the under drainage system.

What are the purpose of under drainage system? The

purpose of under drainage system is two fold

- 0 to carry away the liquid efficient and sloughed biological solids.
- 1 To distribute air through the bed

What are the merits of conventional trickling filter?

The efficient obtained from truckling filters is highly nitrified and stabilized. The efficient can therefore be disposed of in smaller quantity ofdeputationwater

It has good dependability to produce good efficient under very widely varying whether and other conditions

The working of truckling filter is simple and sheep and does not require any skilled supervision.

What are the demerits of conventional trickling filters?

- 0 The loss of head through the filter system is high their making the

automatic dosing through siphonic doing tanke necessary

- 1 The cost of construction of the filter is high
- 2 They require large area in comparison to their biological treatment

processes.

What is the necessary of Recirculation in T.F?

Recirculation is necessary to provide uniform hydraulic loading as well as to dilute the high strength waste waters. In constant to the low rate filters, in high rate filters a part of settled or filter efficient is recycled through the filter.

24. Define humus tank?

The efficient of the filter is therefore, passed through a sedimentation take called Humus tank otherwise called secondary clarifier or secondary settling tank.

UNIT – IV

SECONDARY TREATMENT OF SEWAGE

1. What is the bawe deference between Activated sludge processes and Trickling Filter?

Trickling Filter	Activated sludge processes
The bacterial film coasting the grains of the filter media is stationary	The bacterial film which is kept moving is the constant agitation

Give any 4 advantage of activated sludge plaof?

Lesser land area is reqd

The head loss on the plant is quite low

There is no fly or idour nuisance

Capital cost is less

(g)What are the disadvantages of the activated study I plant?

High cost of operation, tooth greater power consumption

A lot of machinery to be handled

The sudden change in the quantity and character of sewage may produce adverse effects on the working of the process thus producing inferior efficient

4. Define the term ertro phication?

The excess growth of algue and other aquatic plants in a river stream is called ertroplication

What are the filters used in sewage treatment? 1

contact beds (very small plant)

2 Intermittent fillers (small plant)

3 Trickling filters (commonly used in modern days)

4 Miscellaneous type filters (under special circumference)

What is the range of sand particle in the filtering métier?

D10 (effective size) = 0.2+0 0.5 mm

$D60/D10$ (*uniformly* coefficient) --> 2 to 5

What are the types of track long filters?

0 Conventional track long filter or ordinary or standard rate or low rate trick long filter

1 High rate filters or high rate trick long filter

What are the advantage of track long filters?

Rate of filter loading is high as such requiring lesser land areas and smaller quantities of filter media for their installations.

They are self- clearing

Mechanical wear and tear is small as they contain less – mechanical equipment.

Moisture content of sludge obtained from driclling filters is high as 99% or 80.

9.What are the disadvantages of trickling filters?

0 The head loss through these filters is high, making automatic during of the filters necessary

1 cost of construction is high

2 There filters cannot treat ratio sewage and primary sedimentation is a must.

Differentiate between low rate & high rate?

Low Rate Trickling Filter	High RateTrickling Filter
1. Hydraulic loading varies between 20 to 44 ML/ hec/ day	Varies form 110 to 330 M.C/hec/day
2. Dept of filter media rateje	Varies b/w 1.2 b/w 1.2 to 1.8m

b/w1.6 to 2.4m	

11. Define the term recirculation ratio?

The ratio R/I of the volume of sewage recirculated (R) to the volume of raw sewage (I) is called recirculation ratio.

Write the formula for recirculation factor?

$$F = \frac{1 + \frac{R}{I}}{\left(1 + 0.1\frac{R}{I}\right)^2}$$

Where,

F = Recirculation factor

R = Volume of sewage recirculated

I = Volume of raw sewage

What are the types of high rate Filters?

- Bio filters
- Accelo filters
- Aero filters

What are the special types of filters?

Durban filter

Magnetic filters

Rapid sand filters

15. Give any four advantages of activated sludge process?

- Lesser land area is required
- The head loss on the plant is quite low
- There is no fly ash or odour nuisance
- Capital cost is less

What are the disadvantages of the activated sludge process?

- High cost of operation, tooth greater power consumption
- A lot of machinery to be handled
- The sudden change in the quantity and character of sewage may produce adverse effects on the working of the process thus producing inferior efficient

What are the types of track long filters?

- Conventional track long filter or ordinary or standard rate or low rate trick long filter

18. What are the disadvantages of trick long filters?

ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ0 The head loss through these filters is high, making automatic during of the filters necessary

ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ1 The cost of construction is high

ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ2 There filters cannot treat ratio sewage and primary sedimentation is a must

What are the special types of filters?

0 Durban filter

1 Magnetic filters

ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ0 Rapid sand filters

What do you mean by magnetic filters?

In this type of filter, a layer of crashed magnetic ore of

Iron is provided in about 80mm, thickness, and is supportedon a non-magnetic metal wire screen sewage is filtered through the magnetic layer which removes the impurities purely by mechanical starching action.

What are the types of high late Filters?

0 Bio filters
1 Accelo filters
2 Aero filters

UNIT – V
DISPOSAL OF SEWAGE AND SLUDGE

1. Define the term "Dilution Factor"?

The ratio of the quantity of the diluting water to that of the sewage is known as the Dilution Factor.

What are the methods adopted for sewage disposal?

- Dilution is disposal in water.

Effluent Irrigation or Broad Irrigation or Sewage forming is disposal on land.

What are the conditions adopted for disposal by dilution?

- When sewage is comparatively fresh (4 to hr old) and free from floating and settlable solids.

When the dilution water has a high dissolved oxygen (D.O.) content.

- When the out fall sewer of the city or the treatment plant is situated near some natural waters having large volumes.

What are the natural forces of purification?

- Dilution and dispersion.
- Sedimentation
- Oxidation – reduction in sun-light.
- Oxidation
- Reduction

What are the factors affecting self purification of polluted streams?

- Temperature
- Turbulence
- Hydrography such as the velocity and surface expanse of the river stream.
- Dissolved oxygen and the amount and type of organic matter.
- Rate of re aeration.

What are the types of self purification?

The self purification divided into four zones

- Zone of degradation.
- Zone of active decomposition.
- Zone of recovery
- Zone of Cleaner water

What is meant by "Self purification phenomenon"?

When sewage is discharged into a natural body of water, the receiving water gets polluted due to waste products, present in sewage effluent. The natural forces of purification such as dilution, sedimentation, oxidation – reduction in sun light go on acting upon the pollution elements and bring back the water into its original condition. This automatic purification of polluted water, in due coarse is called the self purification phenomenon.

8. What is meant by photo synthesis?

The sun light has a bleaching and stabilizing effect of bacteria. It also helps certain micro organisms to derive energy from it and convert themselves into food for other forms of life, thus absorbing Co_2 and releasing O_2 by a process known as Photo synthesis.

9. What do you mean by Oxidation?

The oxidation of the organic matter prevent in sewage effluents, will start as soon as the sewage out falls into the river water containing dissolved oxygen. The deficiency of oxygen so created will be filled up by the atmospheric oxygen. The process of oxidation will continue till the organic matter has been completely oxidized. This is the most important action responsible for effecting self purification of rivers.

10. What do you understand by Reduction?

Reduction occurs due to hydrolysis of organic matter settled at the bottom either chemically or biologically. An aerobic bacteria will help in splitting the complex organic constituents of sewage into liquids and gases and thus paving the way for their ultimate stabilization by oxidation.

11. Define the term Re-oxygenation curve?

In order to counter – balance the consumption of D.O. due to de-oxygenation, atmosphere supplies oxygen to the water and the process is called re-oxygenation.

12. What is mean by "Oxygen sag curve"?

The amount of resultant oxygen deficit can be obtained by algebraically adding the de-oxygenation and re-oxygenation curves. The resultant curve so obtained is called the oxygen sag curve or the oxygen deficit curve.

13. What is meant by epilimnion zone?

The water of a lake gets stratified during summers and winters. Since such turbulence extends only to a limited depth from below the water surface, the top layers of water in the lake become well mixed and aerobic. This warmer, well mixed and aerobic depth of water is called epilomnion zone.

14. What is meant by hypolimnion zone?

The lower depth of water in the lake which remains cooler, poorly mixed and an aerobic, is called are hypolimnion zone.

15. What do you understand by monocline? Give example.

The water of a lake gets stratified during summers and winters. The change from epilimnion to hypolimnion can be experienced while swimming in a lake. When you swim in top layers horizontally you will feel the water warmer and if you dive deeper, you will find the water cooler. The change line will represent monocline.

16. What are the advantage of land filling methods of dispoal?

It is simple and economical

No plant / equipment is required

There are no by products and hence there is no problem of the disposal of the by-products.

- Separation of varies materials of the refuge is not required.

17. What are the disadvantages of land filling methods of disposal?

- Proper site may not be available near by
- Wind direction map not be favourable.
- Large band areas are required.
- It may be difficult to get large quantities of covering material.

What do you understand by pulverization?

In this method, the dry refuse is pulverized into power form, without changing its chemical form. The power can either be used as a poor quality manure, or else be disposed of by land filling.

19. What are the disadvantages of incineration of method of disposal?

Large initial expenditure.

- Improper operation results in air pollution problems and incomplete reduction of the waste materials.
- Disposal of the remaining residue is required.
- High slacks needed for natural draft chimneys present safety problems.

What do you understand by mechanical composting?

The open window method of composting is very laborious and time consuming process. Also it requires large area of land which may not be available in big cities these difficulties are overcome by adopting mechanical composting in which the process of stabilization is expedited by mechanical devices of turning the compost.

21. What are the methods adopted for composting?

- Composting by trenching.
- Open window composting.
- Mechanical composting.

What is meant by "humus"?

The refuge gets stabilized in about 4.5 months period, and gets changed into a brown coloured odourless innocuous powdery form known as humus, which has high manure value became of its nitrogen content.

23. What are methods adopted for sludge drying?

- Drying the sludge on prepared sand beds.
- Drying the sludge on centrifuges.
- Drying the sludge by heat dryers

What is meant by house refuse?

This consists of vegetable and animal waste matters, ashes, cinders, rubbish, debries from cleaning and demolition of structures.

25. What is meant by organic waste?

It includes dry animal and vegetable refuse, cow dung, excreta of birds, tree leaves, sticks, plastic bottles, paper waste, rags. This waste is subject to decay with time and evolve highly offensive odour and gases which are highly detrimental to health.

26. What are the types of preventive measure in adopted for sewage sickness?

- Primary treatment of sewage
- Choice of land
- Under-drainage of sool.
- Giving rest to the land.
- Rotation of crops
- Applying shallow depths.

Define the term "Raw sludge"?

The sludge, which is deposited in a primary sedimentation tank is called Raw sludge. Raw sludge contains highly putrecible organic matter, and is thus, very objectionable.

28. What is meant by "conditioning"?

Conditioning improves the drainability of digested sludge. Prior conditioning of sludge before application of dewatering methods renders it more amenable to dewatering.

16 MARKS QUESTION BANK

UNIT I - PLANNING FOR SEWAREGE SYSTEM

PART – B

Write in detail about the characteristics of sewage.

BOD of a sewage incubated for 2 days at 30^{o}c was found to be 160 mg/l. Find the value of 5 day 20^{o}c BOD. Assume k (base 10) at 20^{o}c as 0.12 per day.

Describe the factors influencing the dry weather flow.

How will you do the storm water flow estimation?

Find the combined flow discharge of sewage for the given data. Area to be served is 150 hec. Population density is 50000. Time of entry is 5 minutes. Time of flow is 20 minutes. Rate of water supply is135 lpcd Impermeability factor =0.45 Assume 80% of water supplied turns into sewer and peak factor as 1.5.

Discuss the significance of total solids and BOD in determining the characteristics of sewage.

State the different sources of waste water that are produced from a community. Discuss the systems of sewerage with its merits and demerits.

A city with a population of 100,000 has an area of 50km^2. Rate of water supply is 110 litres per capita per day of which 80% turns into sewer. The average run-off coefficient is 0.5 and intensity of rainfall is 14.5mm/hr. Estimate the quantity of combined sewage. Take peak factor as 2.5.

9. The rainfall distribution of an area is as follows. The total area of distribution is 36 hectares and the maximum rainfall is 5 mm/hour. Calculate the total runoff if the population density is 250/hec.

Type of area	% of area	Run off coefficient
Roof	20	0.9
Pavement	20	0.85
Housing	5	0.80
Roads	15	0.4
Lawns	35	0.1
Wooden area	5	0.05

Classify the legal requirements and standards regarding treatment of sewage.

Illustrate the information to be collected while planning for sewerage systems. How will you use the corrected information?

Explain the terms BOD and COD. Differentiate between first and second stage BOD.

The BOD of a sewage incubated for one day at 30^{o}c has been found to be 120mg/l. what will be the 5-day BOD at 20^{o}c. Assume BOD rate constant K = 0.21 (base e) per day at 20^{o}c and temperature correction coefficient.

B.O.D. of a sewage incubated for one ay at 30°C has been found to be 120 mg/l. What will be its 5 day 20°C BOD, if K at 30°C is 0.16 per day (base 10).

What is population equivalent? State its uses.

16. Derive the first stage BOD equation and ultimate BOD.

UNIT II - SEWER DESIGN

PART – B

1. Determine the diameter of a separate sewer section running half full at maximum discharge for a town with a population of 100000. Water is supplied at a rate of 200 lpcd. Assume 80% of water supply turns as sewage. Take peak factor = 2.25 and n = 0.013 at all depth. Permissible slope is 1 in 600.

Describe about the various types of pumps used for lifting the sewage.

Write down the procedure for laying and testing of sewer lines with neat diagram.

What are the systems of plumbing? With help of a neat sketch discuss various systems of plumbing used for drainage.

Discuss the choice available and the factors to be considered while selecting pumps and pipes for sewerage system and explain.

With help of neat sketch explain the location and functions of drop manhole inverted siphon.

Classify the shapes of sewer pipes. Explain in detail.

Explain the laying of sewers in the field for the designed alignment and gradient.

Describe the one pipe and two pipe plumbing systems. Compare them.

Enumerate and explain the various sewer appurtenances with neat sketches.

With help of a neat sketch discuss any two pumps used for sewage.

A town has a population of 100000 persons with a per capita water supply of 200 lpcd. Design a sewer running 0.7 times full. Take n=0.013 and slope 1 in 500 and a peak factor of 3. Assume 85% of water supply turns into sewer.

UNIT III - PRIMARY TREATMENT OF SEWAGE

PART – B

Describe about the component parts of septic tank, its advantages and disadvantages with neat sketches.

A grit chamber is designed to remove particles with a diameter of 0.2mm, Specific gravity = 2.65. Settling velocity for these particles has been found to be range from 0.016 to 0.22m/s, depending on the shape factor, a flow through velocity of 0.3m/s will be maintained by proportioning weir, determine the channel dimensions for a maximum waste water flow of 10,000cum/day.

Describe the designing procedure of a screen chamber.

State the objectives of primary treatment. Discuss about the grit chambers which is adopted in sewage treatment.

Explain in detail the Sedimentation tank with neat sketches.

State the objectives of treatment processes and what are the treatment processes, explain? Discuss the various types of screens adopted in sewage treatment with neat sketch.

Design a bar screen for a peak average flow of 30 million litres per day.

Determine the settling velocity of spherical particle of specific gravity 2.65,diameter 0.18mm. Take kinematic viscosity of water as $1.01 \times 6\ 10^{-2}$ m /sec.

Design a circular primary sedimentation tank to treat an average sewage flow of 5000 m^3/day, suitably assuming the design criteria. Draw a neat sketch of the designed tank.

Explain in detail about i) grey water harvesting and ii) on-site sanitation.

Design a rectangular sedimentation tank for treating 12 MLD adopting L:B ratio as 2.5 and overflow rate 40m^3/m^2/day. Assume D.T as 2 hours.

Estimate the screen requirement for a plant treating a peak flow of 60 million litres per day of sewage.

Design a septic tank with dispersion pit for a hostel with a population of 150 and peak discharge of 205 LPM. Take desludging period as one year. Assume suitable design criteria and draw a neat sketch of the designed tank.

UNIT IV - SECONDARY TREATMENT OF SEWAGE
PART – B

Write in detail about the UASB reactor with neat sketch, advantages and disadvantages.

Describe about the oxidation ditches with neat sketch, advantages and disadvantages.

Describe with neat sketches about the trickling filters.

Discuss the operational principles of activated sludge process.

Discuss the operational problem of standard rate trickling filters and their remedies.

What do you understand by waste stabilization ponds, explain.

Determine the size of standard rate trickling filter to treat 6 million litres of sewage per day having BOD of 160 mg/l. Take hydraulic loading of 6m^3/m^2/d and organic loading of 0.35kg/m^3/d.

Determine the size of a high rate trickling filter for the following data Sewage flow= 4.5 million litres per day, recirculation ratio=1.5, BOD for raw sewage=230mg/l, BOD removal in PST=30%, BOD of treated effluent required = 25 mg/l.

Compare the advantages and disadvantages of ASP and Trickling Filters.

What do you understand by secondary treatment of sewage water? Explain the various methods of biological treatment.

Explain in detail the activated sludge process with neat diagram.

Design an oxidation ditch for a community of 7500 with a per capita sewage contribution of 90 Lpcd and BOD 250 mg/l.the desired BOD of the treated sewage is 30mg/l.

UNIT V - DISPOSAL OF SEWAGE AND SLUDGE MANAGEMENT
PART – B

A large stream has a rate of reaeration constant, kr = 0.24 per day (to base 10) and deoxygenation constant, kd = 0.1 per day (to the base 10).The initial deficit of the mixture of stream and waste water at the point of reference Do = 4 mg/l and the ultimate 5 day BOD, Lo = 35mg/l. Find the DO deficit and critical time.

What is sewage farming? List the methods and state its advantages over the method of disposal of sewage dilution.

Write short notes on (a) Wastewater reclamation (b) Sewage disposal to sea water.

Name the various actions involved in the self-purification process of a stream and explain briefly.

Explain the mechanism of biogas recovery from sludge.

A waste water treatment plant produces sludge of 1000kg dry solids per day with a moisture content of 97%. The solids are 65% volatile with specific gravity 1.05 and inorganic solids of specific gravity 2.55. Determine the sludge volume of raw sludge, after dewatering to 70% and after incineration.

Explain the methods available and limitations of land disposal of sewage.

Solve the Streeter Phelps equation and show its application.

A town discharges 14 million litres per day sewage at a temperature of 23°C into a river having flow of 1.7 m^3/sec and water temperature of 20°C. BOD at 20°C for the waste water is 160 mg/l and k (base 10) is 0.1 per day. If R is 0.2 per day what is the critical oxygen deficit and the distance at which it occurs. Assume the stream as 92% saturated with oxygen before sewage addition the solubility of oxygen at 20°C as 9.0 mg/l and river flow velocity as 0.12 m/s.

Explain the principle of the self-purification process of stream and factors influencing the process.

Explain the various process involved in sludge treatment and disposal.

With the help of flow chart explain various process involved in sludge treatment and disposal. Explain the mechanism of anaerobic and aerobic sludge digestion with their relative merits and demerits.

Explain the anaerobic sludge digestion process and also the effects of pH and temperature on it.

14. State the Indian standards for sewage disposal on land and conditions favoring it.

Draw a typical oxygen sag curve and explain its meaning.

Determine the BOD of river water at the discharge point of the treated sewage from a town having a BOD of 30mg/l discharged at the rate of 5 m^3/s into a river having a flow of 30m^3/s and no BOD?

CE6604-RAILWAYS, AIRPORTS & HARBOUR ENGINEERING

TWO MARKS QUESTION AND ANSWES

UNIT – I

RAILWAY PLANNING

1. Define Permanent way?

The combination of rails, fitted on sleepers and resting on ballast and sub grade is called the Railway track or Permanent way.

2. Define Gauge?

The „Gauge" of a railway track is defined as the clear distance between inner or running faces of two track rails.

3. Define Rails?

The rails on the track can be considered as steel girders for the purpose of carrying axle loads. They are made of high carbon steel to withstand wear and tear.

What are the different types of rail sections?

- Double headed rails (D.H.Rails)
- Bull headed rails (B.H.Rails)
- Flat footed rails (F.F.Rails)

What are the different types of rail joints?

- Supported rail joints.
- Suspended rail joints.
- Bridge joints.
- Base joints.
- Welded joints.
- Square joints.

Define Creep?

Creep is defined as the longitudinal movement of rails with respect to sleepers in a track.

Classify Sleepers?

- Wooden sleepers
- Metal sleepers
  - Cast iron sleepers
  - Steel sleepers
- Concrete sleepers
  - Reinforced concrete sleepers
  - Prestressed concrete sleepers

What are the uses of Fish plates?

Fish plates are used in rail joints to maintain the continuity of the rails and to allow for any expansion or contraction of the rail caused by temperature variations. They maintain the correct alignment of the line both horizontally and vertically.

What is the use of Spikes?

- For holding the rails to the wooden sleepers.
- Spike should be strong enough to hold the rail in position.
- Spike should be as deep as possible, easy in fixing, removal, cheap in cost.

10. What is the use of Keys?

Keys are small tapered pieces of timber on steel to fix rails to chairs on metal sleepers.

11. What are the different materials used for Ballast?

Broken stone, Gravel. Ashes (or) Clinker, Sand, Moorum, Kanbar, Brick Ballast, Blast furnace slag, Selected earth.

12. Define track alignment?

The direction and position given to the center line of the railway track on the ground is called the track alignment.

13. Write the different surveys required for railway projects?

Traffic survey.
Reconnaissance survey.
Preliminary survey (or) survey for initial location.
Detailed survey (or) survey for final location.

14. Define super elevation?

When a train moves round a curve, it is subjected to centrifugal force acting horizontally at the center of gravity of each vehicle radially away from the center of the curve. This increases the weight on the outer rail. To counteract the effect of centrifugal force, the level of the outer rail is raised above the inner rail by a certain amount to introduce the centripetal force. This raised elevation of outer rail above the **inner rail at a horizontal curve is „called super elevation".**

15. What are the different types of curves?

Simple curve.
Compound curve.
Parabolic curve.
Transitional curve.

16. What are the necessities of points and crossings?

Points and crossings provide flexibility of movement by connecting one line to another according to requirements.
They also help for imposing restrictions over turnouts, which necessarily retard the movements.

17. What are the two types of Switches?

Stub switch.
Split switch.

18. Define Crossings?

A „Crossing" or a „Frog" is a device, which provides two flange ways through which the wheels of the flanges may move, when two rails intersect each other at an angle.

19. Classify the Crossings?
A) On the basis of shape of crossing.
Acute angle crossing or "V" crossing or Fog.
Obtuse angle crossing or Diamond crossing.
Square crossing.
On the basis of Assembly of crossing.
1) Spring or movable wing crossing.
2) Ramped crossing.

20. What you mean by Diamond crossing?
When straight tracks or curved tracks of the same or different gauges cross each other at an angle less than 90 degree, a diamond shape is formed. So this crossing is called as diamond crossing.

UNIT – II
RAILWAY CONSTRUCTION AND MAINTENANCE

1. Define cross-over in track junction?
When two adjacent parallel or diverging tracks, which may be straight or curved, are connected by two sets of turnouts, with or without a straight length between them, the connecting line is known as cross-over.

2. Define Ladder tracks?
When a number of parallel tracks are branched off from the straight track in continuation of a turnout, it is called a gathering line or ladder track.

3. What are the different classifications of railway stations?
A) Operational classification B) Functional classification

Block station.	1) Way side station.
Non-Block station.	2) Junction station.
Special class station.	3) Terminal station.

4. Define Platforms?
A raised level surface, from where either passengers board and alight from trains or **loading and unloading of goods is done, is known as a „Platform".**

5. Define station yards?
A yard is defined as a system of tracks laid usually on a level within defined limits, for receiving, storing, making up new trains, dispatch of vehicles and for other purposes over which movements are not authorized by a time table. The various movements on a system of tracks are governed by prescribed rules, regulations and signals.

6. Define Buffer stop?
The dead end of a siding or the end of any track of terminal station is not kept bare but a form of stop or barrier is provided at the end of the track, to prevent the vehicles, from running off the track. This stop or barrier provided at the end, across **the track of a siding or at terminal station is known as "Buffer stop".**

What are the three stages of construction of new railway track?

- First stage. Earth work – formation and consolidation.
- Second stage. Plate Laying – laying of a railway track.
- Third stage. Laying of ballast on the track.

8.Explain about track construction.

The process involved in track construction are:

i)land acquisition
ii)earth work and bridges.
iii)passenger amenities
iv)laying railway track including ballasting of track v)opening of section for traffic.

Write about the process involved in track maintenance. The items involved in track maintenance are:
i)slopes of embankments and cuttings ii)catch water drains iii)cess level iv)weed removal
v)recuperation of ballast
v)packing and overhauling of track vi)deep screening of ballast.
vii)upkeep of track drainage
viii)attention to fittings, fastenings, flexure.

Explain in detail about track drainage.

In track drainage it include surface drainage and sub-surface drainage. The methods involved to stabilize the soil are:

i)sand piling ii)cement grouting iii)layer of moorum

11.Explain about railway stations and yards.

The different types of railway stations are:

i)halt station
ii)flag station
iii)crossing station
iv)double line station
v)junction station
vi)terminal station.

The different types of yards are:

i)goods yards
ii)passenger yards
iii)marshalling yards.

List the equipment needed for rolling stock.

Locomotive sheds
Examination pits
Ashpits and ash pans
Water columns
Turn table
Triangles

13. What is a turn table?

Turntable is a device used for changing the direction of movement of a locomotive. It is normally provided at locomotive yards, marshelling yards, and terminal stations.

14. What is a platform?

Platforms may be of two types, viz., passenger platforms and goods platforms. Passenger platforms are constructed for entraining and detraining of passengers. Goods platforms are similar to passenger platforms but are of higher heights.

list the methods of sub-surface drainage methods adopted in railways.

Provision of an inverted filter
Sand piling
Laying of geotextile

What is Directed Track Maintenance?

It is a method of maintaining the track. This is based on the directions that are given for maintenance given every day rather than the routine maintenance. It is a need based maintenance.

List different dewatering methods.

Pumping Electro-osmosis

Elimination or reduction of ground water by cement grouting, chemical consolidation, displacement grouting and freezing.

What are the preliminary works needed for re-laying of a track?

Unloading track materials
Ballasting the section
Fixing centre line pegs and taking levels
Arranging traffic blocks.

List the sequence of operations involved in tunneling of rock.

Drilling hole on the rock face
Loading the holes with explosives
Blasting
Removing the debris Disposing
off the broken rock.

What is needle beam method?

In needle beam method full section of the tunnel is broken out. At the time of excavation from a centrally placed longitudinal girder called needle beam. The needle beam is kept at the bottom of the top heading, after placing of the beam the trench jacks are removed. Concreting is done at top and bottom.

UNIT – 3

AIRPORT PLANNING

1.List out the advantages and disadvantages of air transport. ADVANTAGES:
Accessibility, Continuous journey, Emergency use
Engineering use, Saving in time
DISADVANTAGES: Flight rules, Operating expenses, Unsafe
Weather conditions

2.What are the drawings should be prepared for construction of new airport?
Drainage plan, Grading plan, Lighting plan, Master plan, Obstruction plan, Paving
plan, Topographic plan

3.Define apron.
It indicates a defined area of the airport to accommodate aircrafts for loading and
unloading of cargo and passengers, parking, refueling, etc. It is usually paved and is located in front of the building or adjacent to hangers.

4.Define wind coverage.
The percentage of time in a year during which the crosswind component
remains within the limit of 25km p.h. is called the wind coverage of the runway.

5.What are the four basic patterns of runway?
1.Single runway
2.Parallel runways
3.Intersecting runways
4.Divergent or Open-V runways

6.What are the different types of parking of aircraft?
1.Nose -in parking.
2.Angled nose -in parking
3.Nose-out parking
4.Angled nose-out parking
5.Parallel parking

7.What is the main function of hangar?
The main function of a hangar is to provide an enclosure for housing and repairing of the aircraft. They are constructed of steel framework covered with the galvanized iron sheets.

8.Define crosswind component.
It is not possible to get the direction of opposite wind parallel to the center-line of
the runway length everyday or through out the year .For some period of the year at **least, the wind may blow making some angle ɵ with the direction of the center**-line
of the runway length. If V km ph is the velocity of the inclined opposing wind, its **component V sinɵ, which is normal to the ce**nterline of the runway length, is called the crosswind component.

9.What are the factors should be consider for layout of taxiway?

1.Arrangement, Busy airports, crossing, Higher turn-off speeds, Route

10.What do you mean by airport capacity?

The number of aircraft movement, which an airport can handle within a specified period of time.

11.What are the phases of Master plan by FAA recommendation?

Phase I: Airport Requirements
Phase II: Site selection
Phase III: Airport plans
Phase IV: Financial plans

12.What are the advantages of head wind?

1.During landing, it provides a breaking effect and the aircraft comes to a stop in a short length of the runway.

2.During take off, it provides greater lift on the wings of the aircraft.

13.What are the corrections required for runway length?

Correction for elevation
Correction for gradient
Correction for temperature

14.Define holding apron.

The portion of paved area which is provided adjacent to the ends of runway incase
of busy airports is known as the holding apron.

15.What is the necessity of surveying in construction of new airport?

1.To ascertain the characteristics of soil.
2.To workout the detailed estimate of the project.
3.To prepare suitable drawings
4.To make provision for future extension of the airport
5.To give an idea of the meteorological conditions prevailing at the proposed site

16.What is wind rose diagram?

The diagram showing direction, duration and intensity of wind over a certain period in a specified region is known as wind rose diagram.

17.What are the aims of Airport drainage?

1.It grants longevity to the pavements.
2.It increases the efficiency of the airport.
3.It is essential for proper and safe functioning of the aircraft.
4.It reduces the maintenances of an airport.

18.Define clear zone.

The term clear zone is used to indicate the innermost portion of the approach zone and it is to be provided at the ends of runways.

19.What are the two types of zoning?

1.Height zoning
2.Land-use zoning

20.Define Turning zone.

The turning zone is the area of airport other than the approach area and it is intended for turning operations of the aircraft incase of emergencies like failure of engine or trouble in smooth working of aircraft experienced at the start of the takeoff.

UNIT -4

AIRPORT DESIGN

Mention the purposes of installing visual aids at the airport?

- To avoid accidents during landing of the aircraft.
- To maintain an orderly flow of aircraft without any congestion.
- To satisfy the visual requirements for takeoff and taxiing.
- To grant safety to the persons and properties
- To direct the pilot to make the landing of the aircraft in the landing area only.

What are the airport markings?

1.Apron marking
2.Landing direction indicator
3.Runway marking
4.Shoulder marking
5.Taxiway marking
6.Wind direction indicator

3. Define Hangar.

The large shed erected at the airport for the purpose of housing, servicing, and repairing of aircrafts is known as hangar.

What are the guidance and information required by the pilots during landing operation?

- Alignment guidance
- Height information
- Visual parameters

What are the factors, which affect the type and intensity of airport lighting?

1.Airport classification
2.Amount of traffic
3.Availability of power
4.Nature of airport using the airport
5.Type of night operations planned
6.Type of the landing surfaces provided
7.Weather conditions

6.Give the elements of airport lightings.

1.Airport beacon
2.Approach lighting
3.Apron and hanger lighting
4.Boundary lighting

5.Lighting of land direction indicator
6.Lighting of wind direction indicator
7.Runway lighting
8.Taxiway lighting

7. Define heliport.

The area for landing and taking off helicopter is known as heliport.

8.What are the three factors which affect the size of an apron?

1.Gate position
2.Number of gates
3.Systems of aircraft parking

9.Define terminal building.

The building or buildings which are meant for providing facilities to all passengers, for serving as office for airport management and for carrying out other non- aeronautical functions are known as terminal buildings. They act as the focal points of the terminal area.

10.What are the markings made on the runways?

1.Runway centerline marking
2.Runway edge stripes
3.Runway numbering
4.Touch down or landing zone
5.Threshold marking
6.Two or more parallel runways

11.What are the two arrangements adopted for approach lighting?

1.Calvert system
2.ICAO system

12. Define the term visibility.

The term visibility is defined differently for day and night in the meteorology.
During the day, it is the distance that a black circular target subtended by a visual age of 1 can be seen .At night; it is the distance from which a human can see a 25 candela light.

13.Define ceiling.

The meteorological visibility is also generally associated with the height of the underside of a dense cloud above the airport surface .The height is referred to as the ceiling.

14.What are the broad principles that are to be observed in the design of a terminal building?

1.Arrival and departure areas
2.Baggage delivery
3.Information
4.Movement

15.What are the systems of aircraft parking?

1.Frontal or linear system
2.Open- apron or transporter system
3.Pier or finger system
4.Satellite system

16.What are the importances of air traffic control?

It avoids the possibility of occurrence of the accidents in the air.
It grants the economic and efficient utilization of the aircraft and the airports.

17.What are the three components of an air traffic control network?

1.control centers
2.control towers
3.Flight service stations.

18.What are the types of air traffic control aids?

1.En route aids or airway aids
2.Landing aids or terminal aids.

19.Define passenger flow.

The design of the terminal building should be such that an uninterrupted flow
route is formed for the passengers to follow on or off an aircraft without offending or disturbing each other.

20.What are the basic requirements to be kept in mind while deciding the site for a terminal building?

1.It should be centrally located with respect to the runways.
2.It should have convenient and easy access to the highway.
3.The site should have easy facility of natural drainage.
4.There should be adequate space available for the parking of the vehicles.

UNIT V

HARBOUR ENGINEERING

Advantages of water transport

-Cheapest mode of transport
- High load carrying capacity
- Powerful defense of national security
- To encourage consumption of foreign goods.

Dis advantages of water transport

-Slow Operation
-Use only when water is available
- Accidents due to ocean storms.
-Water level fluctuations will affect the transport.

3. Define Harbour :

Harbour can be defined as a basin of navigable waters will protected naturally (or) artificially from action of wind and waves, and it is situated along the sea - shore (or) river.

Classify Harbour :

- Based on protection needed:
  (a) Natural (b) Semi - Natural (c) Artifical

Based on the Utility:

(a) Harbour of refuge (b) Commercial (c) Fishery
(d) Military (e) Marina

(iii) Based on Location:

(a) Canal (b) Lake (c) River (d) Sea

5. Define Port:

The term port is used to indicate a harbour where terminal facilities Such as stores, loading of passengers and cargo etc.

Classification Ports:

- Based on Location
  (a) Canal Port (b) River Port (c) Sea Port

(ii) Based on Size

(a) Major (b) Intermediate (c) Minor

7. Define Sea water waves:

The periodic rise and fall of sea water Surface is termed as sea water waves.

8. Define Littoral Drifts:

The process of carrying and depositing materials by waves on the shore line. Such process of movement and deposition of sand is called Littoral Drifts.

9. Define Clapotis :

When tidal wave is reflected back by solid wall of marine structure, the reflected water may fall on the incoming tidal wave, increasing height of water surface, which looks like a wall of water, such a wall of water is called as clapotis.

10. What is tidal range ?

The difference in water level of high tide and low tide levels.

11. Define Break water:

The protective barrier constructed to enclose harbours and to keep the harbour waters undisturbed by the effect of waves and winds is called breakwater.

Different Layout of ports

- Square layout

Rectangular layout

- Machicolated layout

ÀrĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀ0 Tridentine layout

1 Digital layout

Classify Docks

0 Wet docks (ii) Dry docks

Define quays

It is a solid structure constructed along the shore for Loading & Un loading facilities.

15. Define Piers:

It is a solid structure perpendicular (or) oblique from share for loading & unloading facilities.

16. Define Pier heads:

A pierhead is a structure constructed at a tip of break water near the harbor entrance.

17. Define - Dolphins:

The construction in the form of a cluster of closely spaced piles is known as dolphins. It is used for tying up ships and also for transferring cargo from one ship to another when moored along both of their sides.

18. Differentiate between wharf and Jetty.

The Wharf is a berth parallel to the share, and wharf has berth on one side only as it has a backfill of earth.

A Jetty is perpendicular to shore or break water and it may have berths on two faces.

19. Define dredging:

It is defines as excavation of bed below water.

What are the types of dredging?

0 Dipper dredging

1 Grapple dredging

ÀrĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀ0 Ladder dredging

ÀrĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀ1 Hydraulic (or) Suction. Dredging.

IMPORTANT 13 MARK QUESTIONS

UNIT I

Briefly explain the modern methods of surveys for track alignment.

(a) Explain the widening of gauge on curves with the formula.

⁰ Briefly explain about super- elevation, gradients.

(i) Briefly explain the modern methods of surveys for track alignment.

⁰ What are the objectives of providing transition curves in railways?

(i) What are the requirements of an ideal permanent way? What are the factors that govern the cross section and length of rails?

(ii) Explain super elevation giving the relationship of super elevation with gauge, speed and radius of the curve.

Compare the different types of sleeper. Give all details.

(i) What do understand by „cant deficiency"?

⁰ If an 8º curve track diverges from main curve of 5º in an opposite direction in the layout of a BG yard. Calculate the super elevation and speed on branch line, if the maximum speed permitted on the main line is 45Kmph.

(i) What is the necessity of geometric design of a railway track? Enumerate the Significant features of design of a railway track.

UNIT II

Illustrate with a neat sketch, the turnout, points and crossings and explain their Working principles.

Briefly explain about

ÀÃÃÃÃÃÃÃÃdÃÀÃÃÃÃÃÃÃÃ0 Track drainage

ÀÃÃÃÃÃÃÃÃdÃÀÃÃÃÃÃÃÃÃ1 Re- laying of railway track

¹ Track circuiting

(i) With neat sketches, differentiate between reception, signal and departure signals.

What is meant by a crossing? Discuss various types of crossings used in Indian railways.

(i) Explain in detail the miscellaneous measures of track modernization.

⁰ **Define „plate laying". Explain the telescopic methods of plate laying.**

How are stations classified? Explain the features of each station.

Explain with neat sketches, how surface and sub-surface water can be removed from railway track.

(i) Explain the centralized traffic control system.

What is a marshaling yard? Explain with a neat sketch, the working of a humptype of marshaling yard.

UNIT III

(i) Explain the steps in the determination of proper orientation for runway.

(ii) Give the various geometric standards for different classes of runways and Taxiway.

(i) Explain in detail about airport zoning.

- The length of a runway at mean sea level, standard temperature and zero gradients is 1600m. The site has an elevation of 320m, with a reference temperature of 33.6ºC. The runway has to be constructed with an effective gradient of 0.25%. Determine the actual length of the runway at site.

(i) List the factors to be considered for the selection of site for a commercial airport.

- What are the functions of airport drainage system?

(i) Summarize briefly the various runway geometrics as recommended by ICAO

- What is a wind rose diagram? Explain different types of wind rose diagrams.

The length of runway under standard conditions is 1620m. The airport site has an elevation of 270m. Its reference temperature is 32.90ºC. If the runway is to be constructed with an effective gradient of 0.20%. Determine the corrected runway length.

What are the basic patterns of runway configurations? Discuss each pattern.

Explain about Exit taxiway and factors for the location of an Exit taxiway.

Explain the necessity, functions and special characteristics of airport drainage.

Explain the sub surface drainage system of airport.

Explain the importance of airport planning.

UNIT IV

(i) Draw a layout of any one international airport in India and explain the concept.

- Explain the planning concept of airport buildings.

(i) Explain the various runway and taxiway markings.

- Explain in detail about air traffic control.

(i) Describe briefly the salient features and functions of aprons in an airport.

- What are the passenger facilities, required at an airport terminal? Explain using Sketches.

(i) Discuss the importance of air traffic control and list the various equipments needed Foe en-route air traffic control.

ÀrÃÃÃÃÃÃÃÃdÃÀrÃÃÃÃÃÃÃÃ0 Describe the importance of runway lighting. Explain threshold lighting with the Help of sketches.

Describe the different systems of aircraft parking.

Write notes on the following with neat diagrams:

- Terminal facilities
- Airport markings

Briefly explain the Night- time aids provided at Airports.

What are flight rules? Discuss the advantages and disadvantages of each system.

Explain the characteristics of commercial airport layout and military airport layout.

Draw a typical layout of airport for a single runway and two parallel runways.

UNIT V

Explain about the different types of break waters with the sketches.

(i) Write descriptive notes on mooring and mooring accessories.

What are the different components of a harbor? And explain them with the layout. 3.

(i) Discuss the tides and wave effects and its action on coastal structures.

- Distinguish between wet docks and dry docks. Explain with sketch the features and functioning of a dry dock.

(i) List the common types of break waters in use and bring out the advantages of each of them.

- Discuss briefly container transportation.

Write a detailed note on break waters. Explain all essential aspects.

(i) What are the types of Navigational Aids?

- Discuss the fixed navigation structures and floating navigation aids.

Classify harbours on broad basis and on the basis of utility and explain them.

(i) Define a port and bring out the differences between a port and a harbor. What are the requirements of good port?

- Classify different types of break water. Explain any one in brief.

Explain the different natural phenomena to be studied before the design of harbours.

What is littoral drift? How it affects the location of a harbour?

V.S.B. College of Engineering Technical Campus, Coimbatore

Department of Civil Engineering

ACADEMIC YEAR: 2017-2018 (EVEN Semester)

CE6002-CONCRETE TECHNOLOGY
TWO MARK QUESTION AND ANSWERS
UNIT-I
CONSTITUENT MATERIALS

What is meant by Surkhi?

Surkhi is fine powdered under burnt bricks. It is also known as artificial pozzolona

Define hydration of cement?

Cement in dry state has no bonding property. When mixed with water react Chemically and becomes a bonding agent. These reactions are called hydration.

Define setting of cement

When water is added to cement, hydration takes place immediately as it continuous, cement paste which is plastic becomes stiff and rigid known as setting of cement.

What are pozzolonas?

These are siliceous materials which, while having no cementations values within themselves, will chemically react with calcium hydroxide at ordinary temperature and in thepresence of moisture to form compounds possessing cementitious properties.

Name any 2 natural pozzolonas.

Clay and shales, opalinccherts, diatomaceous earth, volcanic tuffs and pumicites.

Name any 2 artificial pozzolonas.

Surkhi, fly ash, blast furnace slag, silica fume, rice husk ash, metakaoline.

What is natural cement?

Natural cement is manufactured by burningand then crushing the natural cement stones.Natural cement stones are such stones which contain 20 to 40% of argillaceous matter i.e. clay,and remaining content mainly calcareous matter which is either calcium carbonate alone or amixture of calcium carbonate and magnesium carbonate.

What is artificial cement?

Artificial cement is manufactured by burning approximately proportioned mixture ofcalcareous and argillaceous materials at a very high temperature and then grinding the resultingburnt mixture to a fine powder.

What is the function of gypsum in the manufacture of cement?

In order to delay the setting action of cement, when mixed with water, a little percentageof gypsum is added in the clinker before grinding them to fine powder.

What is known as clinker?

Artificial cement is manufactured by burning approximately proportioned mixture ofcalcareous and argillaceous materials at a very high temperature and then grinding the resultingburnt mixture to a fine powder. The burnt mixture of calcareous and argillaceous matter isknown as clinker.

What are the constituents of ordinary cement?

Alumina or clay, silica, lime, iron oxide, magnesia, sulphur trioxide, Alkalies, calciumsulphate (gypsum).

What are the harmful constituents of cement?

Alkalies which are oxides of potassium and sodium, and magnesium oxide are theharmful constituents of cement.

What are ball mills?

Ball mills are used for grinding the clinkers. The ball mills consist of 2 to 2.5m diametersteel cylinder. The clinkers to be ground are fed into the cylinder and the cylinder is rotatedabout its horizontal axis to carry out the grinding action.

What are the types of cement?

Ordinary Portland cement, rapid hardening cement, low heat cement, blast furnace slagcement, sulphate resistant cement, air entraining cement, white and coloured cement, highalumina cement, pozzolanic cement, super sulphate cement, expansive cement, quick settingcement, water repellant cement, water proofing cement.

What are the 2 methods of manufacture of cement

Dry process
Wet process

Define mortar.

The mortar is a paste like substance prepared by adding required amount of water to a drymixture of sand or fine aggregate with some binding material like clay, lime or cement.

Define lime mortar.

If lime is used as a binding material, the resulting mortar is known as lime mortar.

Define mud mortar.

When clay is used as a binding material, the resulting mortar is known as mud mortar

What is known as bulking of sand?

Bulking of sand means increase in its volume. Fine aggregates or sands, increase involume when they possess some moisture. Bulking is due to formation of a thin film of wateraround the fine aggregate or sand particles. Thickness of water film goes on increasing withmore and more moisture and consequently increase in volume continues. But after certainpercentage of water, volume of sand starts decreasing with increasing amount of water.At certainpercentage of water, increase in volume completely vanishes and volume occupied by sandbecomes equal to the volume of dry sand.

What are the types of mortars?

Mud mortar
Lime mortar
Gauged mortar

Define Segregation.

The tendency of separation of coarse aggregate grains from the concrete mass is calledsegregation.

What are the methods adopted to avoid segregations of concrete.

Addition of little air entraining agents in the mix.
Restricting the amount of water to the smallest possible amount.
Concrete should not be allowed to fall from larger heights.

Define workability.

Workability is that property of concrete which determines the amount of internal worknecessary to produce full compaction. It is a measure with which concrete can be handledfrom the mixer stage to its final fully compacted stage.

What are the factors affecting workability.

Quantity of water in the mix
Proper grading of the aggregate mix
Ratio of fine aggregate and coarse aggregate
Maximum size of coarse aggregates Method
of compaction of concrete

What are the factors affecting proportioning of concrete mixes?

Water cement ratio
Cement content
Temperature Age
of concrete
Size, shape and grading of
aggregate Curing

Define mixing of concrete.

The process of mixing cement, water, fine aggregate and coarse aggregate in suitableproportion is known as mixing of concrete.

What are the methods of consolidation or compaction of concrete?

Hand compaction

Machine compaction – i) Internal vibrators

0. Form vibrators
1. Surface vibrators

Define curing of concrete.

Curing is the operation by which moist conditions are maintained on finished concretesurface, to promote continued hydration of cement.

What are admixtures?

Admixtures are ingredients other than cement, fine aggregate and coarse aggregate toimprove the quality of concrete. The addition of an admixture may improve the concrete withrespect to its strength, hardness, workability, water resisting power etc.

Name the types of joints in concrete.

Construction joints 2. Expansion joints

Contraction joints 4. Working joints

What are the types of concrete used?

Plum concrete, light weight concrete, air-entrained concrete, no-fines concrete, vaccumconcrete, water-proof concrete, reinforced cement concrete, pre-stressed concrete, cellular oraerated concrete, foamed concrete, pre-cast concrete.

Mention the test adopted to test the properties of cement in laboratories?

0. Fineness
1. Consistency test
2. Setting time
3. Soundness
4. Compressive strength

Mention the test adopted to test the properties of cement in field?

0. Open the bag and take a good look at the cement, there should not be any visible lumps
1. Thrust your hand into the cement bag should feel cool feeling
2. Take a pinch of cement and feel between the fingers. It should give a smooth feeling not a gritty feeling
3. Take a hand full of cement and throw it on a bucket full of water, the particle should float for sometime before they sink.

34. Mention the test adopted to test the quality of water?

Determination of acids and alkalis

Determination of total solids.

UNIT-II
CHEMICAL AND MINERAL ADMIXTURES

What are admixtures?

Admixtures are ingredients other than cement, fine aggregate and coarse aggregate to improve the quality of concrete. The addition of an admixture may improve the concrete with respect to its strength, hardness, workability, water resisting power etc.

Define chemical admixtures

Chemicals mixed with concrete ingredients and spread throughout the body of concrete to favorably modify the molding and setting properties of concrete mix known as chemical admixtures.

Define Mineral admixtures

It is a siliceous materials used to strengthen the durability properties that is classified as pozzolanic or cementitious materials. It acts as by-product agent. E.g.: fly ash

What is accelerators

Accelerators reduce the setting time and produce early removal of forms and speed up hardening. The common accelerators are $cacl_2$, Al_2cl, Nacl, Na_2SO_4.

What is the purpose of retarders?

Retarders increases the setting time of concrete mix and reduce the water cement ratio. Up to 10% water reduction is achieved.

Define plasticizers

Plasticizers are defined as chemical admixtures added to wet concrete mix to impart adequate workability properties.

Mention the types of plasticizers

- Finely divided minerals
- Air entraining agents
- Synthetic derivatives

Define superplasticizers

Superplasticizers produce extreme workability and achieve reduction of water content without loss of water cement ratio i.e workability.

Mention few mineral admixtures.

- Fly ash
- Silica fume
- Rice husk ash

3 Metakaoline
4 GGBFS

What are the various admixtures used other than chemical and mineral admixtures/

0 Gas forming and expansive chemicals
1 Pigments
2 Antifungal admixtures
3 Curing compounds
4 Sealants
5 Flooring
6 Guniting aids.

Name the admixtures available in India?

0 Plasticizers
   - Conplast P211- Water reducing plasticizers
   - Conplast P509- Water reducing plasticizers/High performance plasticizers
1 Super Plasticizers
   - Conplast SP337- High workability aid
   - Conplast SP430- High range water reducer

UNIT-III
PROPORTIONING OF CONCRETE MIX

What is proportioning of concrete mix

Proportioning of concrete mix is the art of obtaining a suitable ratio of the various ingredients of concrete with the required properties at the lowest cost.

What is the principle of mix proportioning

0 Environmental exposure conditions
1 Grades of concrete
2 Type of cement
3 Type and size of aggregates
4 Nominal maximum size of aggregates
5 Maximum and minimum cement content
6 Maximum free water cement ratio by weight
7 Degree of workability
8 Air entrained agent

9 Types of admixtures used if any
10 Maximum/ minimum density of concrete

11. Maximum/ minimum temperature of fresh concrete
12. Type of curing and mixing
13. Source of water

Mention the properties related to mix design

0. Durability
1. Workability
2. Strength
3. High strength concrete

Describe the physical properties of materials required to mix design

0. Cement
1. Aggregate
2. Water
3. Admixtures

Define Nominal mix

Nominal mix is permitted by IS456:2000 for concrete of strength lower than M_{25}

Define Design mix

Design mix is permitted by IS 10262-1982 and IS456:2000for concrete of strength Greater than M_{25} is design mix.

List out the advantages of Design mix

0. Properties of all materials are used.
1. Cement content is low and hence the mix design is economical.

List out the disadvantages of nominal mix

0. Nominal mix does not say which type of sand, cement, aggregate to be used.
1. High cement is required which leads to high cost.

What is ACI

American concrete institute was revised to include the use of entrained air.

What are the data used for ACI

0. Fineness modulus
1. Unit weight of dry rodded coarse aggregate
2. Specific gravity of cement, coarse and fine aggregate

UNIT-IV
FRESH AND HARDENED PROPERTIES OF CONCRETE

Define workability.

Workability is the 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.

List out the requirements of fresh concrete.

0. Mixability
1. Stability
2. Mobility

ÀrāāāāāāāādāÀrāāāāāāāāā0 Compactability

ÀrāāāāāāāādāÀrāāāāāāāāā1 Finishability

3 List out the Factors affecting Workability?

ÀrāāāāāāāādāÀrāāāāāāāāā0 Water content

ÀrāāāāāāāādāÀrāāāāāāāāā1 Mix proportion

ÀrāāāāāāāādāÀrāāāāāāāāā2 Size of aggregate

ÀrāāāāāāāādāÀrāāāāāāāāā3 Shape of aggregate

ÀrāāāāāāāādāÀrāāāāāāāāā4 Surface texture

ÀrāāāāāāāādāÀrāāāāāāāāā5 Grading

ÀrāāāāāāāādāÀrāāāāāāāāā6 Admixture

4 Mention the methods to measure the workability? a.Slump Test

ÀrāāāāāāāādāÀrāāāāāāāāā0 Compaction Factor

ÀrāāāāāāāādāÀrāāāāāāāāā1 Vee-Bee Consistometer

ÀrāāāāāāāādāÀrāāāāāāāāā2 Kelly Ball Penetration test

ÀrāāāāāāāādāÀrāāāāāāāāā3 Flow table Test

ÀrāāāāāāāādāÀrāāāāāāāāā4 Vibrating table

Mention the values of different type of slump.

- True slump - up to 125mm from top
- Shear slump - up to 150 mm from top

Collapse slump -150-225mm

6. List out the usage of slump values

slump 0 – 25 mm are used in road making

10 – 40 mm are used for foundations with light reinforcement

50 - 90 for normal reinforced concrete placed with vibration

Define compaction factor?

Compaction Factor is the ratio of the weight of partially compacted concrete to the weight of the concrete when fully compacted in the same mould.

Define Vee bee consistometer

Consistometer is based on consistency test which is a mechanical variation of the simple slump test which includes determination of the workability of concrete.Measures consistency of concrete in terms of time required to transform by vibration a frustum of fresh concrete sample into a cylinder. This time is called VB time.

What is the use of Kelly Ball Penetration test

Kelly Ball Penetration method is used to determine the penetration of a hemispherical metal weight into freshly mixed concrete, which is related to the workability of the concrete.

What is the use of flow table method

Flow table indicates consistency and proneness to segregation. It is used for aggregate of size <40mm. The flow is determined by = {D-250/250}*100.

What is batching.

Batching is the correct measurement of various materials used in the concrete mix. It can be either volume or by weight.

How is weight batching is obtained

Weight batching is more accurate and hence preferred weighing can be done by

- Simple spring balance
- Platform weighing machines
- Automatic weighing machines

How is mixing operation is done in concrete

- Hand
- Machine

a) Tilting type

Charging by hand

Charging by machine

b)Non tilting type

1. Continuous mixer
2. Pan mixer
3. Truck mixer

What is the purpose of compaction?

Compaction is done to eliminate air voids in concrete.

What is hardened concrete and mention the factors influence its strength

Hardened concrete gives an overall idea about the quality of concrete. It depends on

- Water cement ratio
- Degree of compaction
- Age of concrete
- Richness of mix
- Curing of concrete
- Temperature of concrete.

Define curing

- Curing is done to keep the concrete saturated until the water filled space in concrete is filled up by the product of hydration.

1. Curing is done to prevent the loss of water by evaporation and to maintain the process of hydration.

Define shrinkage

Volume change due to loss of moisture affects durability and strength, causes cracks in concrete at different stage due to alkali aggregate reaction, sulphate action, settlement of fresh concrete is shrinkage.

Define creep.

When a concrete member is loaded it deforms to a certain extent as soon as the load is applied. When the load is kept constant, the deformation increases with time. This increase in strain under sustained stress is called creep of concrete.

Mention the test conducted to test the properties of hardened concrete.

0. Compression Testing Machine
1. Flexure Strength Testing Machine
2. Lateral Extensometer
3. Split Tensile Test
4. Shear strength
5. Bond strength

List out the factors affecting the results of strength test.

0. Size and shape of aggregate
1. Condition of casting
2. Moisture condition
3. Bearing condition
4. Rate of loading

UNIT-V
SPECIAL CONCRETE

What is the density of concrete?

The density of concrete varies between 2200 t0 2600 kg/m^3

Define light weight concrete.

The concrete is said to be light weight concrete whose density is between 300 to 1850 kg/m^3

Define High density concrete

The concrete is said to be High density concrete whose density is between 3360 to 3840 kg/m^3.

Name some of the natural light weight aggregate

- Pumice
- Diatiomite
- Scoria
- Volcanic cinders
- Saw dust
- Rice husk

Name some of the artificial light weight aggregate

- Brick bat
- Foamed slag
- Cinder, clinker
- Bloated clay
- Sintered fly ash
- Exfoliated vermiculite
- Expanded perlite

Where does high density concrete is applicable.

High density concrete is used as radiation shielding agent and it has satisfactory mechanical property .

Mention the applications of sulphur infiltrated concrete

- Pre cast industry
- Fencing post
- Sewer pipes
- Railway sleepers

Define Gunitingor Shotcrete?

It is defined as a mortar conveyed through a hose and pneumatically projected at a high velocity on to a surface.

SIXTEEN MARK QUESTION

UNIT I

Explain in details the different tests employed for cement to ascertain its quality as per IS specification.
Explain with the help of a neat sketch, the wet process of manufacture of ordinary cement.
Explain with the help of a neat sketch, the dry process of manufacture of ordinary cement.
What do you understand by the term grading of aggregates. What importance this term carries as far as design of concrete mix is concerned.
Explain in details various stages of manufacturing of cement concrete.
Describe the importance of the quality of water used for concreting.

How does increasing the quality of water influence the properties of fresh and hardened concrete?
List the various tests conducted on coarse aggregate indicating the property being tested.
What is the effect of the maximum size of aggregate on concrete strength?
List the various types of cement indicating their use for different applications.
What are the important chemical tests conducted on cement to determine its quality?
What is soundness of cement and how is it tested?
Write explanatory notes on (a) uniform grading (b) gap grading (c) continuous grading.
What are the effects of the shape and texture of aggregates on the strength and workability of concrete?
What are the different moisture states in which aggregates exit?
Describe a test to determine the initial moisture content of fine aggregate in the construction site.
Describe the role played by gypsum in the hydration reaction of cement

UNIT II

Explain plasticizer and super plasticizer?
Explain action of plasticizers and classification of superplasticizer.
Explain the various types of mineral admixtures
Mention some of the construction chemicals
Discuss briefly the role of admixture in concrete
Classify the admixtures in detail.
Write short notes on retarders.
Describe the role played by super plasticizers in concrete.
State any four pozzolanic admixtures and discuss briefly.
Write short notes on gas forming agents.
List the corrosion inhibiting agents and briefly explain any one of them.
Why are chloride based accelerators not used in pre-stressed concrete structures?
Distinguish between Plasticizers and Superplasticizers.
List the different types of workability aids.
How does a surface –active agent increase workability?
Why do superplasticizers perform better than surface-active agents?
What method will you adopt to cure concrete in areas of water shortage?
What are the different chemicals used to obtained the desired colours on a concrete surface?
How are mineral admixtures classified?
Distinguish between pozzolanic and or cementitious admixtures.

UNIT III

Design a concrete mix for the following requirements using IS method. Also find the mix proportions by weight and by volume. M40 grade , OPC cement, sp gravity – 3.15, bulk density – 1440kg/m3, sand – grading zone I , sp gravity – 2.65, bulk density – 1610kg/m3 Coarse aggregate – 10mm angular, sp gravity – 2.66, bulk density – 1580kg/m3 Degree of workability – 0.85 compacting factor, quality control – very good.

Design a M30 grade concrete with compaction factor of 0.9 by IS code method for moderate exposure and good quality control conditions using 20mm coarse aggregate which conforms to IS 383 grading . sp gravity of cement , fine and coarse aggregates is 3.15, 2.65 and 2.60 respectively. Water absorption of CA and FA is 0.5% and 1.0% respectively. Natural moisture content and grading zone of FA are 1.0% and zone III respectively. Assume suitable data if found necessary.

Design a concrete mix for construction of an elevated water tank . The specified design strength of concrete is 30mpa at 28 days measured on standard cylinders. Standard deviation can be taken as 4mpa. The specific gravity of FA and CA are 2.65 and 2.7 respectively. The dry rodded bulk density of CA is 1600 kg/m3 and fineness modulus of FA is 2.8. opc used A slump of 50mm is necessary. CA is found to be absorptive to the extent of 1% and free surface moisture in sand is found to be 2%. Assume any other data.

Explain the procedure for road not no.4 method
Explain the procedure for DOE method
Discuss the various methods of proportioning.
Differentiate between nominal mix and design mix.
Compare ACI and IS method of concrete mix design.
Explain in detail, the step by step procedure of IRC 44 method of concrete mix design.
What are the parameters to be considered while designing a concrete

UNIT IV

1.What are the various factors which affecting the workability of concrete?
Compare the relative merits and demerits of various workability tests.
Distinguish between segregation and bleeding of concrete.
What is re-vibration? Is it detrimental to concrete? Where is it practiced?
Why age factor not taken advantage of in IS 456-2000? Comment.
Discuss maturity of concrete? How is it measured? What are its practical uses in the concrete industry?
Describe the importance of curing? When should it be commenced? For how long should it be continued?
What is meant by autogenous healing of concrete? Comment on its relevance.
Under what circumstances is concrete subjected to fatigue stresses?
Is impact strength higher or lower than static strength? Give examples of two case where concrete is subjected to impact loading.
What is the relationship between the strength and density of concrete?
Define the term workability. What are the various tests conducted to determine the Workability of concrete and explain them.

UNIT V

What is the significant difference between mixture proportioning of normal weight and light weight concrete?
Why is lightweight concrete preferred for construction particulars in multi-storey building?
Explain with respect to their physical characteristics of lightweight aggregate concrete.

Discuss the importance and effects of water absorption and moisture content of lightweight aggregate concrete.
Discuss the environmental impact of normal-weight and lightweight concrete.
List the aspects of HPC that are related to strength and durability separately.
What are the important approaches for achieving durable concrete?
What are the methods of transportation of fluids and gases which aid permeation in concrete?
How does the porous structure of rice husk as influence the properties of fresh/hardened concrete?
What aspects are to be investigated for high performance in complex exposure conditions?
Describe the various applications of high-strength concrete in India.

CE 6603- DESIGN OF STEEL STRUCTURES

CE 6603/ DESIGN OF STEEL STRUCTURES

UNIT1-INTRODUCTION

Properties of steel – Structural steel sections – Limit State Design Concepts – Loads on Structures – Connections using rivets, welding, bolting – Design of bolted and welded joints – Eccentric connections - Efficiency of joints

PART-A (2 marks)

What are the various types of connections used for connecting the structural members?

- Riveted connections
- Bolted connections
- Pin connections
- Welded connections

2. Define riveting.

Riveting is a method of joining two or more structural steel components by inserting ductile metal pins, called rivet.

3. Define nominal diameter of rivet.

It is the diameter of the unheated rivet measured before driving. It is the stated diameter of the rivet, available in the market

4. Define gross diameter of rivet.

It is the diameter of the rivet in the hole, measured after driving. It is taken equal to the diameter of the rivet hole.

5. What is meant by pitch of rivet?

The pitch of the rivets is the distance between centers of two adjacent rivets in a row.

6. Define gauge line.

It is the line of rivets, which is parallel to the direction of stress

7. What is meant by gauge distance and edge distance?

Gauge distance is the perpendicular distance between two adjacent gauge lines. This is also called as back pitch. Edge distance is the distance of the edge of the member or the cover plates from the center of extreme rivet hole.

8. Define staggered pitch.

It is also called as alternate pitch or reeled pitch. The staggered pitch is defined as the distance measured along one rivet line from the center of a rivet to the center of the adjoining rivet on the adjacent parallel rivet line.

9. Define lap.

It is the distance normal to the joint between edges of the overlapping plates in a lap joint or between the joint and the end of cover plates in a butt joint.

10. What is meant by tensile stress?

When a structural member is subjected to direct axial tensile load, the stress is **known as tensile stress (σ_{st})**. The tensile stress is calculated on net cross-sectional area of the member.

$$\sigma_{st}=P_t/A_n$$

Where, P_t is the direct axial tensile load and A_n is the net cross-sectional area of the member.

11. What is meant by compressive stress?

When a structural member is subjected to direct axial compressive load, the stress is known as compressive stress (σ_{sc}). The compressive stress is calculated on gross cross-sectional area of the member.

$$\sigma_{sc} = P_c/A_g$$

Where, P_c is the direct axial compressive load and A_g is the gross-sectional area of the member.

12. Define bearing stress.

When a load is exerted or transferred by the application of load through one surface **for another surface in contact, the stress is known as bearing stress (σ p). the bearing stress** is calculated on net projected area of contact.

$$\sigma_p = (P/A)$$

Where, P = load placed on the bearing surface

13. What is working stress?

The working stress is also termed as allowable stress or permissible stress. The working stress is evaluated by dividing yield stress by factor of safety. For the purpose of computing safe load carrying of a structural member, its strength is expressed in terms of working stress. The actual stresses resulting in a structural member from design loads should not exceed working stress.

14. 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.

15. What are the methods employed for the design of the steel framework?

Simple design
Semi-rigid design
Fully rigid design
Plastic design.

What are the assumptions made in simple design?

- The beams are simply supported
- All connections of beams, girders, or truss are virtually flexible and are proportioned for the reaction shears applied at the appropriate eccentricity
- The members in compression are subjected to forces applied at the appropriate eccentricities.
- The members in tension are subjected to longitudinal forces applied over the net area of the sections

Define Modulus of Elasticity

The modulus of elasticity is defined as the ratio of longitudinal stress to the **longitudinal strain within the elastic region; it is denoted by „E".**

Define Poisson"s Ratio.

The Poisson"s ratio is defined as the ratio of transverse strain to the longitudinal strain under an axial **load. It is denoted by „μ" or 1/m. the value of Poisson"s ratio for steel** within the elastic region ranges from 0.25 to 0.33.

⁰ What are the types of riveted joints?

Lap joint

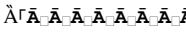

Single riveted lap joint


Double riveted lap joint

Butt joint


Single cover butt joint


Double cover butt joint


D

efine Lap joint and Butt Joint.

Lap joint:

When one member is placed above the other and these two are connected by means of rivets, then the joint is known is lap joint.

Butt Joint:

When the plates are placed end-to-end and flushed with each other and are joined by means of cover plates, the joint is known as Butt joint.

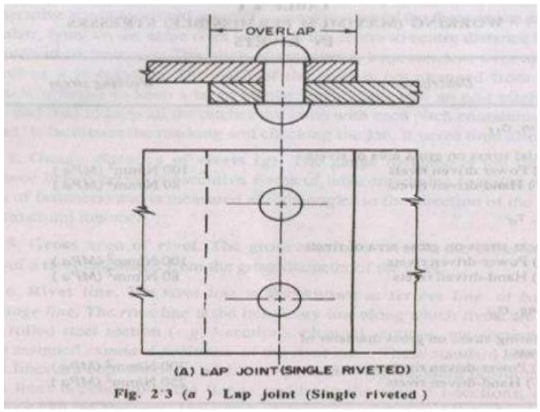


Fig. 2·3 (a) Lap joint (Single riveted)

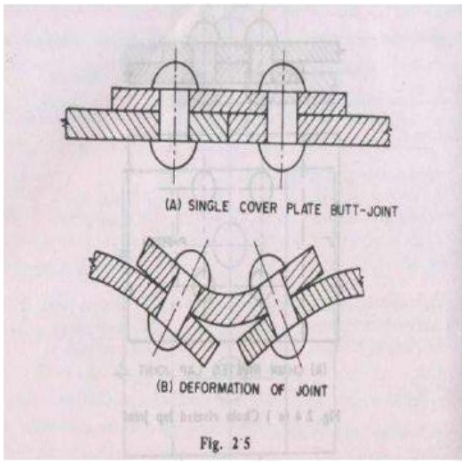


Fig. 2·5

[1] What are the types of failures occur in riveted joint?

Shear failure of rivets
Shear failure of plates
Tearing failure of rivets
Bearing failure of plates
Splitting failure of plates at the edges
Bearing failure of rivets.

[0] Write about Minimum pitch and Maximum pitch Minimum pitch:

The distance between centers of adjacent rivets should not be less than 2.5 times the gross diameter of the rivet

Maximum pitch:

The maximum pitch should not exceed 12t or 200 mm whichever is less in case of compression member, and 16t or 300 mm whichever is less in case of tension member.
The distance between centers of any two consecutive rivets in a line adjacent and parallel to an edge of an outside plate shall not exceed (100mm + 4t) or 200 mm, whichever is less in compression or tension members.
If the line of rivets (including tacking rivets) does lie in the direction of stress, the maximum pitch should not exceed 32 t or 300 mm whichever is less, where t is the thickness of the thinner outside plate

[1] What is edge distance?

A minimum edge distance of approximately 1.5 times the gross diameter of the rivet measured from the centre of the rivet hole is provided in the rivet joint.

24. What is meant by limit state design? (IS800:2007-Pg: 28)

Limit state design method is technologically sound method which results in significant economy in design of structures. The design of a structure to satisfy all appropriate requirements derived from probability considerations is referred to as a limit state design.

25. State the different limit states. (IS800:2007-Pg: 28)

The limit states are broadly grouped in to two major types, namely:

Limit state of strength

Limit state of serviceability**.**

26. What are the four types of serviceability limit states applicable to steel structures? (IS800:2007-Pg: 28)

- Deflection
- Durability
- Vibration
- Fire resistance

27. Define durability. (IS800:2007-Pg: 2)

It is defined as ability of the structure to maintain its level of reliability and performing the desired function in the working environment under exposure conditions, without deterioration of cross sectional area and loss of strength due to corrosion during its life span.

How the loads are classified? (IS800:2007-Pg: 4)

Dead load

Live load

Earthquake load

Wind load

Dynamic loads.

What is a partial safety factor? (IS800:2007-Pg: 4).

The safety of the structure depends on each of the two principal design factors namely, load and material strength, which are not the functions of each other. Each of the two factors contributes partially to safety and they are termed as partial safety factors.

30. 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

31. Define bolt.

A bolt is a metal pin with a head formed at one end and the shank threaded at the other end in order to receive a nut.

What are the advantages of bolted connections? (May / June 2007)

There is silence in preparing bolted connection. In riveting, hammering is done. The hammering causes noise in the riveting.

There is no risk of fire in bolted connection. The rivets are made red hot in riveting and there is risk of fire.

The bolted connections may be done quickly in comparison to the riveting.

Though the cost of bolts is more than the cost of rivets, the bolted connections are economical to use because less persons are required for installation, and the work proceeds

quickly.

Noiseless

Easy to dismantle and reuse the materials.

ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ0 **What are the various types of bolts used for structural purposes? (May / June 2007)**

Unfinished bolts

Turned bolts

Black bolts

High strength bolts

0 **What are the advantages of HSFG bolts?**

Do not allow slip between the connected members.

Loads are transferred by friction only.

Due to high strength less number of bolts are required.

No noise pollution

Deformation is minimized.

0 **Define nominal diameter and gross diameter of bolt.**

Nominal diameter of bolt:

The nominal diameter of a bolt is the diameter of unthreaded shank of bolt.

Gross diameter of bolt:

The gross diameter of a bolt is the nominal diameter of the bolt.

36. Define slip factor.

The slip factor is defined as ratio of the load per effective interface, required to produce slip in a pure shear joint to the total shank tension induced in the bolts.

37. Define weld.

The welding is one of the methods of connecting the structural members. In the welding, a metallic link is made between the structural members. The weld is defined as a union between two pieces of metal at faces rendered plastic or liquid by heat or by pressure or both.

1 **Write about the advantages of welding.**

There is silence in the process of welding.

There is safety of welding operator in the welding

The welding may be done quickly in comparison to the riveting.

The welded joints have better appearance than riveted joints.

The welded joints are more rigid than the riveted joints

ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ0 **List the various types of welded joints.**

Butt weld

Fillet weld

Slot weld and plug weld

Spot weld

Seam weld

Pipe weld

- **Write about the disadvantages of welding.**

The members are likely to distort in the process of welding.
A welded joint fails earlier than riveted joint, if the structure is under fatigue stresses.
There is a greater possibility of brittle fracture in welding than the rivet.
The inspection of welded joint is more difficult and more expensive than the riveted joint.
More skilled person is required in the welding than in the riveting

- **What is the effective area of butt weld?**

The effective area of a butt weld is taken as the product of the effective throat thickness and the effective length of butt weld.

42. How the length of bolt is calculated?

The length of bolt is equal to the distance from the underside of the bolt head to the extreme end of the shank, including any camber or radius.

43. What is meant by stiffened & unstiffened seat connection?

The simple seat connection consists of an angle with its horizontal leg at its top, to receive the reaction from the beam and transfer it to the column or beam. The seat connection requires more space in the vertical direction.

When the beam reaction is large (>100 KN) the angle alone cannot support it. In such case the horizontal leg of an angle is stiffened (strengthened) by means of one or two tight fitting angles. Such connection is called as stiffened seat connection.

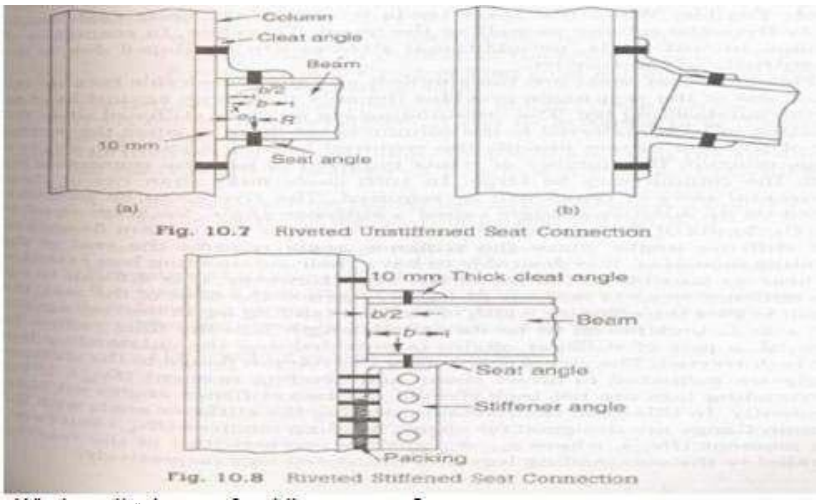


Fig. 10.7 Riveted Unstiffened Seat Connection

Fig. 10.8 Riveted Stiffened Seat Connection

À r Ā Ā Ā Ā Ā Ā Ā Ā dĀ À r Ā Ā Ā Ā Ā Ā Ā Ā 0 **What are the types of welding process?**

Electric arc welding
Gas welding
Termite welding
Forged welding
Resistance welding.

- **How to calculate the efficiency of a joint?**

The efficiency of the joint is the ratio of actual strength of connection to the gross

strength of connected member, expressed in % as,

$$\text{Efficiency of joint} = \frac{\text{Least actual strength of the joint}}{\text{Gross strength of solid plate member}} \times 100$$

UNIT2- TENSION MEMBERS

Types of sections – Net area – Net effective sections for angles and Tee in tension – Design of connections in tension members – Use of lug angles – Design of tension splice – Concept of shear lag

PART-A (2 marks)

1. Define tension member.

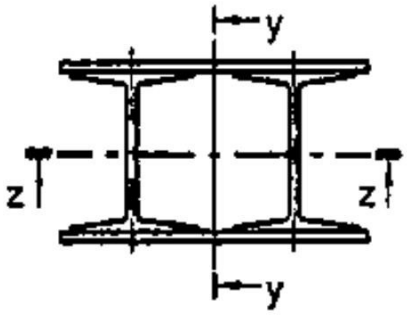
A tension member is defined as a structural member subjected to tensile force in the direction parallel to its longitudinal axis. A tension member is also called as a tie member or simply a tie.

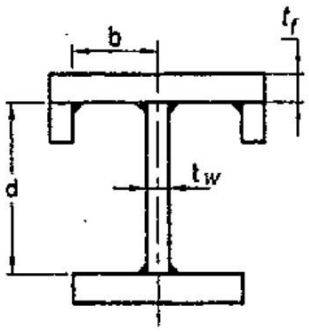
[1] **What are the various types of tension members?**

- Wires and cables
- Rods and bars
- Single structural shapes and plates
- Built-up members

What is meant by built-up members? ***(IS800:2007-Pg: 1)***

Two or more than two members are used to form built-up members. The built-up sections may be made more rigid and stiffer than the single structural shapes. A built-up section may be made of two channels placed back to back with a gusset plate in between them.





4. Define slenderness ratio. ***(IS800:2007-Pg: 4)***

The slenderness ratio of a tension member is the ratio of its unsupported length (l) to its least radius of gyration (r).

Slenderness ratio, $\lambda = l/r$.

5. What is net sectional area? (Nov / Dec 2007)

The net sectional area of a tension member is the gross-sectional area of the member less the maximum deduction for holes.

$A_{net} = A_{gross}$ – sectional areas of holes

6. How to calculate net area in (a) chain bolting (b) zigzag bolting. ***(IS800:2007-Pg: 33)***

a) Chain bolting

Net area, $A_n = (b - n\, d_h)\, t$

b) Zigzag bolting

$$A_n = \left[b - n d_h + \sum_i \frac{p_{si}^2}{4 g_i} \right] t$$

b, t = width and thickness of the plate, respectively,

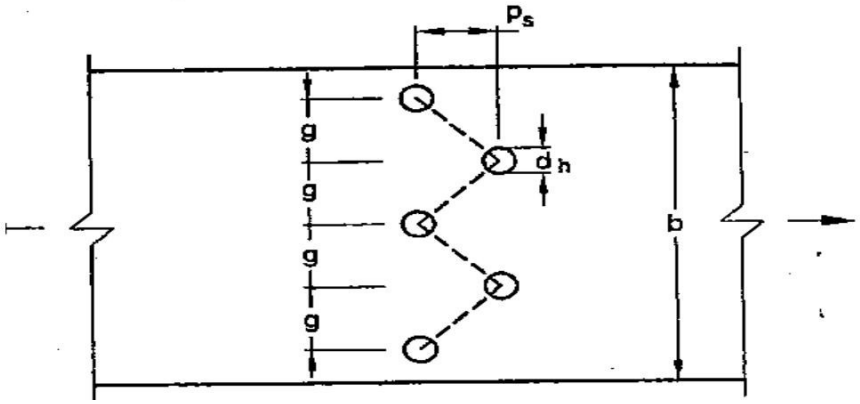
d_h = diameter of the bolt hole (2 mm in addition to the diameter of the hole, in case the directly punched holes),

g = gauge length between the bolt holes, as shown in Fig. 5,

p_s = staggered pitch length between line of bolt holes, as shown in Fig. 5,

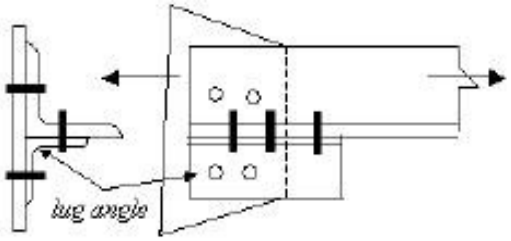
n = number of bolt holes in the critical section, and

i = subscript for summation of all the inclined legs.



7. What is a Lug angle?

In order to increase the efficiency of the outstanding leg in single angles and to decrease the length of the end connections, sometimes a short length angle at the ends are connected to the gusset and the outstanding leg of the main angle directly, as shown in Fig.. Such angles are referred to as lug angles. It also reduces shear lag.



Tension member with lug angle

8. Write any two specifications for designing of lug angle. (IS800:2007-Pg: 83)

10.12.2 In the case of angle members, the lug angles and their connections to the gusset or other supporting member shall be capable of developing a strength not less than 20 percent in excess of the force in the outstanding leg of the member, and the attachment of the lug angle to the main angle shall be capable of developing a strength not less than 40 percent in excess of the force in the outstanding leg of the angle.

10.12.3 In the case of channel members and the like, the lug angles and their connection to the gusset or other supporting member shall be capable of developing a strength of not less than 10 percent in excess of the force not accounted for by the direct connection of the member, and the attachment of the lug angles to the member shall be capable of developing 20 percent in excess of that force.

10.12.4 In no case shall fewer than two bolts, rivets or equivalent welds be used for attaching the lug angle to the gusset or other supporting member.

9. Write note on tension member splice. (May / June 2007)

A tension member is spliced when the available length is less than the required length of the tension member. A tension member is also spliced when the members of different thickness are required to be connected. In such a case packing is required to fill up the gap.

10. What do you understand by Gross area? (Nov / Dec 2007)

Total area of cross section which can be taken as equal weight of the member per unit length divided by density of the material is called Gross area. The sectional area given by the manufacturer is taken as the gross area.

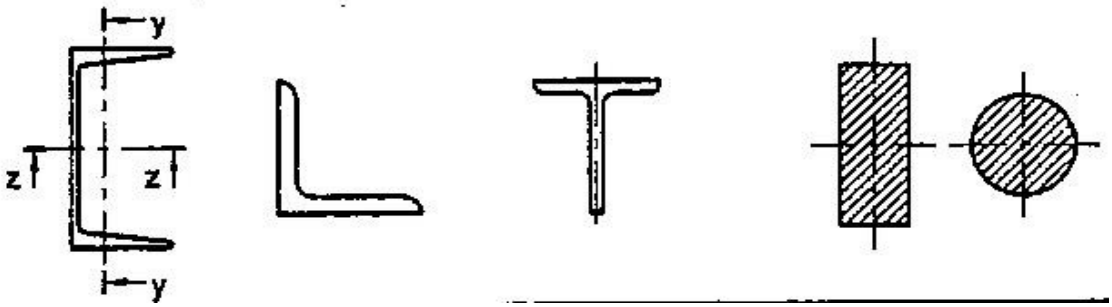
11. Explain shear lag effect. (IS800:2007-Pg: 4)

The tensile force is transferred from gusset to the tension member (such as angles, channels or T- sections) through one leg by bolts or welds. In this process initially the connected leg may be subjected to more stress than the outstanding leg and finally the stress distribution becomes uniform over the section away from the connection. Thus one part lags behind the other; this is referred to as shear lag.

1.3.88 *Shear Lag* — The in plane shear deformation effect by which concentrated forces tangential to the surface of a plate gets distributed over the entire section perpendicular to the load over a finite length of the plate along the direction of the load.

12. Give the sketches of steel sections?

Channel, Angle, T and Solid Sections



UNIT-3 COMPRESSION MEMBERS

Types of compression members – Theory of columns – Basis of current codal provision for compression member design – Slenderness ratio – Design of single section and compound section compression members – Design of laced and battened type columns – Design of column bases – Gusseted base

PART – A (2 marks)

1. What is meant by strut? ***(IS800:2007-Pg: 5)***

A strut is defined as a structural member subjected to compression in a direction parallel to its longitudinal axis. The term strut is commonly used for compression members in roof trusses.

2. What is meant by effective sectional area?

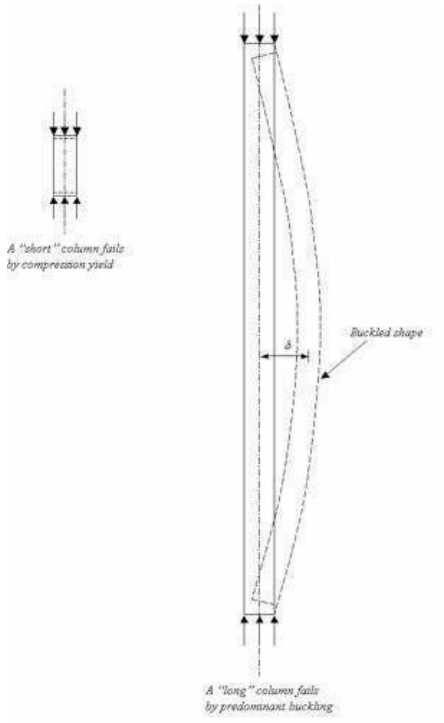
The effective sectional area of a compression member is the gross cross sectional area of the member. The deduction is not made for members connected by rivets, bolts and pins.

3. Define slenderness ratio of compression member.

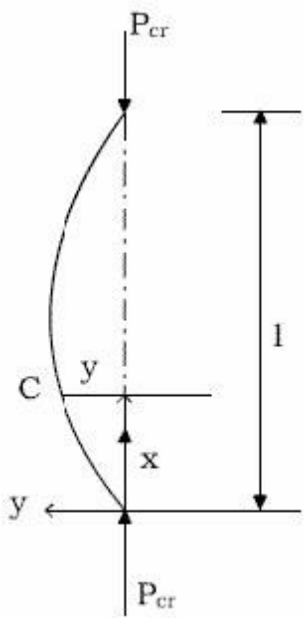
The slenderness ratio of a compression member is the ratio of effective length of compression member (l) to appropriate radius of gyration (r).

Slenderness ratio, $\lambda = l/r$.

4. Draw the diagram of buckling of column.



What are the assumptions made in Euler‟s analysis?



The material is homogeneous and linearly elastic (i.e. it obeys Hooke‟s Law).

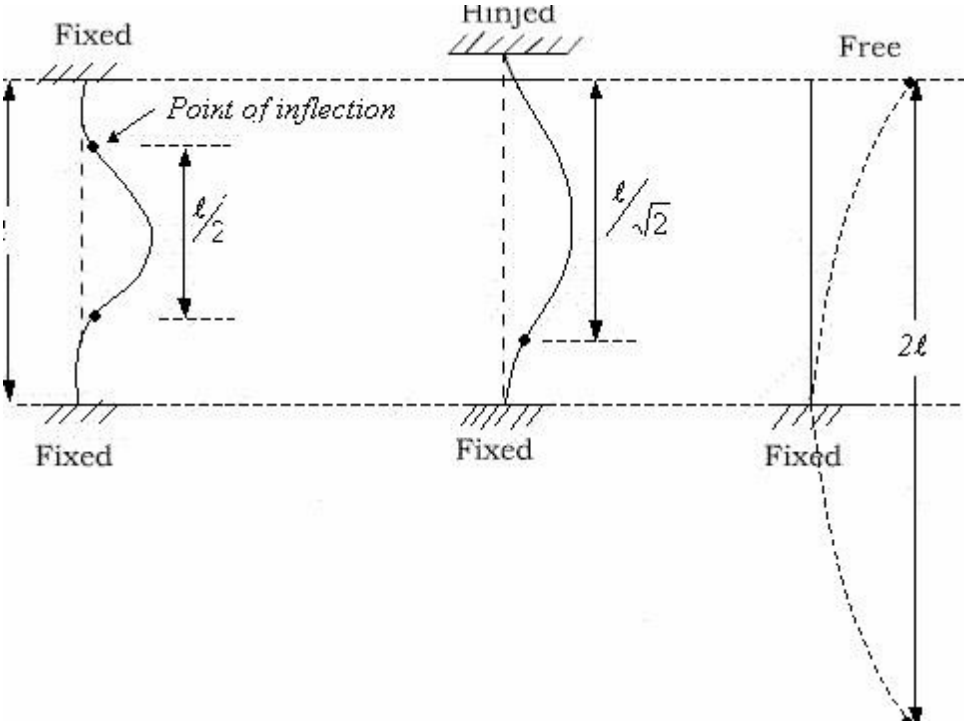
The strut is perfectly straight and there are no imperfections.

The loading is applied at the centroid of the cross section at the ends.

- **Define buckling load.** ***(IS800:2007-Pg: 1)***

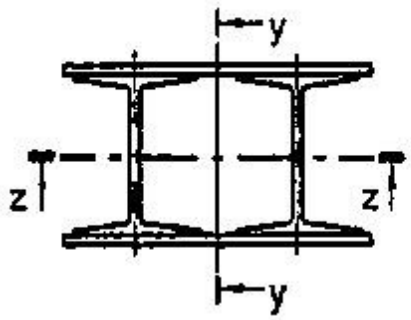
The buckling load is defined as the load at which a member or a structure as a whole collapses in service (or buckles in a load test). The buckling is defined as the sudden bending, warping, curling or crumpling of the elements or members under compressive stresses.

7. What are the buckled modes for different end conditions?



8. What is meant by built-up compression members?

The built-up compression members are needed when the single rolled steel sections are not sufficient to furnish the required cross-sectional area. A built-up compression member may consist of two or more rolled structural steel sections connected together effectively and acts as one compression member.



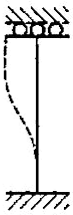
9. Define position restraint.

In position restraint end of the column is not free to change its position but rotation about the end of eth column can take place e.g., hinged end of column**.**

10. What are the different effective lengths for different boundary condition?

Table 11 Effective Length of Prismatic Compression Members

(*Clause* 7.2.2)

Boundary Conditions				Schematic Representation	Effective Length
At One End		At the Other End			
Translation	Rotation	Translation	Rotation		
(1)	(2)	(3)	(4)	(5)	(6)
Restrained	Restrained	Free	Free		2.0*L*
Free	Restrained	Free	Restrained		
Restrained	Free	Restrained	Free		1.0*L*
Restrained	Restrained	Free	Restrained		1.2*L*
Restrained	Restrained	Restrained	Free		0.8*L*
Restrained	Restrained	Restrained	Restrained		0.65*L*

11. Define effective length.

The effective length of a compression member is the distance between the points of contra flexures of a buckled column. It depends on the actual length and the end conditions in regards to restraint against rotation and transverse displacement.

12. What is meant by actual length?

The actual length is taken as the length from centre-centre of intersections with the supporting members.

13. How the effective length of column is determined?

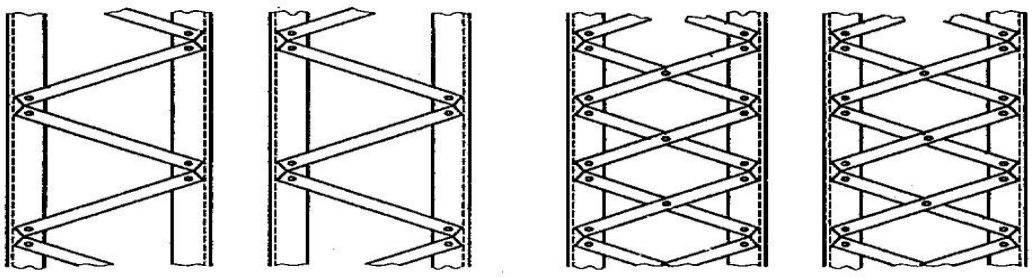
The effective length of columns in framed structures may be obtained by multiplying the actual length of the column between the centers of laterally supporting members (beams) given with the effective length factor K.

Effective length = KL

14. Define single lacing & double lacing. ***(IS800:2007-Pg: 48 & 49)***

7.6.1.4 Single laced systems, on opposite faces of the components being laced together shall preferably be in the same direction so that one is the shadow of the other, instead of being mutually opposed in direction.

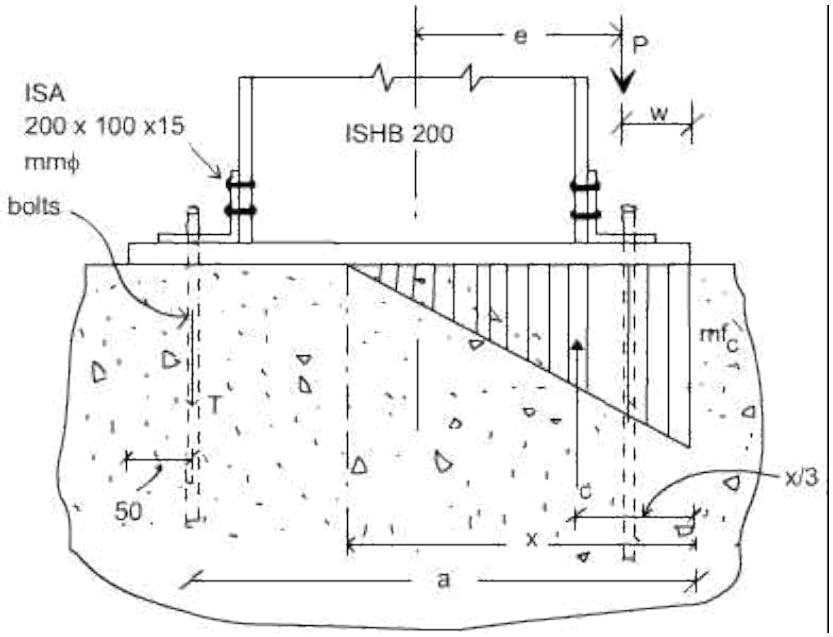
Double laced system, on opposite faces of the components being laced together shall preferably be in mutual opposed in direction**.**



15. What are the forces acting on lacing system?

The forces acting on lacing system are transverse shear force and axial force.

16. Draw the column base plate diagram. (Nov / Dec 2005)



17. Where should the splice plate be located in a column?(IS800:2007-Pg:46)

7.3.4.1 Where the ends of compression members are prepared for bearing over the whole area, they shall be spliced to hold the connected members accurately in position, and to resist bending or tension, if present. Such splices should maintain the intended member stiffness about each axis. Splices should be located as close to the point of inflection as possible. Otherwise their capacity should be adequate to carry magnified moment

18. What is the purpose for providing anchors bolt in base plate?

Anchor bolts are provided to stabilize the column during erection and to prevent uplift for cases involving large moments. Anchor bolts can be cast-in place bolts or drilled-in bolts. The latter are placed after the concrete in set and are not too often used. Their design is governed by the manufacturer's specifications. Cast-in-place bolts are hooked bars, bolts, or threaded rods with nuts placed before the concrete is set.

- **What are the types of bases provided for connecting the column to the base?**

Slab base

Gusseted base

Moment resisting bass

- **Which column formula is recommended in IS 800:2007? (Pg: 34)**

7.1.2.1 The design compressive stress, $f_{cd,}$ of axially loaded compression members shall be calculated using the following equation:

$$f_{cd} = \frac{f_y / \gamma_{m0}}{\phi + \left[\phi^2 - \lambda^2\right]^{0.5}} = \chi f_y / \gamma_{m0} \leq f_y / \gamma_{m0}$$

where

ϕ = $0.5\,[1 + \alpha\,(\lambda - 0.2) + \lambda^2]$

λ = non-dimensional effective slenderness ratio

$$= \sqrt{f_y / f_{cc}} = \sqrt{f_y \left(KL/r\right)^2 / \pi^2 E}$$

f_{cc} = Euler buckling stress = $\dfrac{\pi^2 E}{\left(KL/r\right)^2}$

where

KL/r = effective slenderness ratio or ratio of effective length, KL to appropriate radius of gyration, r;

α = imperfection factor given in Table 7;

χ = stress reduction factor (*see* Table 8) for different buckling class, slenderness ratio and yield stress

$$= \frac{1}{\left[\phi + \left(\phi^2 - \lambda^2\right)^{0.5}\right]}$$

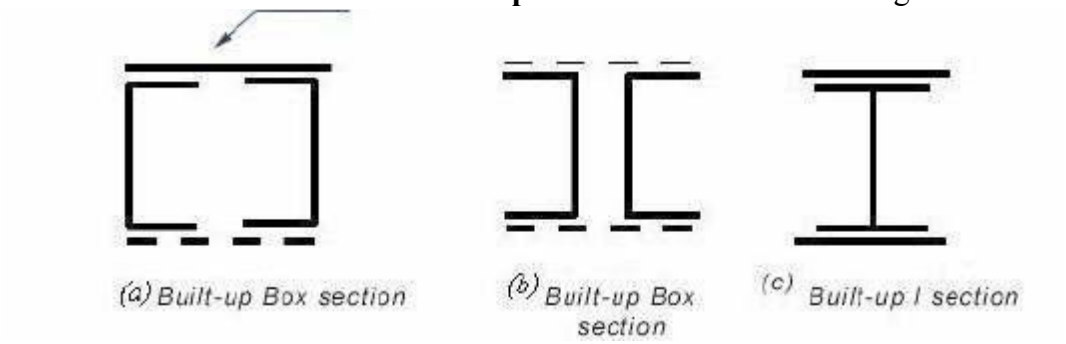
λ_{m0} = partial safety factor for material strength.

21. Under what circumstances gusset base is used?

When the load on the column is large or when the column is subjected to moment along with axial load, gusseted base is provided. It consists of a base plate, gusset plate, connecting angles provided on either side of the column and web cleat angle.

22. Write about batten plates in compression member.

When compression members are required for large structures like bridges, it will be necessary to use built-up sections. They are particularly useful when loads are heavy and members are long (e.g. top chords of Bridge Trusses). The cross section consists of two channel sections connected on their open sides with some type of lacing or latticing (dotted lines) to hold the parts together and ensure that they act together as one unit. The ends of **these members are connected with "batten plates" which tie the ends** together.



23. What are the three classifications for determination of size of plate?

Class I- will pertain to all base plates the moment on which is so small in proportion to the direct load that there is compression over the entire area between the bottom of the base and its foundation

Class II- will pertain to comparatively small range of base plates which have tension over a small portion - one - third or loss of the area

Class III- will include those which are exposed to a comparatively large moment and which therefore have tension over a large portion - more than one -third of the area between the bottom of the base plate and its concrete footing.

24. What are the functions of providing column bases?

The basic function of bases is to distribute the concentrated load from the column over a larger area. The column load is distributed over the base plate and then to supporting concrete and finally to the soil.

25. What is meant by column splice?

A joint in the length of a column provided, when necessary, is known as column splice. It is also described as column joint.

List the limiting slenderness ratio of compression member carrying dead load & live load. (April / May 2008)(IS800:2007-Pg: 20)

Table 3 Maximum Values of Effective Slenderness Ratios

Sl No.	Member	Maximum Effective Slenderness Ratio (*KL/r*)
(1)	(2)	(3)
i)	A member carrying compressive loads resulting from dead loads and imposed loads	180

27. What is meant by slab base?

The slab base as shown in Figure consists of cleat angles and base plate. The column end is faced for bearing over the whole area. The gussets (gusset plates and gusset angles) are not provided with the column with the slab bases. The sufficient fastenings are used to retain the parts securely in plate and to resist all moments and forces, other than the direct compression. The forces and moments arising during transit, unloading and erection are also considered

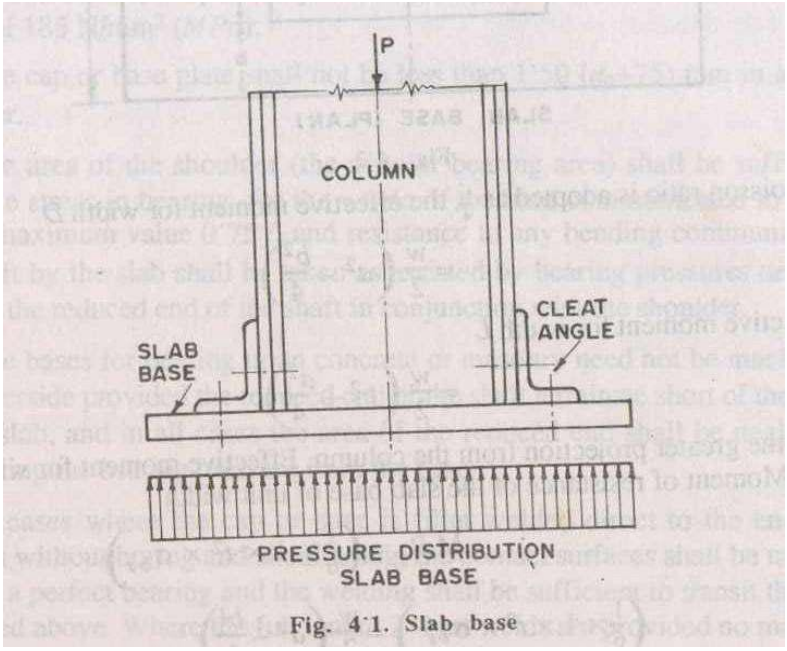


Fig. 4·1. Slab base

UNIT4- BEAMS

Design of laterally supported and unsupported beams – Built up beams – Beams subjected to uniaxial and biaxial bending – Design of plate girders - Intermediate and bearing stiffeners – Flange and web splices.

PART-A (2 marks)

1. What is meant by limit state design?

Designs should ensure that the structure does not become unfit for the use for which it is required. The state at which the unfitness occurs is called a limit state.

2. What are special features of limit state design method?

It is possible to take into account a number of limit states depending upon the Particular instance

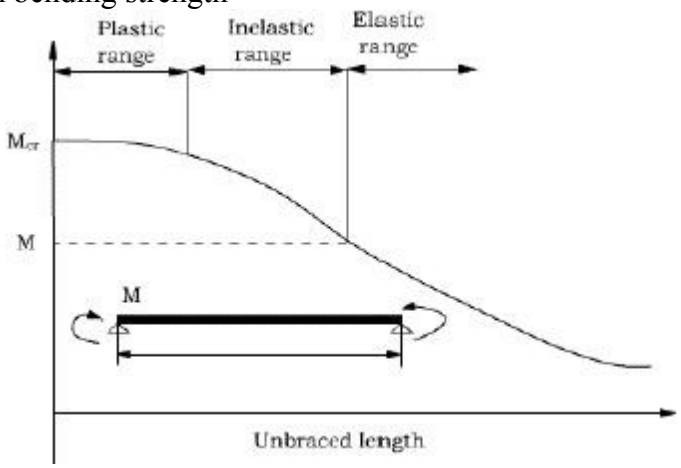
This method is more general in comparison to the working stress method. In This method, different safety factors can be applied to different limit states, which is more rational than applying one common factor (load factor) as in the plastic design method.

This concept of design is appropriate for the design of structures since any new knowledge of the structural behavior, loading and materials can be readily incorporated.

3. Explain the behavior of steel beams?

Laterally stable steel beams can fail only by (a) Flexure (b) Shear or (c) Bearing, Assuming the local buckling of slender components does not occur. These three conditions are the criteria for limit state design of steel beams. Steel beams would also become unserviceable due to excessive deflection and this is classified as a limit state of serviceability. The factored design moment, M at any section, in a beam due to external actions shall satisfy $M < M_d$

Where M_d= design bending strength



4. Write Short notes on compact sections

When the lateral support to the compression flange is adequate, the lateral buckling of the beam is prevented and the section flexural strength of the beam can be developed. The strength of I-sections depends upon the width to thickness ratio of the compression flange. When the width to thickness ratio is sufficiently small, the beam can be fully plastified and reach the plastic moment, such section are classified as compact sections.

5. What is meant by slenderness sections?

When the width to thickness ratio of the compression flange is sufficiently large, local buckling of compression flange may occur even before extreme fiber yields. Such sections are referred to as slender sections.

0 List the various factors affecting the lateral-torsional buckling strength.

Distance between lateral supports to the compression flange.

Restraints at the ends and at intermediate support locations (boundary Conditions).

Type and position of the loads.
Moment gradient along the length.
Type of cross-section.

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What are the classifications in Stiffeners?

1. Intermediate transverse web stiffeners
2. Load carrying stiffeners
3. Bearing stiffeners
4. Torsion stiffeners
5. Diagonal stiffeners and
6. Tension stiffeners

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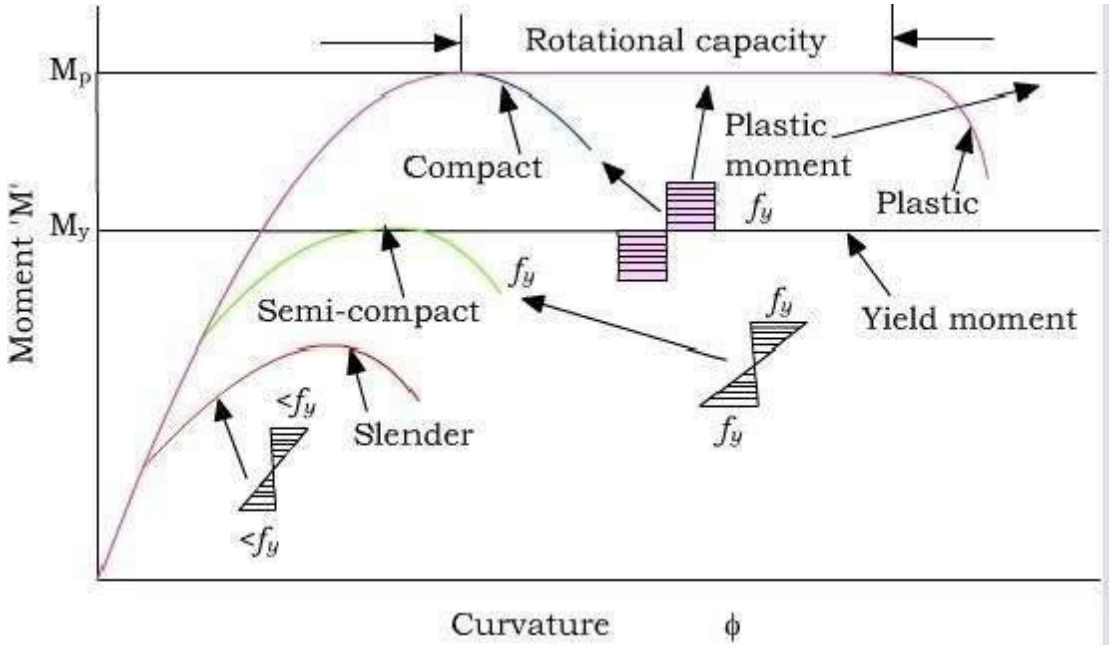
Draw the curvature for flexural member performance and the classification of cross sections.



9. How do you improve the shear resistance in plate girder?

Increasing in buckling resistance due to reduced *c/d* ratio;

The web develops tension field action and this resists considerably larger Stress than the elastic critical strength of web in shear

10. Write about the Box girders

The design and detailing of box girders shall be such as to give full advantage of its higher load carrying capacity. Diaphragm shall be used where external vertical as well as transverse forces are to be transmitted from one member to another. The diaphragms and their fastenings shall be proportioned to distribute other force applied to them and in addition, to resist the design transverse force and the resulting shear forces. The design transverse force shall be taken as shared equally between the diaphragms

11. Write Short notes on Purlin.

Purlins attached to the compression flange of a main member would normally be acceptable as providing full torsional restraint; where purlins are attached to tension flange, they should be capable of providing positional restraint to that flange but are unlikely (due to the rather light purlin/rafter connections normally employed) to be capable of preventing twist and bending moment based on the lateral instability of the compression flange.

12. Write the Special features of limit state design method?

Serviceability and the ultimate limit state design of steel structural systems and their components.

Due importance has been provided to all probable and possible design conditions that could cause failure or make the structure unfit for its intended

The basis for design is entirely dependent on actual behavior of materials in structures and the performance of real structures, established by tests and long-term observations

The main intention is to adopt probability theory and related statistical methods in the design.

It is possible to take into account a number of limit states depending upon the particular instance

⁰ What is meant by laterally supported beam?

The laterally supported beams are also called laterally restrained beams. When lateral deflection of the compression flange of a beam is prevented by providing effective lateral support, (restraint) the beam is said to be laterally supported. The effective lateral restraint is the restraint which produces sufficient resistance in a plane perpendicular to the plane of bending to restrian the compression flange of a beam from lateral buckling to either side at the point of application of the restraint.

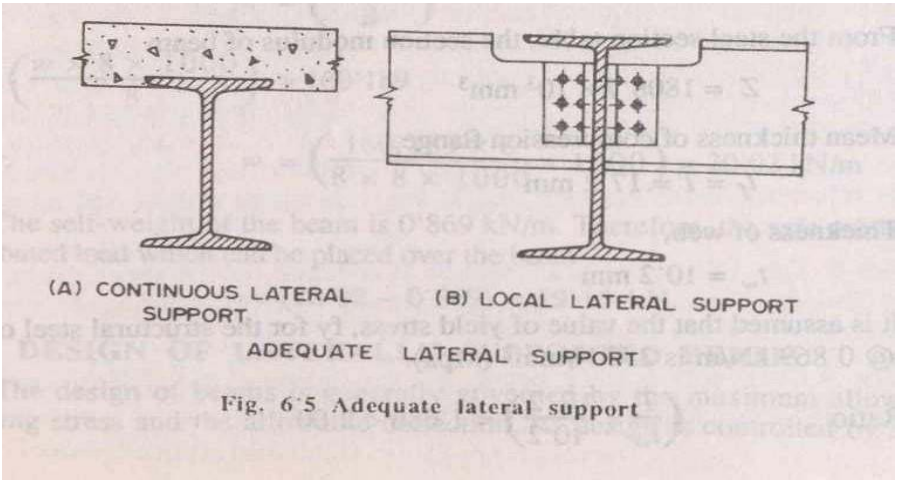


Fig. 6·5 Adequate lateral support

14. Write a note on built up beams.

The built-up beams are also termed as compound beams or compound girders. The built-up beams are used when the span, load and corresponding bending moment are of such

magnitudes that rolled steel beam section become inadequate to provide required section modulus. The built-up beams are also used when rolled steel beams are inadequate for limited depth.

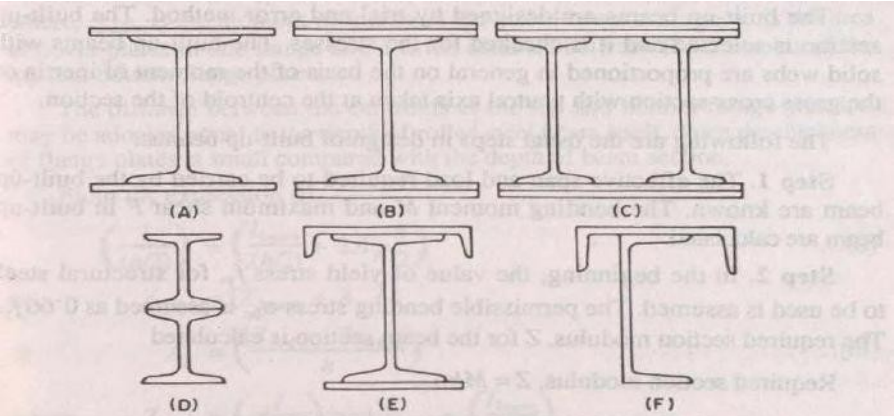


Fig. 6 13 Built-up beam section

15. What are the elements of plate girder?

The vertical plate of the plate girder is termed as web plate. The angles connected at the top and bottom of the web plate are known as flange angles. The horizontal plates connected with the flange angles are known as flange. Plates or cover plates. The web plate, flange angles and flange plates are shown in Fig. The bearing stiffeners, intermediate stiffeners and horizontal stiffeners used with the plate girder are shown in Fig.

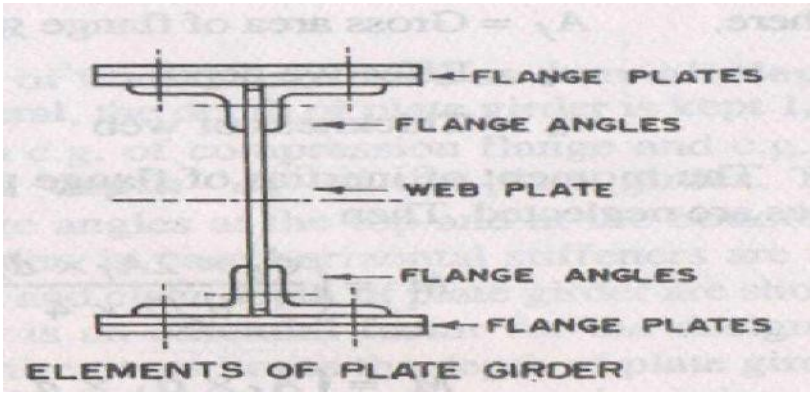
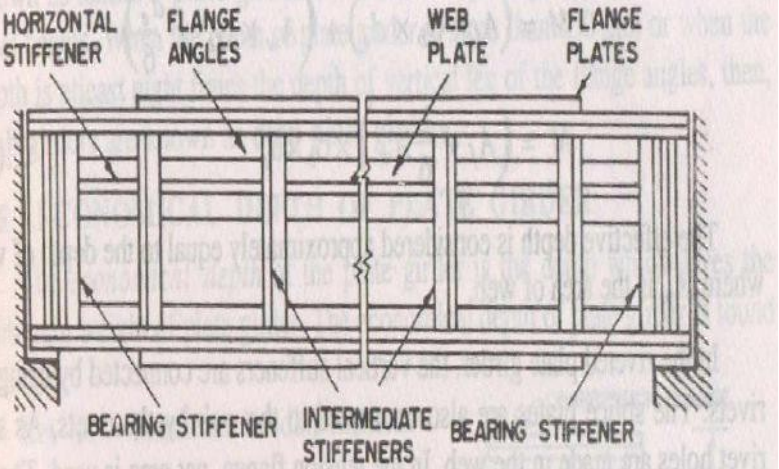


Fig. 8·2



ELEMENTS OF A PLATE GIRDER

Fig. 8·3 Plate girder

16. Under what circumstances web plates are stiffened and unstiffened?

A web plate is kept unstiffened when the ratio of clear depth to thickness of web is less than 85. It does not require stiffeners. A web plate is called stiffened, when the ratio of clear depth to thickness of web is greater than 85 and stiffeners are provided to contribute additional strength to web.

17. What is meant by plastic method of design?

Steel being a ductile material it can absorb large deformations beyond elastic fracture. Steel processes reserved strength beyond yield strength. The method using this reserved strength is called plastic method of design.

18. Define shape factor.

The ratio of plastic moment to elastic moment Mp / My is the property of cross sectional area and is not dependent on material properties. This ratio is called as shape factor.

19. What is meant by plastic hinge?

Plastic hinge is the yield section of the beam, which acts as if it were hinged, except with a constant restraining plastic moment.

20. Define yield length.

The yield length is the length of the beam over which the moment is greater than or equal to the yield moment. It depends upon the type of loading and the cross section of the structural member.

1 What are the methods of plastic analysis?

Static method

Kinematic method or mechanism method.

0 What is meant by static and Kinematic method?

Static method: The lower bound theorem states a load computed, on the basis of assumed equilibrium moment diagram, in which moments are not greater than plastic moment Mp, is less **than or at the best equal to the true collapse load. i.e., W ≤** W_c (collapse load)

Kinematic method: The upper bound theorem states a load computed, on the basis of assumed mechanism, will always be greater than or at the best equal to the true collapse load. i.e., W **≥** W_c

1 *What are the guide lines to locate the plastic hinges?* The plastic hinges occur,

At the points of maximum moment

At the connections involving change in geometry.

Under the concentrated load

At the points of zero shear in a span, loaded by udl.

0 Define virtual work.

It states that „work done by the load during small motion of collapse mechanism **must be equal to the work absorbed in the plastic hinges".**

1 what is meant by complete collapse, partial collapse and over complete collapse?

Complete collapse: The number of plastic hinges, H required to form complete collapse = R+ 1, where R is the degree of redundancy of the structure. **H = R + 1**

Partial collapse: The number of plastic hinges, H required to form partial collapse is < R+ (i.e., H **< R + 1)**

Over complete collapse: The number of plastic hinges, H required to form over complete collapse is > R+ 1. (i.e., H **> R + 1)**

26. What is meant by lateral buckling of beam?

A long beam with laterally unrestrained compression flange when incrementally loaded, first deflects downwards and when load exceeds a particular value; it tilts sideways due to instability of compression flange, and rotates about longitudinal axis. This phenomenon is known as laterally buckling or torsional buckling of beam

0 How the laterally supported beam fails?

The laterally supported beam can fail by,

Flexure

Shear

Bearing.

0 What is web buckling and web crippling?

A heavy concentrated load produces a region of high compressive stresses in the web either at support or under the load. This causes the web either to buckle or to cripple.

Web buckling occurs when the intensity of compressive stress near the centre of the section exceeds the critical buckling stress of web acting as a strut. This type of failure is more in the case of built up sections having greater ratio of depth to thickness of the web.

29. What is the purpose of providing stiffener in plate girder?

In the plate girder the depth of the web is kept large for economy and hence it is made thin to reduce the self weight of the girder. A very thin web may buckle laterally or may cripple under the heavy concentrated load. In such a case the web is strengthened by providing stiffeners.

30. Under what circumstances load bearing stiffeners are used in plate girder?

The load carrying stiffeners are attached with the web plate of the plate girder to avoid local bending failure of flanges, crushing of web and buckling of web plate. They are provided under the heavy concentrated loads and the reactions at supports**.**

31. Under what circumstances bearing stiffeners are used in plate girder?

Bearing stiffeners should be provided for webs where forces are applied through the flange by loads or reactions exceeding the local capacity of the web at its connection to the flange.

32. What is the purpose of providing intermediate stiffeners?

The intermediate transverse stiffeners are provided to strength the buckling strength of web. They remain effective after the buckling of web and provide anchorage for tension field.

33. What is the main function of providing horizontal stiffener in plate girder?

The main function of horizontal stiffener is to increase the buckling resistance of the thin web. They are located in the compression zone. It prevents the web from bending laterally.

34. What are the reasons behind splicing in plate girder?

The joint in the plate girder called splicing becomes necessary for plate girders of longer span due to the following reasons:

The rolled steel plates are manufactured up to a limited length. When the maximum manufactured length is insufficient for full length, splicing becomes necessary.

For convenience of handling during transportation and erection it is essential that the plate is too long.

Due to unsymmetrical loading the thickness of plate may change.

- **What are the types of splices?**

Flange splice

Web splice**.**

- **How the flange area of a plate girder is designed?**

Flange area, $A_f = M / (D\ f_{yf} / Y_{mo})$

M = factored moment

D = total depth of girder

f_{yf} = Yield stress of steel

Y_{mo} = Partial safety factor of material.

UNIT5- ROOF TRUSSES AND INDUSTRIAL STRUCTURES

Roof trusses – Roof and side coverings – Design of purlin and elements of truss; end bearing – Design of gantry girder

PART-A (2 marks)

1. What are the types of load that may act on roof trusses?

Dead load

Load from coverings, purlins, self weight of trusses and bracing.

Live load

Wind load

- **How economical spacing of roof trusses obtained?**

The economical spacing of trusses is between 1/3 to 1/5 of span.

3. List the various forces acting on a gantry girder.

Weight of the trolley or crab

Weight of the crane girder

Impact loads – it is due to sudden application of brakes.

Lateral load (surge load) – transverse to the rail

Longitudinal load (drag load)

- **What are the loads to be considered while designing the purlins?**

Dead load

Weight of roof sheets

Self weight of purlin

Live load

Wind load acting on roof area.

- **List the various types of roof sheetings commonly used.**

Asbestos cement sheets
Tiles
Galvanized corrugated iron sheets
Aluminium sheets
Slate roofing.

- **Which section is best suited for a purlin?**

Angle section
Channel section
I-section

- **How is the selection of section made for roof truss element?**

The members of the truss are made of either rolled steel sections or built-up sections depending upon the span length and intensity of loading.

Rolled steel single or double angles, T-section, hollow circular, square or rectangular sections are used in the roof trusses of industrial buildings.

In long span roof trusses and short span bridges, heavier rolled steel sections, such as channels and I – sections are used.

Built-up I-sections, channels, angles and plates are used in the case of long span bridge trusses.

8. How to fix the spacing of trusses?

The economical spacing of trusses is between *1/3 to 1/5 of span*.

For lighter load, carrying no snow or superimposed load except wind, the larger spacing may be more economical.

Spacing of 3- 4.5 m for spans up to 15m and 4.5 – 6 m for spans of 15 – 30 m may be economical.

The spacing of long span trusses may be 12 – 15 m.

⁰ What are economical considerations for industrial truss?

Method of fabrication and erection to be followed, facility for shop fabrication available, transportation restrictions, field assembly facilities.

Preferred practices and past experience.

Availability of materials and sections to be used in fabrication.

Erection technique to be followed and erection stresses.

Method of connection preferred by the contractor and client (bolting, welding or riveting).

Choice of as rolled or fabricated sections.

Simple design with maximum repetition and minimum inventory of material.

⁰ Write about basics of plastic analysis?

In plastic analysis and design of a structure, the ultimate load of the structure as a whole is regarded as the design criterion. The term *plastic* has occurred due to the fact that the ultimate load is found from the strength of steel in the plastic range.

This method is rapid and provides a rational approach for the analysis of the structure. It also provides striking economy as regards the weight of steel since the sections required by this method are smaller in size than those required by the method of elastic analysis.

11. What is meant by first yield moment?

As *W* is increased gradually, the bending moment at every section increases and the stresses also increase. At a section close to the support where the bending moment is maximum, the stresses in the extreme fibers reach the yield stress. The moment corresponding to this state is called the *first yield moment My*, of the cross section.

12. Write about Principles of plastic analysis.

Mechanism condition: The ultimate or collapse load is reached when a mechanism is formed. The number of plastic hinges developed should be just sufficient to form a mechanism.

Equilibrium condition: $\Sigma Fx = 0$, $\Sigma Fy = 0$, $\Sigma Mxy = 0$

Plastic moment condition: The bending moment at any section of the structure should not be more than the fully plastic moment of the section.

13. Explain about Crane gantry girders.

The function of the crane girders is to support the rails on which the traveling cranes move. These are subjected to vertical loads from crane, horizontal lateral loads due to surge of the crane, that is, the effect of acceleration and braking of the loaded crab and swinging of the suspended load in the transverse direction, and longitudinal force due to acceleration and braking of the crane as a whole.

14. What are assumptions are made for arrangement of live load in the analysis of frames?

- Consideration is limited to combination of:

Design dead load on all spans with full design live load on two adjacent spans

and

Design dead load on all spans with full design live load on alternate pans.

When design live load does not exceed three-fourths of the design dead load, the load arrangement of design dead load and design live load on all the spans can be used.

15. Explain about Drift Analysis

Drift in building frames is a result of flexural and shear mode contributions, due to the column axial deformations and to the diagonal and girder deformations, respectively. In low-rise braced structures, the shear mode displacements are the most significant and, will largely determine the lateral stiffness of the structure.

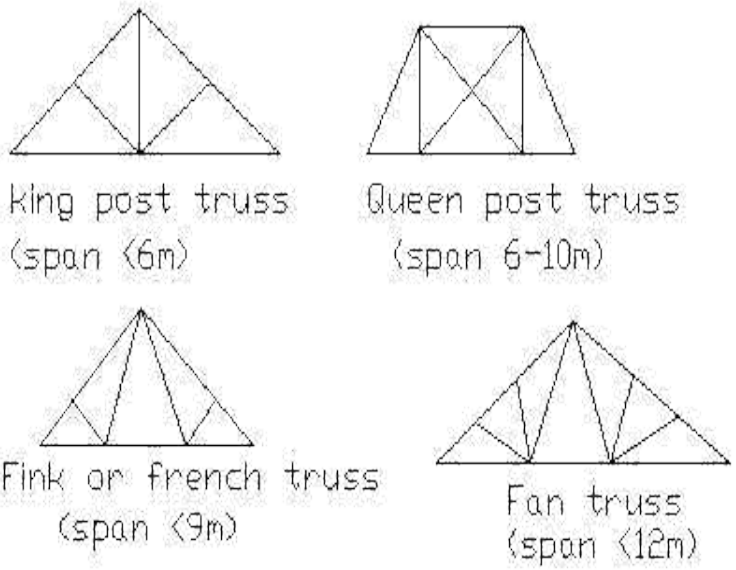
In medium to high-rise structures, the higher axial forces and deformations in the columns, and the accumulation of their effects over a greater height, cause the flexural component of displacement to become dominant**.**

Calculate the permissible deflection for a truss of 10 m span. *(IS800:2007-Pg: 31 – table 6)*

Deflection limit = span / 150

- 10 x 1000 / 150
- 66.67 mm

Sketch the various types of roof truss.



UNIT-1
INTRODUCTION
PART-A:

Define limit states.
Write any two comparison of bolted and welded connection.
What do you mean by staggered pitch?
List out the uses of bolted connection.
Distinguish between gauge distance and pitch of the bolt.
What are the merits and demerits of welded connections?
Define pitch of rivet.
What do you mean by splitting of plates?
What are the factors to be considered in mechanical properties of structural steel?
Define "High Tension Bolts".
What is meant by characteristic strength?
In grade 4.6 bolts, what do the number 4 and 6 indicates?
Define efficiency of joint?
Define throat thickness.
Name the different mode of failure in weld connection.
How will you calculate the number of rivets?
What are the various types of connections used for connecting the structural members?
Define riveting.
Define gauge line.
What is meant by gauge distance and edge distance?
Define lap
What is meant by tensile stress?

What is meant by compressive stress?
Define bearing stress
What is working stress?
Define factor of safety.
What are the methods employed for the design of the steel framework?
What are the assumptions made in simple design?
Define Modulus of Elasticity

What are the types of riveted joints?
Define Lap joint and Butt Joint
Write about minimum pitch and maximum pitch
What is edge distance?
What is meant by limit state design? (IS800:2007-Pg: 28)
State the different limit states. (IS800:2007-Pg: 28)
What are the four types of serviceability limit states applicable to steel structures? (IS800:2007-Pg: 28)
Define durability. (IS800:2007-Pg: 2)
How the loads are classified? (IS800:2007-Pg: 4)
What is a partial safety factor? (IS800:2007-Pg: 4)
Define design load
Define bolt
What are the advantages of bolted connections? (May / June 2007)
What are the various types of bolts used for structural purposes? (May / June 2007)
What are the advantages of HSFG bolts?
Define nominal diameter and gross diameter of bolt.
Define slip factor.
Define weld.
Write about the advantages of welding.
List the various types of welded joints
Write about the disadvantages of welding.
What is the effective area of butt weld?
How the length of bolt is calculated
What are the types of failures occur in riveted joint?
What is meant by stiffened & unstiffened seat connection?
What are the types of welding process?
Write the equation for calculating the effective throat thickness of weld.
Draw a neat sketch of ISMB 400 and mention its properties.
Define the terms gauge, pitch, edge and end distance of bolt joint. (IS800:2007-Pg: 2,3 &4)
How to calculate the efficiency of a joint?
What are the factors to be considered in mechanical properties of structural steel?

6**2. Define „high tension bolts‟?**

PART-B:

(i) Design a double bolted lap joint for a plate of 20mm thickness to carry its full load.

0 A double riveted lap joint in plates 10mm thick is made with 16mm rivets at 60mm pitch. Estimate hoe the joint will fail and calculate its efficiency if the tearing strength of the plates is 475 N/mm2 and shearing and bearing strength of the rivets are 380 N/mm2 and 750 N/mm2 respectively.

An ISLC 300@331 N/m is used to transmit a force of 500kN.The channel section is connected to a gusset plate of 8mm thick. Design a fillet weld if the overlap is limited to 350mm.

Determine the safe load and the efficiency of a double cover butt joint. The main plates are 12mm thick connected by18mm diameter rivets at a pitch of 100mm.design the cover plates also. What is the percentage reduction in the efficiency of the point if the plates are lap jointed.

Design a single bolted double cover butt joint to connect plates of fy 410 grade having thickness 16mm.Use M16 bolts of grade 4.6.Fine the efficiency of the joint.

A tie member of a roof truss consists of 2 ISA 90mmx60mmx10mm. The angles are connected on either sides of 12mm gusset plate and the member is subjected to the pull of 400kN.design the welded connections.

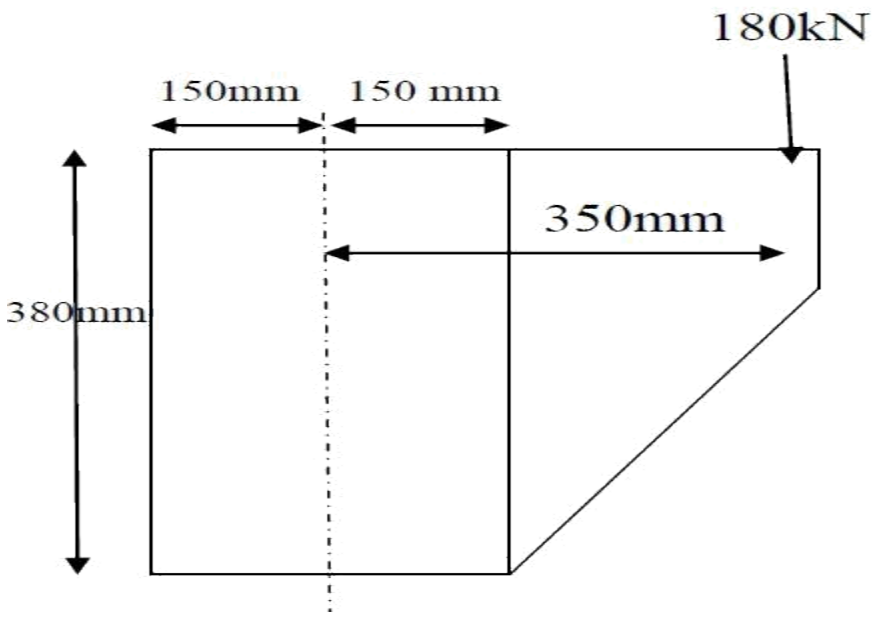
A single riveted double cover butt joint is used to connect two plates 12mm thick. The rivets used are power driven 18 mm in diameter at a pitch of 60mm. Find the safe load per pitch length and the efficiency of the joint.

A tie member consisting of angle section 80mm x60mm x8mm is welded to a 8mm gusset plate. Design the weld to transmit a load equal to the full strength of the member.

A plate in which the axial tension is 520kN is to be provided with a splice joint. The size of the plate is 400 mm x 20 mm. Design a suitable riveted joint.

Design a double riveted double cover butt joint connects two plates of 12 mm thick. Adopt power driven rivets. Take fy = 250Mpa. Find also the efficiency of the joint.

A bracket is welded to a stanchion by fillet welds having a throat thickness of 9mm and a load of 180 kN is applied in the plane of the bracket, as shown in the figure. The weld extends round three sides and has the given dimensions. Determine the maximum stress in the throat of the weld.



What are the types of load to be account for steel design?

A bracket carrying a load of 100 kN is connected to column by means of two horizontal fillet welds, of 130 mm effective length and 10 mm thick. The load acts at 70 mm from the face of the column as shown. Find the throat stress. (May / June 2007)

A tie member 75 mm X 8mm is to transmit a load of 90 kN Design the fillet weld and calculate the necessary overlap. (Nov / Dec 2007)

A single bolted double cover butt joint is used to connect two plates 8mmthick. Assuming 20mm bolts at 50mm pitch calculate the efficiency of the joint. The thickness of cover plate is 4mm

The figure shows the joint in the bottom chord continuous member of the truss. Design the connection using M16 black bolt of property class 4.6 and grade Fe410 steel. Assume edge distance of 35 mm and minimum pitch.

Design the seat angle connection between the beam ISMB 250 andcolumn ISHB 250 for a reaction from beam equal to 85 KN. Use M16 blackbolt of property class 4.6 and grade Fe410 steel with fy =250 MPa.

A beam ISWB 550 having equal flange width to that of column, transfers a factored end reaction of 275 KN to the flange of the column ISSC 250. Design the stiffened seat angle connection using 20 mm bolts of grade 4.6, fy =250MPa.

UNIT-II
TENSION MEMBERS
PART-A:

1. Define Tension member.

What is Lug angle?

What is Shear Lag Effect?

What do you mean by tension splices?

Draw any two typical cross section of tension member using angle sections.

What is block shear?

What is meant by slenderness ratio?

Why are drilled holes preferred over punched holes?

What are the factors that influence the strength of the tension member?

PART-B:

A tie member in a roof truss consists of two ISA 90 mm x 60 mm x 8 mm.

Determine the safe load to carrying capacity of the member if

(i) The angles are on the same side of the gusset plate

(ii) The angles are on either side of the gusset plate. 16mm rivets are used for connection at the ends and the members tracked along the length.

A tension member is subjected to a pill of 300kN. Design suitable section if

ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ0 It consists of a single angle connected by one leg.

ÀrĀĀĀĀĀĀĀĀdĀÀrĀĀĀĀĀĀĀĀ1 It consists of double angle on either side of gusset plate ant tacked along the length.

Design a tension member to carry a load of 300kN. The two angles placed back to back with long leg outstanding are desirable. The length of the member is 2.9m.

Design a tension splice for tension member sections 160 mm x10 mm and 250 mm x12 mm. The member is subjected to a pull of 200 kN.

Design a tension member to carry factored axial tension of 450kN. Use 10mm thick gusset plate and 20mm diameter black bolts.

(i) What is a Lug angle? Where it is used?

0 Design a splice to connect a 300mmx 20mm plate with 300mm x10mm plate to carry design load of 500kN.Use 20mm black bolts.

Design a tension member of length 3.6m between c/c of intersections and carrying a pull of 150kN.The member is subjected to reversal of stresses.

Design a tension member to carry a load of 300kN. Two angles placed back to back with long leg outstanding are desirable. The length of the member is 3m.

A double angle ISA 75mm x75mm x 8mm back to back welded to one side of a 12mm gusset have allowable stress 150Mpa. Determine the allowable tensile load on the member and weld length and overlap length of gusset plate.

An ISA 100x100x12 is used as a tie riveted to a gusset plate with 24mm rivets arranged in one row along the length of the angle. Determine the allowable tension on the angle if the allowable tensile stress is 150Mpa.

UNIT-III
COMPRESSION MEMBERS
PART-A:

Define compression members.

What do you mean by eccentrically loaded column?

Define effective length of column.

Draw a neat sketch of column with double lacing and mention specifications for lacing.
What do you mean by latticed columns?
What is meant by slenderness ratio of a column?
How do classify the columns as per end conditions?
State the possible failure modes in an axially loaded column.
What is the main purpose of lacings and battens?
In a Gusseted base how is the total force of the gusset plate transferred to the cleat?

PART-B:

Design completely a built up column composed of channel sections placed back to back carrying an axial load of 1500 kN. Its length is 6m and it is effectively held in position at both ends restrained against rotation at one end. Take fy = 250N/mm2
Design a gusseted base for a column ISHB 450@87.2kg/m carrying an axial load of 2000kN. Take allowable bearing pressure in concrete as 4 N/mm2.
Design a built up column with two channel sections. The column is of 6.4m effective length and supports a load of 1000kN.
Design a suitable slab base for a column section ISHB 300.subjecte4d to a load of 450kN. The base plate is to rest on a concrete pedestal of M20 grade.
Design a column with double lacing system to carry a factored axial load of 1800kN.The effective height of column is 4.5m. Use two channels placed back to back.
Design a gusseted base to carry a factored axial load 2500kN. The column consists of ISHB @ 0.855 kN/m with two cover plates 250mm x 20mm on either side. Take the effective height of column as 4m.
Design a column with single lacing system to carry a factored axial load of 1500kN. The effective height of the column is 4.2m.Use two channels placed toe to toe.
Design suitable slab base for a column section ISHB 400 @ 822 N/m, supporting an axial load 500kN. The base plate is rest on a concrete pedestal of M20 grade concrete.
Design a laced column for an axial load of 1200 kN with an effective span of 7.5m has one end fixed and the other end hinged. Use channels for main members and an angle for lacing bars.
A column of ISHB 400 is subjected to an axial force of 750kN. Design suitable base plate.
Assume necessary data‟s required.

UNIT-IV
BEAMS
PART-A:

Write down the simple bending equation.
What will be the allowable average shear for un-stiffened web of plate girder?
Define laterally restrained beam.
Write the formula for calculating the thickness of beam bearing plate.
What is laterally unsupported beam? Give an example.

What is plate girder? where it is used?

What do you mean by web buckling?

What do you mean by castellated beam?

Differentiate beam, built up beam and plate girder.

What is the function of stiffeners in plate girder?

PART-B:

Design a built up beam section for a span of 8m to carry a uniformly distributed load of 15 kN/m and a central concentrated load of 100kN.The beam is laterally supported throughout. Show the curtailment if plated also.

A plate girder of span 15m is made up of web plates of 1600mmx 8mm, flange angles 150mmx115mmx10mm and two flange plates 480mmx10mm it carries a uniformly distributed load of 100 kN/m including its own weight. Design and Sketch the web splices at 5m from one end.

Design a simply supported(laterally supported) of effective span of 12m to carry o factored load of 70 kN/m the depth of the beam is restricted to 500mm.

Design a riveted plate girder using Fe 415 steel for a span of 22 m to carry a load of 25kN/m.

Design a simply supported beam of effective span 10m to carry factored load of 60kN/m, the depth of the beam is restricted to 500mm . Assume the beam is laterally unsupported.

Design a welded plated girder using Fe 415 steel for a span of 25 m to carry a load of 30kN/m.

Design a simply supported beam to carry uniformly distributed load of 44 kN/m .The effective Span of beam is 8 m. The effective length of compression flange of the beam is also 8 m. The ends of beam are not to free to rotate at the bearings.

The effective length of compression flange of simply supported beam MB 500 @0.869 kN/m. Determine the safe uniformly distributed load per meter length which can be placed over the beam having an effective span of 8 m. The ends of beam are restrained against rotation at the bearings. ISMB 550 @1.037 kN/ m has been used as simply supported over a span of 4 m. The ends of beam are restrained against torsion but not against lateral bending. Determine the safe UDL per meter, which the beam can carry.

Design rolled steel I- sections for a simply supported beam with a clear span of 6m .it carries a UDL of 50 KN per metre exclusive of self-weight of the girder .the beam is laterally unsupported.

Check the beam section WB 500 @1.45 kN/m against web crippling and web buckling if reaction at the end of beam is 179.6 KN, The length of bearing plate at the support is 120 mm. Design bearing plate. The bearing plate is set in masonry.

A beam simply supported over an effective span of 7m, carries a uniformly distributed load of 50kN/m inclusive of its own weight. The depth of the beam is restricted to 450mm. design the beam, assuming that the compression flange of the beam is laterally supported by a floor construction. Take fy = 250N/mm2 and E =2X105N/mm2. Assuming width of the support is 230mm. (May/June 2007).

Design a bearing stiffener for a welded plate girder with the following specifications. Web = 1000mm X 6mm thick. Flanges = 2 Nos. of 350X20mm plate on each side. Support reaction = 350kN.Width of the support = 300mm.. (May/June 2007).

13 A simply supported steel joist with a 4.0m effective span carries a udl of 40kN/mover its span inclusive of self weight. The beam is laterally unsupported. Design a suitable section. Take fy = 250N/mm2. (Nov/Dec 2007)

Design the step by step procedure for design of vertical and horizontal stiffeners in a plate girder. (Nov/Dec 2007)

15.Design a built up beam section for a span of 8m to carry a uniformly distributed load of 15 kN/m and a central concentrated load of 100 kn. The beams is laterally supported through out. Show the curtailment of plates also.

A plate girder of span 15m is made-up of web plates of 1600mm x 8mm flange angles 150mmx 115mm x 10mm and two flange plates 480mm x 10mm it carries a uniformly distributed load of 100kn/m including its own weight. Design and sketch the web splices at 5m from one end.

Design a simply supported (laterally supported) of effective span 12m to carry a factored load of 70kN/m. The depth of the beam is restricted to 500mm.

UNIT-V
ROOF TRUSSES AND INDUSTRIAL STRUCTURES
PART-A:

Define pitch of a roof.

How do you calculate the self weight of truss when the pitch of the root is ¼ and the root covering is GC sheeting?

What is the use of sag rod in a roof truss?

Draw a neat sketch of a FINK type truss.

What are the loads to be considered for the design of gantry girder?

Give general guidelines for fixing spacing of roof trusses.

What is the necessity of curtailment of flange plate girder?

What is the use of sag rod?

Define gantry girder.

Give the role of end bearing in roof trusses.

PART-B:

In an industrial building, the trusses of 16 m span and 4m rise are spaced at 8m apart .The building is in medium wind zone in an industrial area of plain land. Design purlin.

A shed is to be provided with a hand operated 5 tonne crane facility. The details of the building and the crane girder are:

Longitudinal spacing of column = 6m

c/c distance of gantry girder=B= 12m

wheel spacing=a= 3m

Edge distance = g = 1m

Weight of crane girder = 40kN
Weight trolley car = 10kN
Design the gantry girder.
Design a channel section purlin for the following data
Spacing of trusses = 4.2m
Spacing of purlins = 2 m
Live load on GC sheets = 0.6kN/m2
Wind load = 1.4kN.m2
Slope of main rafter = 31o
(i) List out various elements of the roof truss and mark all its significance
(ii) Explain the design principles of gantry girder.