DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

23-0009-AH

TEST BOOKLET
CIVIL ENGINEERING
PAPER – I

Time Allowed: 3 hours | **Maximum Marks: 300**

INSTRUCTIONS TO CANDIDATES

Read the instructions carefully before answering the questions: -

1. This Test Booklet consists of 20 (twenty) pages and has 75 (seventy-five) items (questions).
2. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS BOOKLET *DOES NOT* HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.
3. **Please note that it is the candidate's responsibility to fill in the Roll Number and other required details carefully and without any omission or discrepancy at the appropriate places in the OMR Answer Sheet and the Separate Answer Booklet. Any omission/discrepancy will render the OMR Answer Sheet and the Separate Answer Booklet liable for rejection.**
4. Do not write anything else on the OMR Answer Sheet except the required information. Before you proceed to mark in the OMR Answer Sheet, please ensure that you have filled in the required particulars as per given instructions.
5. Use only **Black Ball Point Pen** to fill the OMR Answer Sheet.
6. This Test Booklet is divided into 4 (four) parts – **Part – I, Part – II, Part - III** and **Part – IV**.
7. All three parts are **Compulsory**.
8. **Part-I consists of Multiple Choice-based Questions.** The answers to these questions have to be marked in the **OMR Answer Sheet** provided to you.
9. **Part-II, Part-III** and **Part-IV consist of Conventional Essay-type Questions.** The answers to these questions have to be written in the separate **Answer Booklet** provided to you.
10. In Part-I, each item (question) comprises of 04 (four) responses (answers). You are required to select the response which you want to mark on the OMR Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose ***ONLY ONE*** response for each item.
11. After you have completed filling in all your responses on the OMR Answer Sheet and the Answer Booklet(s) and the examination has concluded, you should hand over to the Invigilator ***only the OMR Answer Sheet and the Answer Booklet(s)***. You are permitted to take the Test Booklet with you.
12. **Penalty for wrong answers in Multiple Choice-based Questions:**

THERE WIL BE **PENALTY** FOR WRONG ANSWERS MARKED BY A CANDIDATE.

(i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, one-third of the marks assigned to the question will be deducted as penalty.

(ii) If a candidate gives more than one answer, it will be treated as a wrong answer even if one of the given answers happens to be correct and there will be same penalty as above to the question.

(iii) If a question is left blank. i.e., no answer is given by the candidate, there will be no penalty for that question.

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PART-I
(Multiple Choice-based Questions)

Instructions for Questions 1 to 50:

- *Attempt all questions. Each question carries 3 marks.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*
- *Unless otherwise mentioned, symbols and notations have their usual meaning.*

[3x50=150]

1. Muller Breslau Principle for obtaining influence lines is applicable to which of the following?
   (i) Trusses
   (ii) Statically determinate beams and frames
   (iii) Statically indeterminate structures, the material of which is elastic and follows Hooke's law
   (iv) Any statically indeterminate structures

   Select the correct answer from the codes given below.
   Codes:
   (a) (i), (ii) and (iii)
   (b) (i), (ii) and (iv)
   (c) (i) and (ii)
   (d) Only (i)

2. A single rolling load of $4kN$ rolls along a girder of $15m$ span. What will the absolute maximum bending moment be?
   (a) $8\ kN-m$
   (b) $15\ kN-m$
   (c) $30\ kN-m$
   (d) $60\ kN-m$

3. Which of the following is Castigliano's first theorem applicable to?
   (a) for statically determinate structure only
   (b) when the system behaves elastically
   (c) only when principle of superposition is valid
   (d) None of the these

4. A simply supported beam has an effective span of $16m$. What shall be the limiting ratio of span to effective depth as per **IS: 456-2000**?
   (a) 26
   (b) 20
   (c) 12.5
   (d) 7

5. Splicing of bars in RCC beams can be done at a section where _____

Instruction: Complete the statement given above by selecting the correct answer from the options given below.

(a) bending moment is zero
(b) bending moment is less than half of the maximum bending moment in beam
(c) bending moment is maximum
(d) shear force is zero

6. The load carrying capacity of a column designed by working stress method is $\mathbf{600}\ \boldsymbol{kN}$. What is the ultimate collapse load of the column?

(a) $500\ kN$
(b) $662.5\ kN$
(c) $900\ kN$
(d) $1100\ kN$

7. The plastic modulus of a section is $\mathbf{5 \times 10^{-4} m^3}$. Its shape factor is $\mathbf{1.2}$ and the plastic moment capacity is $\mathbf{150}\ \boldsymbol{kNm}$. What is the value of the yield stress of the material?

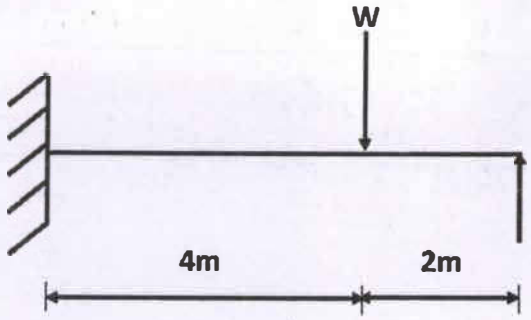
(a) $125\ N/mm^2$
(b) $200\ N/mm^2$
(c) $240\ N/mm^2$
(d) $300\ N/mm^2$

8. For a vertical stiffened web of a plate girder, the lesser clear dimension of the panel should not exceed _____. (Note: $\boldsymbol{t}$ is the thickness of the web)

Instruction: Complete the statement given above by selecting the correct answer from the options given below.

(a) $85t$
(b) $180t$
(c) $200t$
(d) $250t$

9. What is the collapse load for a propped cantilever beam shown in the diagram below with a plastic moment capacity of M_p?

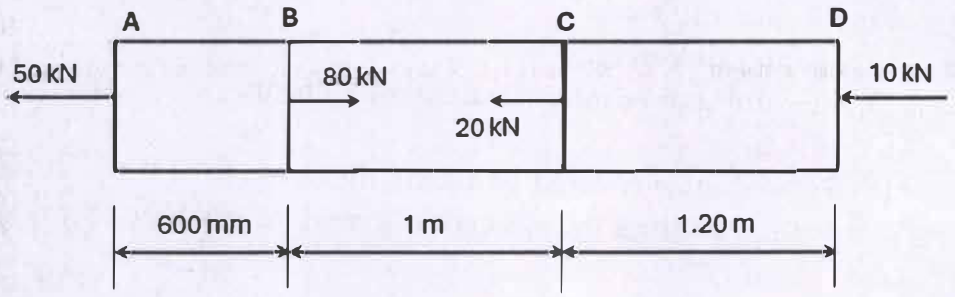


(a) 1.25 Mp
(b) 1.5 Mp
(c) Mp
(d) 2 Mp

10. Why areBearing stiffeners provided in plate girders?
(a) To decrease the effective depth of web.
(b) To transfer the load from the top flange to the bottom flange.
(c) To prevent buckling of web.
(d) To increase the bearing capacity of the flange.

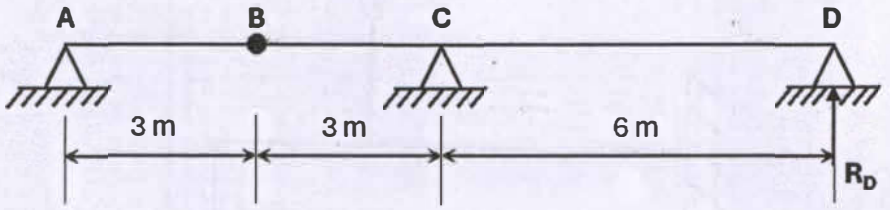
11. At what stress does the first flexural crack appear in RCC beams made of **M25** grade concrete?
(a) 3.0 MPa
(b) 3.5 MPa
(c) 4.0 MPa
(d) 4.5 MPa

12. A brass bar having cross-sectional area of $\mathbf{1000\ mm^2}$ is subjected to axial forces as shown in figure below. Take $\boldsymbol{E = 1.05 \times 10^5\ N/mm^2}$.



What is the change in length in part BC?
(a) 0.2857 mm $(+ve)$
(b) 0.2095 mm $(+ve)$
(c) 0.2857 mm $(-ve)$
(d) 0.1904 mm $(-ve)$

13. What should be the ordinate of the influence line at B for the reaction R_D as shown in figure below.



(a) Zero
(b) 0.5
(c) 0.3
(d) 0.6

14. A three pinned circular arch of span **60 m** and a rise of **6 m** is hinged at the crown and springings. It carries a horizontal load of **200 kN per vertical metre** on the left side. What is the horizontal thrust at the right springing?
(a) 200 kN
(b) 300 kN
(c) 400 kN
(d) 800 kN

15. A two hinged semi-circular arch of radius R carries a concentrated load W at the crown. Assuming unform flexural rigidity, what is the horizontal thrust at each support?
(a) $W/2\pi$
(b) $4W/3\pi$
(c) $2W/3\pi$
(d) W/π

16. What does the Stiffness method of structural analysis start with?
(a) Force - deformation relations
(b) Equilibrium condition
(c) Compatible deformation
(d) Equilibrium state of internal stress components

17. In a double riveted double covered butt joint, the strength of the joint per pitch length in shearing the rivets is n times the strength of one rivet in single shear. What is the value of$n$?
(a) 2
(b) 3
(c) 4
(d) 1

18. A steel rod of $\mathbf{20}\,\boldsymbol{mm}$ diameter has been used as a tie in a bracing system, and may be subject to possible reversal of stress due to wind. What is the maximum permitted length of the member?
    (a) 1600 mm
    (b) 1750 mm
    (c) 1250 mm
    (d) 1400 mm

19. Steel of yield strength $\mathbf{500}\,\boldsymbol{MPa}$ has been used in a structure. What is the approximate value of the maximum allowable tensile strength?
    (a) 300 MPa
    (b) 240 MPa
    (c) 200 MPa
    (d) 96 MPa

20. A compression member has a centre-to-centre length of $\mathbf{5.0}\,\boldsymbol{m}$. It is fixed at one end and hinged at the other end. What is the effective length of the column equal to?
    (a) 4.5 m
    (b) 3.5 m
    (c) 4.0 m
    (d) 3.0 m

21. Which one of the following is a compression member?
    (a) Girt
    (b) Tie
    (c) Boom
    (d) Purlin

22. In a gusseted base, when the end of the column is machined for complete bearing on the base plate, the axial load is assumed to be transferred to the base plate _____

    Instruction: Complete the statement given above by selecting the correct answer from the options given below.
    (a) fully by direct loading
    (b) fully through the fastenings
    (c) 50% by direct bearing and 50% through fastenings
    (d) 75% by direct bearing and 25% through fastenings

23. A partially prestressed member is one in which _____

    Instruction: Complete the statement given above by selecting the correct answer from the options given below.
    (a) tensile stresses and cracking are permitted under service loads
    (b) no tensile stresses are permitted under service loads
    (c) mild steel is used in addition to prestressing steel
    (d) tensile stresses are permitted but not cracking at service loads

24. In the design of prestressed concrete structures, which of the following limit states will come under the limit states of serviceability?

1. Flexure
2. Shear
3. Deflection
4. Cracking

Select the correct answer using the codes given below:

(a) 1 and 4
(b) 3 and 4
(c) 2, 3 and 4
(d) 2 and 3

25. The mode of failure of a very short masonry member having $\boldsymbol{h/t}$ ratio of $\boldsymbol{less\ than\ 4}$ is by which of the following?

(a) Shear
(b) Buckling
(c) Vertical tensile splitting
(d) None of the above

26. For earthquake-resistant masonry buildings, the vertical distance between openings one above the other in a load bearing wallshall not be less than which of the following?

(a) $60\ cm$
(b) $50\ cm$
(c) $100\ cm$
(d) $75\ cm$

27. A square slab $\boldsymbol{6\ m \times 6\ m}$ is isotropically reinforced at the bottom. What is the moment capacity required, as per yield line theory, if it is subjected to a working load of $\boldsymbol{12\ kPa}$ (including self-weight)?

(a) $27\ kN - m/m$
(b) $18\ kN - m/m$
(c) $54\ kN - m/m$
(d) $12\ kN - m/m$

28. The stem of a cantilever retaining wall which retains earth level with top is $\boldsymbol{6\ m}$. What is the effective width of the stem at the bottom, if the angle of repose and weight of the soil per cubic metre are $\boldsymbol{30°}$ and $\boldsymbol{2000\ kg}$ respectively?

(a) $51.5\ m$
(b) $52.5\ m$
(c) $53.5\ m$
(d) $54.5\ m$

29. In a counterfort retaining wall, the main reinforcement in the stem at mid span provided on which of the following?
    (a) Front face only
    (b) Inner face only
    (c) Both front face and inner face
    (d) None of the above

30. Which design method is used for the design of water tank?
    (a) Limit state method
    (b) Working stress method
    (c) Both (a) and (b)
    (d) None of the above

31. What is the hydraulic head that would produce a quick condition in a sand stratum of thickness **1.5 *m***, specific gravity **2.67** and void ratio **0.67**?
    (a) 2.0 m
    (b) 3.0 m
    (c) 1.0 m
    (d) 1.5 m

32. What is the coefficient of passive earth pressure for a loose sand having an angle of internal friction of **30°**?
    (a) 1/3
    (b) 3
    (c) 1/2
    (d) 2

33. Which of the following equations gives the ultimate bearing capacity (q_u) of pure clays for general shear failure?
    (a) $q_u = 5.7 + 0.5\gamma D_f$
    (b) $q_u = 5.7 + \gamma D_f$
    (c) $q_u = 1.3 + \gamma D_f$
    (d) $q_u = 5.7 + 1.2\gamma D_f$

34. Base failure of a finite slope _____

Instruction: Complete the statement given above by selecting the correct answer from the options given below.
    (a) occurs when soil below the level of toe is strong
    (b) occurs when there is a relatively weak zone in upper part of the slope
    (c) occurs when the soil below the toe is relatively soft and weak
    (d) is a most common failure and occurs in relatively steep slopes

35. Which of the following statements is TRUE about the **contact pressure** beneath a rigid footing resting on cohesive soil?
    (a) It is less at edges compared to middle.
    (b) It is more at edges compared to middle.
    (c) It is uniform throughout
    (d) None of the above

36. A shallow foundation is defined as a foundation which _____

    Instruction: Complete the statement given above by selecting the correct answer from the options given below.
    (a) has low bearing capacity
    (b) has a depth of embedment less than its width
    (c) is resting on the ground surface
    (d) causes less settlement

37. Lime stabilization is very effective in treating _____

    Instruction: Complete the statement given above by selecting the correct answer from the options given below.
    (a) sandy soils
    (b) silty soils
    (c) non-plastic soils
    (d) plastic clayey soils

38. In soil consolidation process, the following events take place after loading:
    1. Decrease in excess pore pressure
    2. Increase in total stress
    3. Development of excess pore pressure
    4. Increase in effective stress

    The correct sequence of these events is _____

    Select the correct answer using the codes given below:
    (a) 3,2,1,4
    (b) 2,3,1,4
    (c) 2,3,4,1
    (d) 3,2,4,1

39. A ball is dropped from a height of **6 *m*** on a horizontal floor. It rebounds to a height of **2 *m*** after striking the floor. What is the coefficient of restitution between the ball and the floor?
    (a) $1/\sqrt{3}$
    (b) $1/3$
    (c) $\sqrt{3}$
    (d) $\sqrt{2}/\sqrt{3}$

40. For a given system of coplanar forces, if the pole 'O' of the force polygon moves along a straight line OPthen the sides of the funicular polygon would rotate about fixed points. Where would all of these fixed points lie on?
    (a) On a circle with a centre at O.
    (b) On a straight line parallel to OP.
    (c) Ona circle with a centre at P.
    (d) On an ellipse with OP as the major axis.

41. A ship has a metacentric height of $0.9\ m$ and its period of rolling is $20\ seconds$. What is the relevant radius of gyration approximately equal to?
    (a) $5.5\ m$
    (b) $7.5\ m$
    (c) $9.5\ m$
    (d) $11.5\ m$

42. In a laminar flow through a circular pipe of diameter of $200\ mm$, the maximum velocity is found to be $1\ m/s$. What is the velocity at a radial distance of $75\ mm$ from the axis of the pipe?
    (a) $0.43\ m/sec$
    (b) $0.75\ m/sec$
    (c) $0.23\ m/sec$
    (d) $1.25\ m/sec$

43. Which of the following statements is **TRUE** for a streamlined body?
    (a) The flow is laminar about the body.
    (b) The flow is along the stream lines about the body.
    (c) The flow separation is suppressed about the body.
    (d) The drag is zero about the body.

44. Analysis of a surge in open channels is carried out by using which of the following equations?
    1. Navier Stokes equation
    2. Energy equation
    3. Continuity equation
    4. Momentum equation

    Select the correct answer using the codes given below:
    (a) Only 1.
    (b) Both 2 and 3.
    (c) Both 3 and 4.
    (d) 2, 3 and 4.

45. For laminar flow in circular pipes, what is the Darcy's friction factor f equal to? (Note: R_e is the Reynolds number)
    (a) $16/R_e$
    (b) $32/R_e$
    (c) $64/R_e$
    (d) None of the above

46. If the error in the measurement of the head in a V notch is **1%**, then what will the error in the measurement of discharge be?
    (a) 1%
    (b) 5%
    (c) 2.5%
    (d) 1.5%

47. A triangular channel section is most economical when each of its sloping sides is inclined to the vertical at what angle?
    (a) 30°
    (b) 45°
    (c) 75°
    (d) 60°

48. A Francis turbine under a head of **25 m** produces **2000 kW** at a speed of **250 rpm**. What is its specific speed?
    (a) 50 $r.p.m.$
    (b) 100 $r.p.m.$
    (c) 200 $r.p.m.$
    (d) 150 $r.p.m.$

49. Where does the hydraulic jump always occur from?
    (a) It occurs from below critical depth to above critical depth.
    (b) It occurs from above critical depth to below critical depth
    (c) It occurs from below normal depth to above normal depth
    (d) It occurs from above normal depth to below normal depth

50. Which of the following is TRUE in respect of the friction coefficient for turbulent flow for a hydro-dynamically smooth boundary?
    (a) It is constant.
    (b) It is dependent only on Reynolds number.
    (c) It is a function of Reynolds number and relative roughness.
    (d) It is dependent on relative roughness only.

PART-II
(Short Answer-type Questions)

Instructions for Questions 51 to 63:

- *Write the answers in short for any 10 (TEN) out of the thirteen questions.*
- *Each question carries 5 marks.*
- *Candidates are required to give their answers in their own words as far as practicable.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*
- *Unless otherwise mentioned, symbols and notations have their usual meaning.*

[5x10=50]

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

52. Explain angle of friction and angle of repose.

53. Explain unsymmetrical bending. State few examples of a structure under unsymmetrical bending.

54. A straight bar $\mathbf{2}\,\boldsymbol{m}$ long and $\mathbf{25}\,\boldsymbol{mm} \times \mathbf{5}\,\boldsymbol{mm}$ cross section is compressed longitudinally until it buckles. Calculate the Euler's buckling load. Take $\boldsymbol{E} = \mathbf{200}\,\boldsymbol{kN/mm^2}$, assuming both ends are hinged.

55. Calculate the maximum shear stress in a hollow circular shaft having $\mathbf{300}\,\boldsymbol{mm}$ external diameter and $\mathbf{150}\,\boldsymbol{mm}$ internal diameter. This shaft is subjected to a twisting moment of $\mathbf{4}\,\boldsymbol{kN-m}$.

56. State Castigliano's first and second theorem.

57. What are the uses of influence line?

58. A steel flat $\mathbf{100}\,\boldsymbol{mm} \times \mathbf{100}\,\boldsymbol{mm}$ carries a tensile force of $\mathbf{160}\,\boldsymbol{kN}$. It is to be welded to gusset plate with a lap of $\mathbf{10}\,\boldsymbol{cm}$. Determine the minimum size of the fillet weld. Permissible stress in shear = $\mathbf{100}\,\boldsymbol{N/mm^2}$.

59. Explain the reason for the loss due to elastic shortening in post-tensioned beam is less than that in pre-tensioned beam.

60. Why high grade of concrete and steel is used in pre-stressed concrete?

61. A masonry dam has pervious sand as foundation. Determine the maximum permissible upward hydraulic gradient, if a factor of safety of $\mathbf{4}$ is required against boiling. For the sand, the porosity, $\boldsymbol{n} = \mathbf{45\%}$ and specific gravity of solids, $\boldsymbol{G_s} = \mathbf{2.65}$?

62. Explain clearly the active earth pressure and passive earth pressure. Give one example of each state.

63. Draw following water surface profiles of gradually varied flow, stating conditions justifying the types of profiles:
    (i) $\boldsymbol{M_2}$ type profile
    (ii) $\boldsymbol{S_1}$ type profile

PART-III
(Long Answer-type Questions)

Instructions for Questions 64 to 71:

- ***Answer any 5 (FIVE)out of the eight questions.***
- ***Each question carries 10 marks.***
- ***Candidates are required to give their answers in their own words as far as practicable.***
- ***No Data Books/Tables are allowed; assume the data if required anywhere.***
- ***Unless otherwise mentioned, symbols and notations have their usual meaning.***

[10x5=50]

64. A mild steel bar $\mathbf{25}\ \boldsymbol{mm}$ diameter and $\mathbf{250}\ \boldsymbol{mm}$ long is placed inside a brass tube, having an external diameter of $\mathbf{30}\ \boldsymbol{mm}$ and internal diameter of $\mathbf{25}\ \boldsymbol{mm}$. The combination is then subjected to an axial load of $\mathbf{45}\ \boldsymbol{kN}$. Find the shortening of the rod.

65. A three-hinged parabolic arch hinged at the supports and at the crown has a span of $\mathbf{24}\ \boldsymbol{m}$ and a central rise of $\mathbf{4}\ \boldsymbol{m}$. It carries a concentrated load of $\mathbf{50}\ \boldsymbol{kN}$ at $\mathbf{18}\ \boldsymbol{m}$ from left support and a uniformly distributed load of $\mathbf{30}\ \boldsymbol{kN/m}$ over the left-half portion. Determine the moment at a section $\mathbf{6}\ \boldsymbol{m}$ from the left support.

66. A single angle $\boldsymbol{ISA}\ \mathbf{90 \times 90 \times 10}$ is connected by welding to a gusset plate. Calculate the effective area of the angle in Tension and the Tension capacity if the allowable stress in direct tension is $\mathbf{150}\ \boldsymbol{MPa}$. Area of the angle may be taken as $\mathbf{1703}\ \boldsymbol{sq.mm}$.

67. Enumerate various types of losses in prestress. Explain any two of them in brief.

68. What is negative skin friction in pile? How it affects the load carrying capacity of pile?

69. Explain the importance of dimensional analysis and discuss any one method of dimensional analysis.

70. It is required to pump $\mathbf{0.25}\ \boldsymbol{m^3/s}$ of water to a height of $\mathbf{200}\ \boldsymbol{m}$. The pumps have an overall efficiency of $\mathbf{80\%}$. If pumps running at $\mathbf{1500}\ \boldsymbol{rpm}$ and with specific speed ($\boldsymbol{N_S}$) of $\mathbf{30}$ are to be used, determine the number of pumps and their arrangement.

71. Give the classification of turbine on the basis of:
    (i) Action of water.
    (ii) Head available.
    (iii) Specific speed.

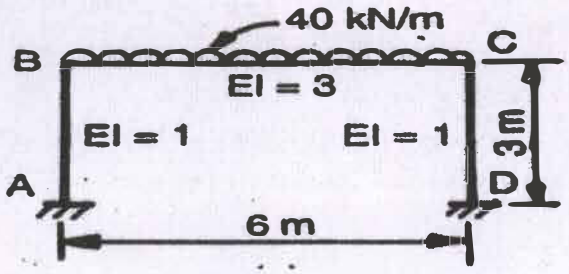
PART-IV
(Essay-type Questions)

Instructions for Questions 72 to 75:

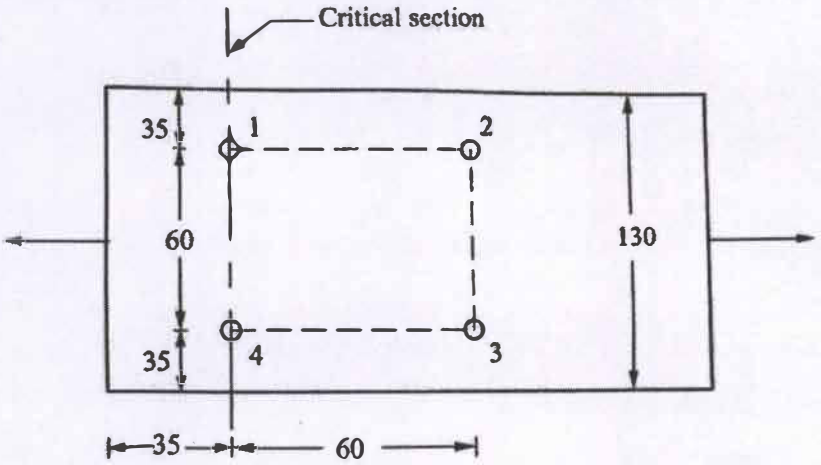
- *Answer any 2 (TWO)out of the four questions.*
- *Each question carries 25 marks.*
- *Candidates are required to give their answers in their own words as far as practicable.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*
- *Unless otherwise mentioned, symbols and notations have their usual meaning.*

[25x2= 50]

72. Using the stiffness method of analysis, obtain the moments at the ends of members for the portal frame shown in figure bellow.



73. Determine the design tensile strength of the plate $\mathbf{200\ mm \times 12\ mm}$ with the holes for $\mathbf{16\ mm}$ diameter bolts as shown in figure below. Steel used is of $\boldsymbol{Fe}$ **415** grade quality.



74. The coefficient of consolidation (C_v) of a clay was found to be $\mathbf{0.955\ mm^2/min}$. The final consolidation settlement for a $\mathbf{5\ m}$ thick layer of this clay was calculated as $\mathbf{280\ mm}$. Assuming a uniform initial excess pore-water pressure distribution and permeable layer to be present both above and below the clay layer, compute the settlement time for-

(a) 90 percent primary consolidation (take $T_v = 0.84$ for $U = 90\%$);

(b) Briefly explain about various type of grouts used in ground improvement.

75. A trapezoidal channel with one side vertical and the other sloping at two horizontals to one vertical, carries a discharge of $\mathbf{28}\ \boldsymbol{m^3/sec}$ at a mean velocity of $\mathbf{1.5}\ \boldsymbol{m/sec}$. Determine the longitudinal slope and channel dimensions for the best hydraulic efficiency, if $\boldsymbol{Manning's\ coefficient} = \mathbf{0.014}$.

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