2013

CIVIL ENGINEERING (Paper - I)

Time allowed : 3 Hours] **[Maximum Ma**

Note :

(i) *Solve any one question from each section.*

(ii) *Do not reproduce any question. Write only the question number against the answer.*

(iii) *Number of optional questions up to the prescribed number in the order in which questions have been solved, will only be assessed, excess answers of the question/s will not be assessed.*

(iv) *Figures to the right indicate the marks for the questions.*

(v) *Assume suitable data if necessary and state it clearly.*

(vi) *Use of Non-programmable calculators is permitted.*

(vii) *Use of I.S. Codes and Steel Tables is* ***not*** *permitted.*

(viii) *Candidates should not write roll number, any name (including their own), signature, address or any indication of their identity anywhere inside the answer books otherwise they will be penalised.*

(ix) *Candidates are expected to answer all the subquestions of a question together. If subquestion of a question is attempted elsewhere (after leaving a few pages or after attempting another question) the later subquestion shall be overlooked.*

SECTION - A

1. (a) A reinforced concrete column is 230×300 mm in size. It is reinforced with six bars of 16 mm diameter. The column is subjected to 800 kN load. Determine the stresses in concrete and steel. Take modular ratio $m = 13$. **10**

(b) A rectangular section for a beam is to be cut out of a log of wood 600 mm in diameter. Determine the dimensions of the strongest section. **10**

(c) A simply supported beam of span 'L' carries two equal point loads 'P' at quarter points from ends. Using conjugate beam method calculate central deflection. Flexural rigidity of beam is EI. **10**

(d) Compare the load carrying capacity of columns with both ends hinged. **10**

(i) Solid square section 40×40 cms.

(ii) Hollow square section with 50 cms outer side and 30 cms inner side. Use

Rankine's formula. Take $\sigma_c = 50$ MPa, $\alpha = \dfrac{1}{750}$.

Length of columns is 3.6 m.

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2. (a) Using slope deflection equations analyse the portal frame shown in the figure 1. Draw B.M.D.

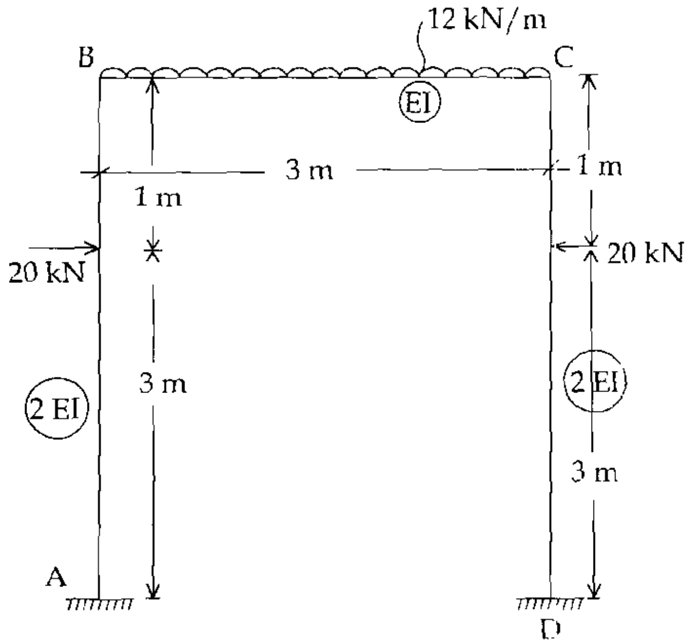

Figure - 1

(b) Determine the forces in all the members of the truss shown in figure. 2. Diagonal members c/s area = 3000 mm^2. Horizontal and vertical members c/s area = 2000 mm^2. **10**

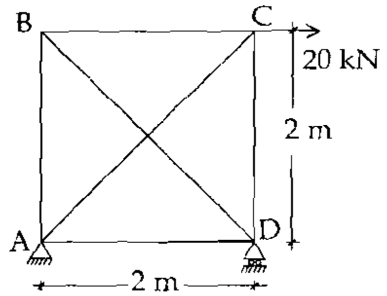

Figure - 2

(c) Find the support moments for the continuous beam ABCD if the support 'B' sinks by 1 cm. Take E = 200 kN/mm^2 I = 800 cm^4. Refer fig. 3. **10**

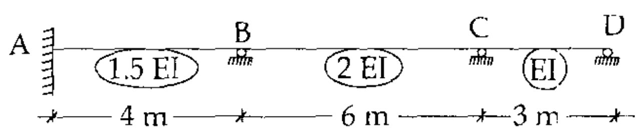

Figure - 3

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(d) Find the deflection of the free end of cantilever beam ABC. Refer fig. 4. Take $EI = 60000$ kN. m^2. 1

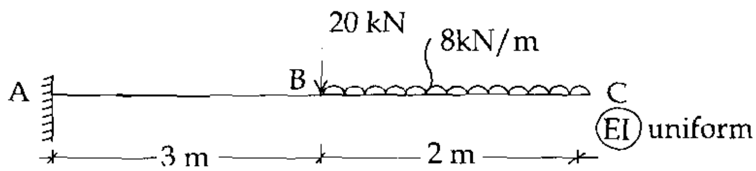

Figure - 4

SECTION - B

3. (a) A beam AD of span 7.5 m is fixed at A and roller supported at D and has an internal hinge at C at a distance of 3 m from D. Construct influence lines for : **10**

(i) Reaction at D, R_D

(ii) Shear at section B, at distance 3 m from A, SF_B

(iii) Moment at A, M_A

(b) A two span continuous beam ABC is fixed at A and simply supported at B and C, such that AB = 4 m, BC = 3 m. It is subjected to uniformly distributed load of intensity 60 kN/m over entire span AB and downward concentrated load of 100 kN at midpoint of span BC. Analyse the beam by using stiffness matrix method. Assume EI is constant throughout the beam. **10**

(c) A laterally supported built up beam consisting of ISMB 400@ 61.5 kg/m and plates of 200 mm $\times$ 10 mm each connected to flange, is simply supported over a span of 4 m. The beam is subjected to a factored column load of 400 kN at centre of span. Load is transferred through base plate of 200 mm length and 10 mm thick. Check the beam for web buckling and web crippling. Take $f_y = 250$ MPa. For ISMB 400 : $t_w = 8.9$ mm, $t_f = 16$ mm, $Z_p = 1176.18 \times 10^3$ mm^3, root radius R = 14 mm. **10**

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(d) Design a welded plate girder to carry a superimposed load of 50 kN/m and two concentrated loads of 200 kN each at one-third points of the span. The effective span of the plate girder is 24 m. Assume that the girder is laterally supported throughout its length. Use the tension field method. Take $f_y = 250$ MPa. (Connections need not be designed)

4. (a) A three hinged parabolic arch, hinged at the springings and crown has a span of 20 m. The central rise of the arch is 4 m. It is loaded with a uniformly distributed load of intensity 2 kN/m on the left 8 m length. Calculate the Normal thrust, Radial shear and Bending Moment at 4 m from the left hand hinge. **10**

(b) The towers of a 120 m suspension bridge are of unequal height. One is 15 m and the other 5 m above the lowest point of the cable, which is immediately above the inner pin of a three hinged stiffening girder hinged at the towers. Find the maximum tension in the cable due to a point load of 100 kN crossing the bridge. **10**

(c) A bracket transmits a load of 100 kN at an eccentricity of 200 mm to a column through 8 bolts of 24 mm diameter arranged in two vertical rows 80 mm apart. The pitch of the bolts is 80 mm and the load lies in the plane of the bolts. Calculate the maximum stress in the bolts. **10**

(d) Design a gusseted base for a beam-column ISSC 250@60.3 kg/m to transfer a factored axial compression of 750 kN and a factored bending moment of 75 kNm. The base rests on M30 grade concrete pedestal. Take $f_y = 250$ MPa. **10**

SECTION - C

5. (a) A doubly reinforced rectangular beam is 240 mm wide and 500 mm deep. If the limiting stresses in concrete and steel are 5 N/mm^2 and 230 N/mm^2 respectively. Determine the steel reinforcement for bending moment of 80 kNm. Assume that steel is burried on both faces with its centre 40 mm from either face. Take $m = 19$. Use working stress method. **10**

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(b) Design a simply supported slab on masonry walls to the following requirements, using limit state method

- Clear span = 2.5 m
- Live load = 3000 N/m^2
- Use M15 concrete and Fe 250 steel

Also draw plan and section showing reinforcement details.

(c) Design a square footing to carry a column load of 1100 kN from A 400 mm square column. The bearing capacity of soil is 100 kN/m^2. Use M15 concrete and Fe 415 steel. Use limit state method. Show reinforcement details. **10**

(d) Design a RCC short column to the following parameters using limit state method. **10**

(i) Axial load = 1200 kN.

(ii) Grade of concrete = M20.

(iii) Length of column = 1.85 m.

(iv) Grade of steel Fe 250.

Sketch the reinforcement details.

6. (a) Design a dog-legged stair case for a building in which the vertical distance between the floors is 3.6 m. The stair hall measures 2.5 m × 5 m. The live load may be taken as 2500 N/m^2. Use M20 grade concrete and Fe 415 steel. Sketch reinforcement details. **10**

(b) Design a circular tank with flexible base for capacity of 4 lakh litres. The depth of water is to be 4 m, including free board of 200 mm. Use M20 grade concrete Sketch reinforcement details. **10**

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(c) Check the stability of a counterfort retaining wall to retain 7 m high embankment above ground level. The foundation is to be taken 1 m deep, where the safe bearing capacity of soil may be taken as 180 kN/m^2. The top of earth retained is horizontal and soil weighs 18 kN/m^3 with an angle of friction $\phi = 30^\circ$, coefficient of friction between concrete and soil may be taken as 0.5. Use M20 grade concrete and Fe 415 steel.

(d) A reinforced concrete beam AB of rectangular section is fixed at A and B. Span = 8 m. The beam carries ultimate udl of 24 kN/m. Design the beam by limit state method with 30% re-distribution of moment. Use M20 grade concrete and Fe 415 steel. Draw BMD envelopes. **10**

SECTION - D

7. (a) Explain the various post-tensioning systems based on wedge action with neat sketches. **10**

(b) Define 'workability', and briefly explain the factors affecting the workability of fresh concrete. **10**

(c) A rectangular concrete beam, 300 mm $\times$ 900 mm with an overhang BC of 2 m is simply supported at A and B over a span of 8 m. It supports a live load in addition to its self-weight of intensity 3.52 kN/m over the whole span of 10 m. Determine the profile of the prestressing cable with an effective force of 500 kN which can balance the dead and live loads on the beam. Sketch the profile of the cable along the length of the beam. **10**

(d) Explain, how the water cement ratio, ratio of cement to aggregate and maximum size of aggregate influence the strength of concrete. **10**

8. (a) List and explain the various types of loss of prestress in pretensioned and post-tensioned members. **10**

(b) Enlist the various non-destructive methods of testing the hardened concrete. Explain in detail the pulse velocity method. **10**

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(c) The end block of a post - tensioned prestressed concrete beam, 300 mm wide and 300 mm deep, is subjected to a concentric anchorage force of 832.8 kN by a Freyssinet anchorage of area 11720 mm^2. Design and detail the anchorage reinforcement for the end block.

(d) Enlist various methods of concrete mix design and briefly explain any two of them. **10**

SECTION - E

9. (a) Find the roots of the equation. **10**

$$f(x) = x^2 - 3x + 2$$

in the vicinity of $x = 0$ using Newton - Raphson Method.

(b) Compute the integral **10**

$$\int_0^{\pi/2} \sqrt{\sin x}\, dx$$

by applying Simpson's one third rule for $n = 4$ with an accuracy of five decimal places.

(c) Write an algorithm and flow-chart for solving a set of three simultaneous equations using Gauss - Jordan Method. **10**

(d) Solve the following equations by Relaxation Method. **10**

$$10x - 2y - 2z = -6$$

$$-x + 10y - z = -7$$

$$-x - y + 10z = -8$$

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10. (a) Using Trapezoidal Rule evaluate the integral

$$I = \int_a^b (x^3+1)\,dx$$

for the intervals (1, 2) and (1, 1.5). Also estimate true error in each case with respect to exact answer.

(b) Perform five iterations of the bisection method to obtain the smallest positive root of the equation. **10**

$f(x) = \cos x - xe^x = 0$

(c) Draw flow chart for the computation of moment of resistance of R.C.C. beam. Take width of the beam 'b', effective depth of beam 'd', permissible stress in concrete is 'σ cbc', permissible stress in steel 'σst' and area of tensile steel is 'Ast'. Width and depth of beam are in 'MM', permissible stresses are in 'MPa' and Area of steel is in 'mm^2' (Use Working Stress Method). **10**

(d) Write a programme in 'C' or Fortran language to solve the set of simultaneous equations using Gauss - Elimination Method. **10**

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