Serial No. | 27660 | A–FRF–M–BUA

CIVIL ENGINEERING
Paper—I
(Conventional)

| Time Allowed : Three Hours | | Maximum Marks : 200 |

INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions :

Candidates should attempt FIVE questions in all.

Question No. 1 is compulsory. Out of the remaining SIX questions attempt any FOUR.

All questions carry equal marks. The number of marks carried by a part of a question is indicated against it.

Answers must be written in ENGLISH only.

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

Assume suitable data, if necessary and indicate the same clearly.

Neat sketches may be drawn, wherever required.

All parts and sub-parts of a question are to be attempted together in the answer book.

*Any pages left blank in the answer book must be clearly struck out.*

1

✦

1. **All** parts carry equal marks :   10×4=40

(a) Cement is made of solid complexes of oxides of calcium etc. Write the names of the four well known complexes along with the notation used to represent these.   4
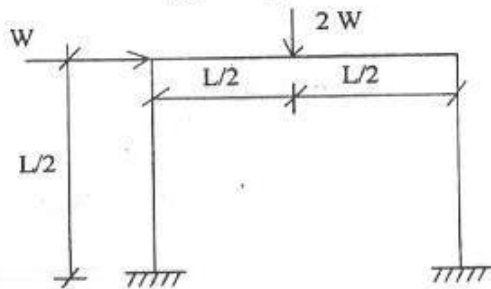
(b) Write the full form of the following in context of civil engineering construction :   4×1=4

    (i)   RMC

    (ii) GIS

    (iii) BOLT

    (iv) BOQ

(c) Draw the bending moment diagram of a beam from the shear force diagram of the beam.   4
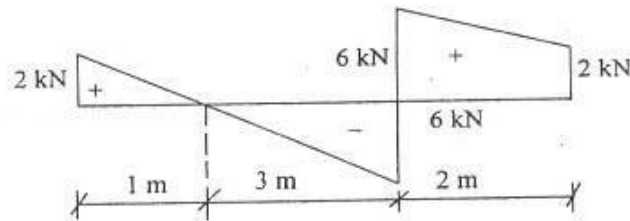
(d) Draw the different mechanisms for the frame as shown in the fig. for plastic analysis.   4

2   (Contd.)

(e) (i) Name 10 commonly used hot rolled structural section for steel construction.   2

    (ii) Give 06 reasons for failure of rivetted joints.   2

(f) A simply supported rectangular beam of length L carries a udl over its entire length. Determine the critical length at which the shearing stress 'τ' and flexural stress 'σ' reach their allowable values simultaneously. The breadth of beam section is 'b' and depth is 'd'.   4

(g) A beam of square section of the side 'a' is placed such that (i) two sides are horizontal (ii) one diagonal is horizontal. Find the ratio of the moments of resistance of the section in two positions for same permissible bending stress.   4

(h) Determine the moment of resistance of a Tee-section having the following properties :

Flange Width = 2000 mm

Flange Depth = 100 mm

Web Width = 250 mm

Effective Depth = 750 mm
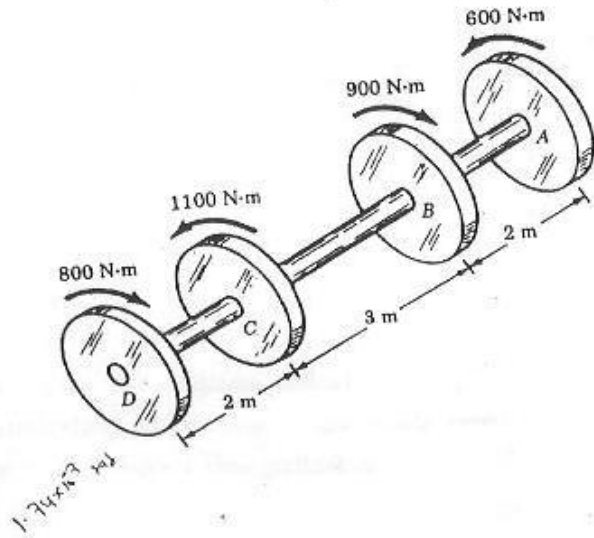
Area of Steel = 8 bars of 20 mm diameter

Material used = M25 grade of conc and

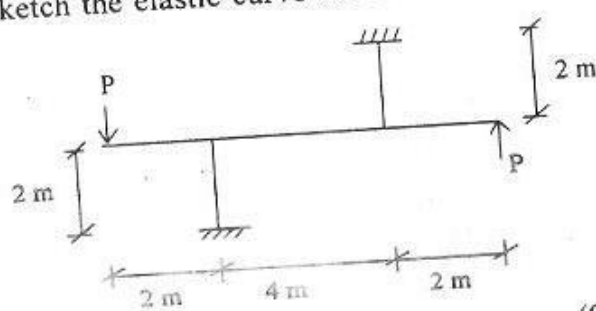   Fe 415 HYSD bars.   4

3   (Contd.)

(i) An aluminium shaft with a constant diameter of 50 mm is loaded by torques applied to gears attached to it as shown in Figure below. Using $G = 28$ GPa, determine the relative angle of twist of gear D relative to gear A.   4

(j) Sketch the elastic curve for the frame as shown.   4

4

(Contd.)

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2. (a) A site is using a concrete where the unit content of water, cement, sand and coarse aggregate is 180 kg/m³, 360 kg/m³, 700 kg/m³ and 1210 kg/m³, respectively. For a portion of the work, the Engineer permits volume batching and rectangular boxes measuring 35 cm by 45 cm have to be fabricated to measure coarse aggregate.

Assume the following :

(i) The mixer available will mix concrete with one bag of cement (of 50 kg) at one time.

(ii) 2 (two) boxes of coarse aggregate will be used in a batch (as defined above).

(iii) When filled in a normal manner, the void content in the box is 40%.

(iv) Specific gravity of the coarse aggregate is 2.75.

Find the height of the box.   10

(b) Corrosion of reinforcement in reinforced concrete construction is matter of serious concern to civil engineers. List and briefly discuss some of the provisions made in codes (such as IS 456-2000) to address this problem during the design and construction of structures likely to be subjected to such deterioration.   10

(c) Write a short answer to the following :   20

(i) When testing cements as per Indian Standards, it may not be possible to decide on their quality only on the basis of the compressive strength results. Why ?

5

(Contd.)

(ii) What are some of the steps that can be taken to prevent the formation of 'thermal cracks' in mass concrete ?

(iii) Explain the concept of 'maturity' of concrete.

(iv) IS 456-2000 suggests use of a certain stress-strain curve of concrete in the absence of actual experimental data. The code also allows use of an expression $(5000 \sqrt{f_{ck}})$ to estimate the modulus of elasticity of concrete (E_c). Draw a neat representation of that curve, briefly explain its salient features. The suggested value represents the value of E at which, if any, of the point(s) on the stress-strain curve.
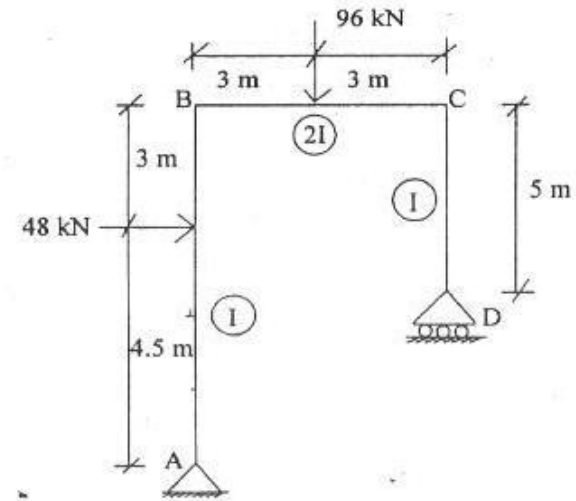
3. (a) Compute the total elongation caused by an axial load of 100 kN applied to a flat bar 20 mm thick, tapering from a width of 120 mm to 40 mm in a length of 10 m as shown in figure. Assume E = 200 GPa.   20

20 mm thick
60 mm
20 mm
20 mm
60 mm
10 m
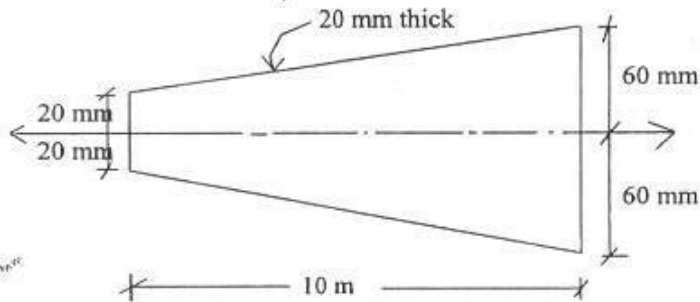
(b) For the rigid frame shown in figure below, find by unit load method, the slopes and deflections at A and C.   20

4. (a) Design a suitable section for steel plate beam girder carrying a uniformly distributed load of 60 kN/m (including self weight) over an effective span of 15 m. Check for shear and deflection also. Use limit state method of design. Use ISWB 600 @ 145.1 kg f/m with $I_{xx} = 106198.5$ cm^4 and $I_{yy} = 4702.5$ cm^4.   20

(b) A 5 m effective span simply supported beam is subjected to a load of 40 kN/m including its self weight. The size of the beam is 250 mm × 500 mm. The beam is reinforced with 4—20 Φ at bottom
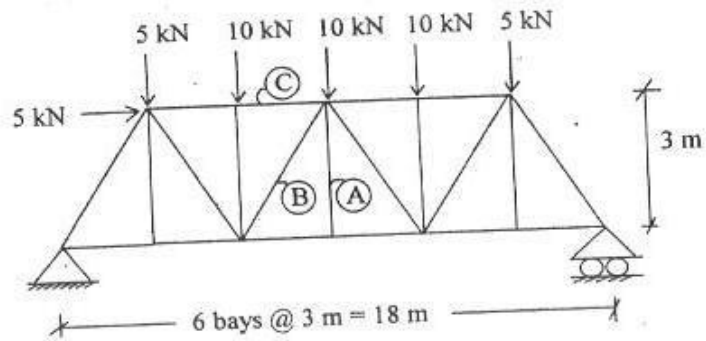
6   (Contd.)

7   (Contd.)

(out of which two bars are curtailed) and 2—12 Φ at top. Design the beam against shear force and show the reinforcement details. Use M20 and Fe415. Use limit state method of design.

% tension steel	0.15	0.25	0.5	0.75	1.0
τ_c (MPa)	0.28	0.36	0.48	0.56	0.62
% tension steel	1.25	1.5	2.0	2.5	3 & above
τ_c (MPa)	0.67	0.72	0.79	0.82	0.82

20

5. (a) Find the member forces in the member marked A, B and C for the truss as shown.   10

5 kN   10 kN   10 kN   10 kN   5 kN

5 kN →

3 m

6 bays @ 3 m = 18 m

(b) A rigid bent ABC is of uniform cross-section and is in a horizontal plane. It is fixed at A and free at C as shown in Fig. It carries two vertical loads

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(Contd.)

10 kN each at B and C. Draw Bending moment, shear force and torsional moment in the bent.

10 kN   10

A ⊗ B

2 m

10 kN ⊗ C

4 m
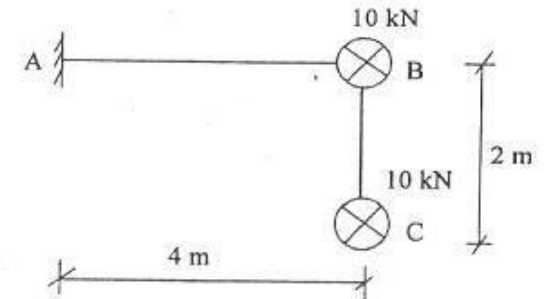
(c) A plate is connected to the flange of an ISMB as shown. The factored load is 100 kN. Find the size of the weld. Assume shop weld and ultimate strength of weld as 410 MPa.   20

100 mm

Pu = 100 kN

60°

300

200
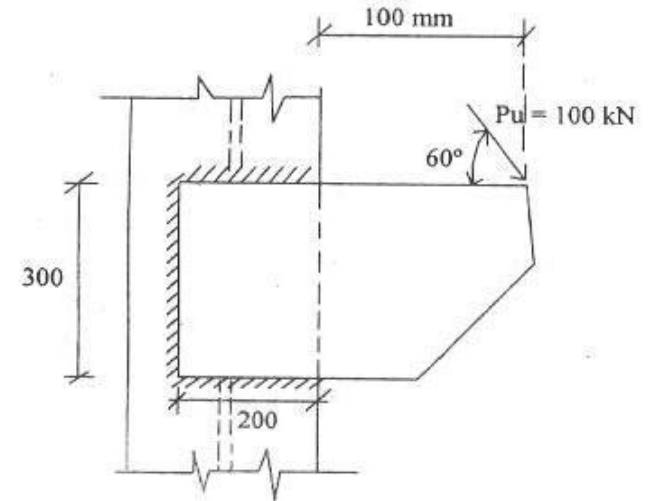
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6. (a) A concrete beam simply supported at both ends with a rectangular section 300 mm × 600 mm is prestressed by 2 post tensioned cables of area 500 mm² each. The cables are located at a constant eccentricity of 100 mm throughout the beam of span 8 m. The cables are stressed to 1600 MPa initially. Calculate the deflection of the beam (maximum) when it carries an imposed load of 20 kN/m allowing 20% loss in prestress. Assume the modulus of elasticity of concrete and steel are 30000 MPa and 2 × 10⁵ MPa respectively. Neglect the effect of shrinkage and creep.   10

(b) Determine the collapse load of the beam as shown below. EI = constant.   10
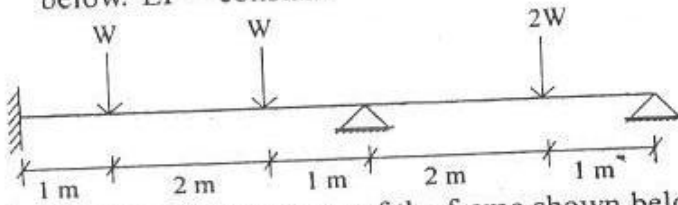
(c) Find the end moments of the frame shown below. Use Moment Distribution method. Also draw BMD.   20
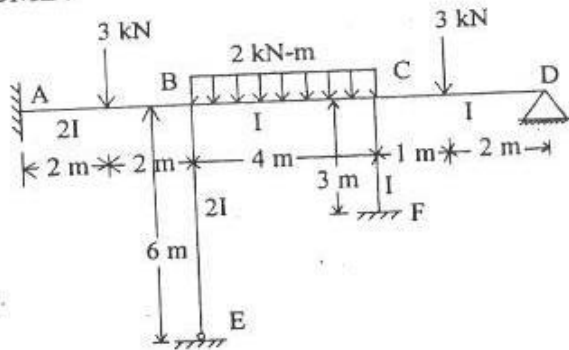
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(Contd.)

7. (a) In a small project, three activities, A, B and C, are on the critical path. Their optimistic, most likely and pessimistic time durations (weeks) is given below :

Activity	Optimistic duration	Most likely duration	Pessimistic duration
A	6	8	11
B	4	6	8
C	11	15	18

Assuming that the non-critical activities are completed within that time :

(i) What is the probability that the project can be completed in 29 weeks ?

(ii) What is the probability that the project can be completed in 27 weeks ?

For a probability of 10%, 20% and 30% the Z values may be taken to be 1.26, 0.84 and 0.53, respectively.   10

(b) Safety precautions to be taken at a construction site are related to the nature of the construction activity. Discuss this statement with appropriate examples.   10

(c) As part of routine quality control, a sample of three cubes is taken from a site using M30 concrete. The cubes are appropriately cured and tested for

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(Contd.)