ESE (Mains), 2019

CIVIL ENGINEERING Paper-I

SECTION 'A'

1. (a) (i) Explain briefly the various tests conducted on Bricks mentioning the relevant codal provisions. 8

(ii) Explain the products of hydration of C_3S and C_2S (Bogues compounds) giving the relevant equations involving the reactions. 4

1. (b) (i) Explain the following defects in timber with neat sketches:
(A) Shakes (B) Knots

(ii) A compound tube consists of a steel tube 150 mm internal diameter and 170 mm external diameter and a brass tube of 170 mm internal diameter and 190 mm external diameter. The two tubes are of the same length. The compound tube carries an axial load of 1000 kN. Find the stresses and the load carried by each tube and the amount it shortens. Length of each tube is 140 mm. Take $\bar{E}$ for steel as 2×10^5 N/mm^2 and for brass as 1×105 N/mm^2. 8

1. (c) (i) On a steel bar specimen of 15 mm diameter and 150 mm gauge length, when tested as a tensile test specimen, a force of 15 kN produces an extension of 0.063 mm. When the specimen of same diameter and same length is tested under torsion, a twisting moment of 6.94 Nm produces an angular twist of 0.15°. Determine the Poisson's ratio of the material of the bar. 4

(ii) Direct stresses of 120 MN/m^2 in tension and 90 MN/m^2 in compression are applied to an elastic material at a certain point on planes at right angles to each other. If the maximum principal stress is not to exceed 150 MN/m^2 in tension, to what shearing stress can the material be subjected? What is then the maximum resulting shearing stress in the material? Also find the magnitude of the other principal stress and its inclination to 120 MN/m^2 stress. 8

1. (d) A beam of uniform cross-section and of length 2L is simply supported by rigid supports at its ends and by an elastic prop at its centre. If the prop deflects by an amount 2 times the load it carries and if the beam carries a total uniformly distributed load of W find the load carried by the prop if EI is constant throughout the length of beam. 12

1. (e) A water main of 1200 mm internal diameter and 12 mm thick is running full. If the bending stress is not to exceed 56 MPa, find the longest span on which the pipe may be freely supported. Steel and water weigh 76.8 kN/m^3 and 10 kN/m^3 respectively. 12

2. (a) (i) How is the presence of surface oxide film responsible for excellent corrosion resistance of Aluminium? 4

(ii) What are the various factors that promote the Alkali Aggregate Reaction? How can this be controlled? 8

(iii) Describe the thermal and electrical properties of ceramics. 8

2. (b) (i) Three vertical rods carry a tensile load of 100 kN. Area of cross-section of each rod is 500 mm^2. Their temperature is raised by 60°C and the load is now so adjusted that they extend equally. Determine the load shared by each. The outer two rods are of steel and the middle one is of brass.

$E_S = 2\ E_B = 210$ GPa. $\alpha_S = 11 \times 10^{-6}$/°C; $\alpha_\beta = 18 \times 10^{-6}$/°C. 12

(ii) A solid steel shaft has to transmit 75 kW at 200 rpm. Taking allowable shear stress as 70 N/mm^2, find suitable diameter for the shaft, if the maximum torque transmitted at each revolution exceeds the mean by 30%. 8

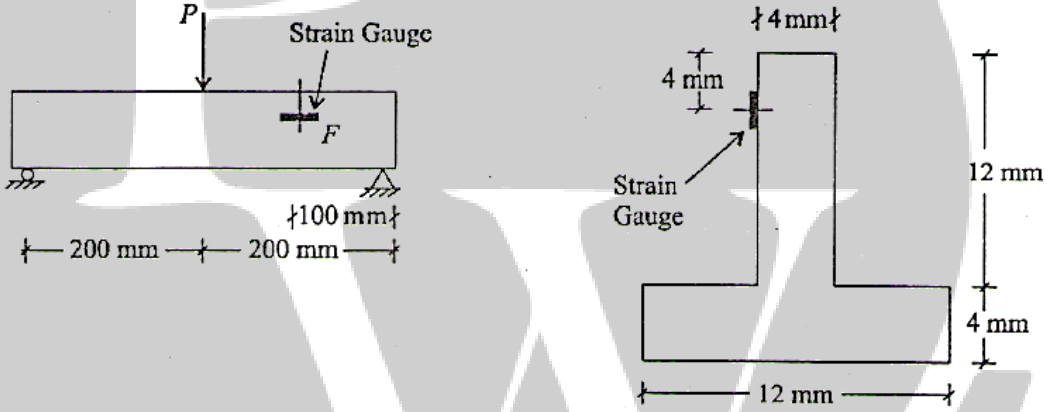
(c) A uniformly distributed load of 40 kN/m and 5 m long crosses a simply supported beam of span 15 from left to right. Draw the influence line diagram for shear force and bending moment at a section 6 m from left end. Use these diagrams to get the maximum shear force and bending moment at this section.

3. (a) (i) Describe the various tests performed to assess the suitability of Lime as a cementing material. 8

(ii) The strength of a sample of fully matured concrete is found to be 50 MPa. Find the strength of identical concrete at the age of 7 days when cured at an average temperature of 25°C during day time and 15°C during the night time. Take constants A and B as 32 and 54 respectively. These are the Plowman's Coefficients for Maturity Equation.

3. (b) (i) What combination of Principal stresses will give the same factor of safety for failure by yielding according to the maximum shear stress theory and distortion energy theory. Consider only a two dimensional case.

(ii)



A small T-section is used in inverted position as a beam and is shown in figure over a span of 400 mm. If due to the application of forces shown, the longitudinal strain gauge at F registers a compressive strain of 1500 microstrains, determine the magnitude of P. Take E = 200 GPa. 10

3. (c) A beam of span L carries a uniformly distributed load @ per unit length on its whole span. It has one simple support at its left end and other support is at a distance of a from the other end. Find the value of a so that the maximum bending moment for the beam is as small as possible. Find also the maximum bending moment for this condition. 20

4. (a) (i) Write briefly about the following:

(A) Air Entraining admixtures

(B) Role of Flyash as a part replacement of cement 10

(ii) Calculate the quantities of ingredients required to produce one cubic metre of structural concrete. The mix is to be used in proportions of 1 part of cement to 1.42 parts of sand to 2.94 parts of 20 mm nominal size crushed coarse aggregate by dry volumes with a w/c ratio of 0·49 (by mass). Assume the bulk densities of cement, sand and coarse aggregate to be 1500, 1700

and 1600 kg/m3 respectively. The percentage of entrained air is 2.0. Take specific gravity of cement, sand and coarse aggregate as 3.15, 2.6 and 2.6 respectively. 10

4. (b) (i) Explain briefly with an example the Acceptance Criteria for Concrete as per IS 456-2000. 8

(ii) Calculate the modulus of rigidity and bulk modulus of a cylindrical bar of diameter 30 mm and of length 2.0 m if the longitudinal strain in a bar during a tensile stress is six times the lateral strain. Find the change in the volume, when the bar is subjected to a hydrostatic pressure of 120 N/mm^2. Take E 1×105 N/mm^2.

4. (c) A suspension cable of 160 m span and 16 m central dip carries a load of $\frac{1}{2}$ KN per linear horizontal metre. Calculate the maximum and minimum tension in the cable. Also find horizontal and vertical forces in each pier under the following alternate conditions:

(i) If the cable passes over the frictionless pulley on the top of the piers.

(ii) If the cable is firmly clamped to saddles carried on frictionless roller on the top of the piers.

In each case the backstay is inclined at 30° to the horizontal. 20

SECTION 'B'

5. (a) In a roof truss, a diagonal consists of an ISA 60 mm × 60 mm x 8 mm (ISA 6060 @ 0.07 kN/m) and it is connected to gusset plate by one leg only by 18 mm diameter rivets in one chain line along the length of the member. Determine tensile strength of the member, if yield stress for steel is 250 MPa. 12

5. (b) Check the adequacy of a HB 450 @ 0.872 kN/m rolled steel beam section for a column to carry an axial load of 1100 kN. The column is 4 m long and restrained in position but not in direction at both ends. Allowable axial stress in compression is 105 MPa. The sectional properties of the given section are as follows:

A = 11114 mm^2, r_{xx} = 187.8 mm, r_{yy} = 51.8 mm. 12

5. (c) A prestressed concrete beam supports an imposed load of 6.5 kN/m over an effective span of 12 m. The beam has a rectangular section of width 250 mm and depth of 700 mm. Find the effective prestressing force in the cable if it is parabolic with an eccentricity of 110 mm at the centre and zero at the ends, for the following conditions:

(i) if the bending effect of the prestressing force is nullified by the imposed load for the mid-span section (neglecting self weight of the beam)

(ii) if the resultant stress due to self-weight, imposed load and prestressing force is zero at the soffit of the beam for the mid-span section. Assume the density of concrete is 24 kN/m^3

12

5. (d) Define the terms activity, event and Net work. 12

5. (e) Find the moment of resistance of a beam 300 × 600 mm deep if it is reinforced with 3 Nos. of 20 mm dia. bars in compression and tension, each at an effective cover of 40 mm. Use M 20 grade concrete and steel grade Fe 415.

Points on stress-strain curve for Fe 415 steel. 12

Stress level	**Fe415 grade**	
	Strain	**Stress (N/mm^2)**
0.80 fy	0.00144	306.7

0.85 fy	0.00163	306.7
0.90 fy	0.00192	324.8
0.95 fy	0.00241	342.8
0.95 fy	0.00276	351.8
1.00 fy	0.00380	360.9

6. (a) (i) What are the various modes of failure for a steel beam? 6

(ii) A pitched roof is to be provided for a workshop of effective span 18 m. The trusses are spaced at 4 m centre to centre and purlins at 1.6 m centre to centre. The pitch of the roof is 28°, weight of the roofing material is 0.162 kN/m, normal wind pressure is 1.2 kN/m^2 and permissible bending stress is 165 MPa. Check the suitability of ISLB 12575 @ 0.119 kN/m section for purlins, if I_{xx}=406.8 cm and I_{yy} = 43.4 cm^4 for given section. 14

6. (b) Design a two way slab for an office room 5.8 m × 4.2 m clear in size if the superimposed load is 4 kN/m^2. Use M 25 grade of concrete and steel grade Fe 415. The bending moment coefficients for two-way slabs simply supported on four sides is given below:

ly/lx	1.0	1.1	1.2	1.3	1.4	1.5	1.75	2.0
ax	0.062	0 .074	0.084	0.093	0.099	0.104	0.113	0.118
ay	0.062	0 .061	0.059	0.055	0.051	0.046	0.037	0.029

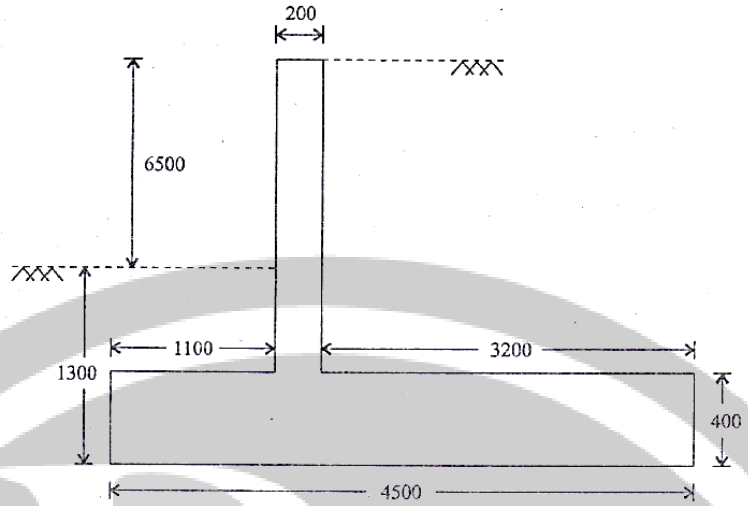
Assume the edges simply supported and the corners not held down. Assume the shape factor for shear k = 1.3.

Design shear strength of concrete of M 25 grade.

100 Ast/bd	τ_c **N/mm^2**
0.25	0.36
0.50	0.49
0.75	0.57
1.00	0.67

6. (c) Briefly explain at least five different types of vibrators used in cement concrete making industry. 20

7. (a) Design the counterforts of a retaining wall to retain earth for a height of 6.5 m above the ground level. The unit weight of soil is 16 kN/m^3 and the angle of repose of soil is 30°. The safe bearing capacity of soil is 180 kN/m^2. Use M 20 grade concrete and steel of grade Fe 415. The cross-section of the retaining wall is given below. The spacing of counterfort is taken as 3.5 m. Assume a cover of 40 mm for counterforts.



All dimensions are in mm.

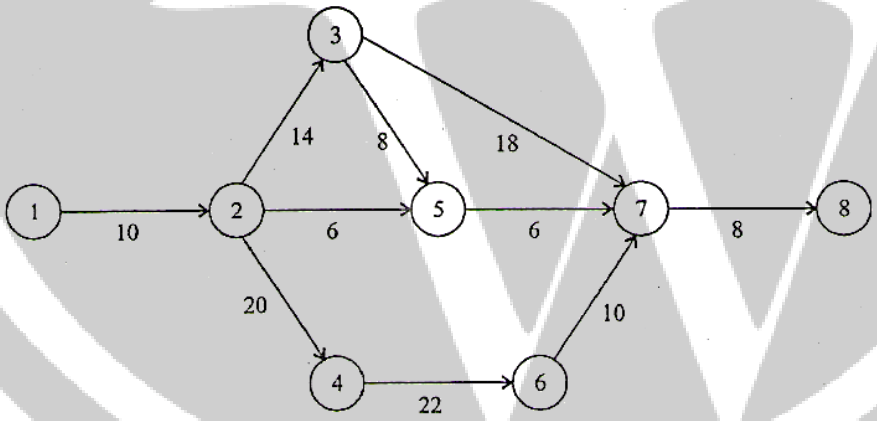
Assume the maximum pressure at toe end is 166.05 kN/m^2 and the minimum pressure at the heel end is 38.92 kN/m^2. Sketch the reinforcement details. 20

7. (b) Design the side walls of an underground tank of size 12 m × 3 m × 3 m deep. The angle of repose of soil is 30°. The density of soil is taken as 17 kN/m^3. Assume the soil is saturated. Use M 25 grade of concrete and Fe 415 grade of steel. Take Q = 1.156 N/mm^2 and J=0·87. 20

7. (c) Explain the different types of contracts adopted in construction. 20

8. (a) Explain major activities involved in different stages of planning for a construction project. 20

8. (b)



Identify the critical path in the network as shown in figure and determine the project completion time. The duration are in weeks.

8. (c) The opening of a masonry building is 3 m and 3.5 m high. The ceiling of the roof is 4.5 m above the floor. The space between top of lintel and bottom of roof is filled with brick masonry. The roof transmits a total load of 25 kN/m run to the lintel. Design the lintel supported on brick walls of width 300 mm. Use M 20 grade concrete and steel grade of Fe 415. Assume the unit weight of the brick masonry is 20 kN/m^3 and that of concrete is 25 kN/m^3. The design shear strength of concrete is given in Table. 20

$\frac{100\,A_S}{bd}$	$\frac{\tau_c\ \mathrm{N/mm^2}}{\mathrm{M20}}$
$\leq$ 0.25	0.36
0.50	0.49
0.75	0.57
1.00	0.67

The design bond stress for M_S bars is given by τ_{bd} = 1.2 N/mm^2 for M 20 grade of concrete. 20

❍ ❍ ❍ ❍