CSM – 18/19

Civil Engineering

Paper – I

Time : 3 hours

Full Marks : 300

The figures in the right-hand margin indicate marks.

Candidates should attempt Q. No. 1 from Section – A and Q. No. 5 from Section – B which are compulsory and any ***three*** *of the remaining questions, selecting at least* ***one*** *from each Section.*

SECTION – A

1. Answer any **three** of the following :

   (a) Distinguish between single reinforced and doubly reinforced RCC beam sections and advantage of a doubly reinforced section. A rectangular RCC beam section of 250mm × 450mm has 3 numbers 20mm diameter bars of Fe415 grade steel as 6.

tension steel. The effective cover to reinforcement is 50mm and M25 grade concrete has been used. Determine whether the beam section is balanced, under reinforced or over reinforced. Calculate the limiting moment carrying capacity of the section. 8+6+6 = 20

(b) Write two advantages of post tensioning over pre tensioning in prestressed concrete. A prestressed concrete beam of 300mm wide and 700mm deep has a span of 10m. The effective prestressing force is 1000 kN at an eccentricity of 150mm. The dead load of the beam is 5 kN/m and it carries a live load of 8 kN/m. Calculate the extreme stresses at mid span of the beam. 6+14 = 20

(c) What is the importance of bonds in brick masonry ? Differentiate between English bond and Flemish bond in brick masonry. Show sketches of each. 6+8+6 = 20

(d) Derive the relation for stresses in a thin walled pressure vessel, where σ_1 and σ_2 are the meridional and hoop stresses respectively, r_1 and r_2 are the corresponding radii. The gauge pressure inside the vessel is p and the thickness of the vessel is t. Determine the normal stress in a basket ball of 240mm diameter and 3mm wall thickness which is inflated to a gauge pressure of 0.62 N/mm^2. 14+6 = 20

2. (a) What are the principal stress and principal strain ? A state of plane stress consists of a tensile stress of 100 MPa along X axis and a tensile stress of 60 MPa along Y axis. There is a shearing stress of 48 MPa. Draw a Mohr's circle and calculate the principal stresses and the principal planes. 8+22 = 30

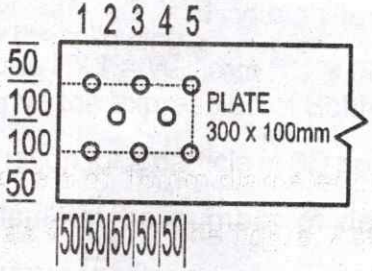
(b) A copper strip (24mm wide × 6mm thick) and an aluminum strip (24mm wide × 6mm thick) are welded together to form a composite bar

of 1.5m long. The bar is bent about a horizontal axis by a couple of 35Nm. Determine the maximum stress developed in the aluminum strip and the copper strip. Draw the variation of stress and strain across the section. 22+8 = 30

3. (a) A portal frame ABCD of span 10m and height 10m is simply supported at A and roller supported at D. It carries a uniformly distributed load of 3 kN/m over BC and 20 kN lateral load at B in the direction of BC. Calculate the deflection and rotation of joint C. The flexural rigidity EI is constant for all members. $E = 2.0 \times 10^5$ N/mm^2 and $I = 400 \times 10^6$ mm^4. Draw the deflected shape, bending moment and shear force diagram. 20+10 = 30

(b) Draw a sketch of a bolted butt joint. What are the ultimate and yield stress of a grade 5.8 bolt ? A plate 300mm wide and 10mm thick is connected to a gusset plate by 8

numbers of 16mm diameter bolts of grade 4.6 as shown in the figure. Assuming bolts are sufficient to carry the load, find the maximum factored load that can be transferred by the plate in tension and efficiency of the joint. Plate is of Fe 410 grade. Dimensions in the figure are in mm. 6+2+22 = 30



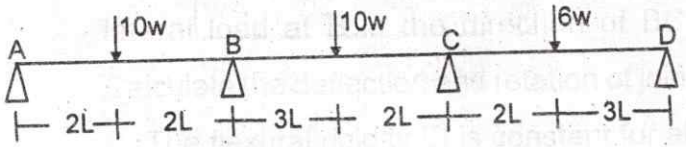
4. (a) Design a rectangular reinforced concrete beam to resist a service moment of 120 kNm from dead loads and 110 kNm from live loads. The beam dimensions are limited to 250mm × 550mm and nominal cover of 25mm with 10mm stirrups. The yield strength of steel is 415 N/mm^2 and characteristic strength of concrete is 20 N/mm^2. The stirrups

are at a distance of 150mm centre to centre. What is the shear strength of this section ?

22+8 = 30

(b) What is a plastic hinge and plastic moment capacity of a section ? Calculate the collapse load for the three span continuous beam as shown below. The beam has constant flexural rigidity. $E = 2 \times 10^5$ N/mm^2 and $I = 200 \times 10^4$ mm^4. W = 1 kN and L = 0.8m.

10+20 = 30



SECTION – B

5. Answer any **three** of the following :

(a) Derive the impulse momentum equation for a fluid in motion. Assume the fluid to be incompressible, inviscid and the flow is steady. Oil of specific gravity 0.9 flows in a pipe 300mm diameter at the rate 120 liters per second and the pressure at a point A is 24.525 kN/m^2. If the point A is 5.2m above

the datum line, calculate the total energy at point A in terms of meters of oil. 12+8 = 20

(b) What is meant by boundary layer in a fluid flow problem ? Distinguish between laminar and turbulent boundary layer. What is separation of boundary layer and how does it affect the fluid flow ? 4+8+8 = 20

(c) Differentiate between compaction and consolidation. A cohesive soil yields a maximum dry density of 1.8 gm/cc at an OMC of 16% during a standard proctor test. If the value of G is 2.65, what is the degree of saturation ? What is the maximum dry density to which it can be compacted further ?

6+14 = 20

(d) What are the different consistency limits of a soil ? The Atterberg limits of a soil sample are $W_L = 50\%$, $W_p = 30\%$, $W_s = 15\%$. If the specimen of this sample shrinks from a volume of $10cm^3$ at liquid limit to $5.94cm^3$ when it is over dried, calculate the shrinkage ratio and specific gravity of the soil.

10+10 = 20

(a) Derive the continuity equation for an incompressible fluid for steady flow condition in rectangular co-ordinate system. A rectangular tank 1.5m wide, 3m long and 1.8m deep contains water to a depth of 1.2m. Find the horizontal acceleration which may be imparted to the tank in the direction of its length so that (i) there is just no spilling of water from the tank and (ii) the front bottom corner of the tank will just be seen. Calculate the forces on the front and back sides of the tank in the first case. 12+10+8 = 30

(b) In an open channel flow, distinguish between sub critical and super critical velocity. How a hydraulic jump is formed and what is the major advantage of a hydraulic jump ? A rectangular channel 7.5m wide has a uniform depth of flow of 2.0m and has a bed slope of 1 in 3000. If due to a weir constructed at the

downstream end of the channel water surface at a section is raised by 0.75m, determine the water surface slope with respect to the horizontal at this section. Assume Manning's $n = 0.02$.

6+6+18 = 30

7. (a) What are the assumptions made in Terzaghi's analysis of bearing capacity of a soil ? Distinguish between general shear failure and local shear failure. Design a strip footing to carry a load of 750 kN/m at a depth of 1.6m in a c-ϕ soil having a unit weight of 18 kN/m^3 and shear strength parameters as $C = 20$ kN/m^2 and $\phi = 25^\circ$. Determine the width of footing, using a factor of safety of 3 against shear failure. Use Terzaghi's relations.

8+8+14 = 30

(b) Explain effective pressure, pore pressure and total pressure in a soil mass. At a construction site, a 3m thick clay layer is followed by a 4m thick gravel layer which is resting on impervious rock. A load of 25 kN/m^2 is applied suddenly at the surface.

The saturated unit weights of the soils are 19 kN/m^2 for clay and 20 kN/m^2 for gravel. The water table is at the surface. Draw the total, effective and pore pressure diagrams.

12+18 = 30

8. (a) What are the assumptions made in Rankine's theory for active earth pressure. Derive relation for active earth pressure on a retaining wall due to a submerged backfill. A retaining wall 4m high has a smooth vertical back. The backfill has a horizontal surface in level with the top of the wall. There is uniformly distributed surcharge load of 36 kN/m^2 intensity over the backfill. The unit weight of the backfill is 18 kN/m^3 and its angle of shearing resistance is 30° and cohesion is zero. Determine the magnitude and point of application of active earth pressure.

6+10+14 = 30

(b) Derive the relation for ultimate bearing capacity of a pile using static formulae for

cohesive soil and non cohesive soil. A group of 9 piles 10m long and 30cm in diameter is used as foundation for a bridge pier. The piles are placed at a spacing of 0.9m center to center. The subsoil consists of clay with unconfined compressive strength of 1.5 kg/cm^2. Determine the efficiency of the pile group neglecting bearing action and an adhesion factor of 0.9. 18+12 = 30